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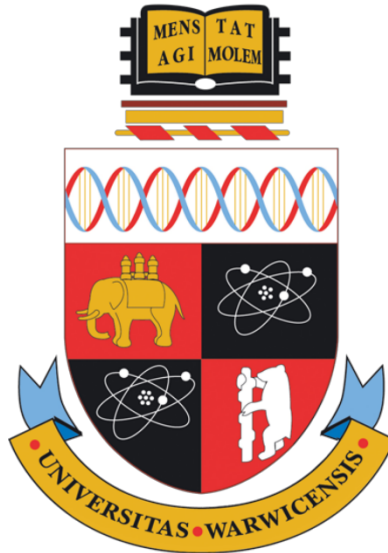
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Behavioural science and financial capability: designing and testing complex
interventions

by
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Thesis

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Declaration

This thesis is submitted to the University of Warwick in support of my application for the degree of Doctor of Philosophy. It has been composed by myself and has not been submitted in any previous application for any degree. The work presented (including data generated and data analysis) was carried out by the author except in the cases outlined below:

- Part of this work (the analysis of formative research, 0) was performed on secondary data from the Money Lives project, commissioned by the Money Advice Service. The presented findings in the chapter are comprised of the additional quantitative analysis. The data was supplied by Ipsos Mori.
- Chapter 6 was conducted in collaboration with Monash University with Dr. Kristian Rotaru, who acted as a secondary researcher in data collection. Dr. Rotaru, recruited participants and supplied the data from the Monash site, but made no contributions to the project design, analysis or thesis.

Outputs from the Thesis

1. Chapter 1 has been accepted as a chapter in the book “A research Agenda for Economic Psychology” (Erich Kirchler, Katharina Gangl), expected publication in 2019).
2. At the time of writing this thesis, it has been at two conference talks; at the Network of Integrate Behavioural Science and the Behavioural Science PhD Research Exchange at the University of Warwick.
3. The project has spun off a grant funding from the Money Advice Service for £248K to support an additional study with University students as well as with a working age adult population (Schmidtke, K., Patel, K., Scharf, S., King, D., Elliot, A. & Vlaev, I. (2017-2018). Using habits and goals to increase people’s financial capabilities. Money Advice Service.)

4. A spin-off project was funded investigating avoidance behaviour in checking bank accounts, in collaboration with Prof. Harmen Oppewal and Dr Kristian Rotaru (Monash Universtiy). The project was funded by the Monash-Warwick Alliance call for \$12,190 (AUD) & £2,393 (GBP).

Abstract

Financial capability is a multifaceted concept that describes the skills and knowledge of managing one's financial resources. This area has seen recent interest in identifying the underlying factors due to the increasing responsibility placed upon consumers. Policy makers typically use financial education to improve financial behaviours (based on economic assumptions), which has demonstrated mixed effects. To develop more reliable methods, the current thesis uses a comprehensive model of behaviour to understand the barriers and facilitators of financial capability, in addition to developing and testing interventions to improve financial capability.

The first chapter provides a conceptual review of financial capability through a behavioural science lens, to understand why greater financial literacy may not translate to optimal financial behaviours. The second chapter details the behavioural framework used in the thesis in greater depth, the third chapter details some of the issues why individuals fail to maintain their goals under the concept of cognitive control.

In the fourth chapter I present secondary analyses of previously conducted formative research identifying several key behavioural mechanisms affecting people's financial capability. Firstly, individuals often fail to keep within their means due to automatic mechanisms to improve their social rank amongst peers. Secondly, individuals often struggle to save for the future due to deficits in more reflective mechanisms, e.g., goal-directedness. I provide a behavioural diagnosis from these findings in chapter five, from which I design and pilot three intervention. The pilot study's findings are then used to inform the design of a randomized control trial.

The sixth chapter details a multi-site randomised-controlled trial. This trial uses Goal-Setting and Habit-Based interventions to improve participants' financial capability, measured via their consumption, account balances, and savings. The Goal-Setting group demonstrated significant improvements across all three measures. In contrast, the Habit-Based group improved only in their account balances compared to the Control group.

The seventh chapter examines the moderating effects of individual differences which have been previously demonstrated to account for variations in consumption and savings. These results demonstrate that higher levels of goal-directedness can improve reductions in monetary consumption.

Abbreviations

APEASE	A framework for policy and intervention evaluation
ASVAB	Armed Services Vocational Aptitude Battery
ATM	Automated Teller Machine
BCT's	Behavioural Change Techniques
BMI	Body Mass Index
COMB	A framework model of human behaviour
ELSA	English Longitudinal Study of Aging
FCA	Financial Conduct Authority
IQ	Intelligence Quotient
ISLAGIATT	It Seemed Like A Good Idea At The Time
LCD	Liquid Crystal Display
M	Mean
MINDSPACE	A mnemonic of commonly used behavioural mechanisms
MRC	Medical Research Council
OCD	Obsessive Compulsive Disorder
PIT	Pavlovian Instrumental Transfer
RAM	Random Access Memory
RCT	Randomised-controlled trial
SD	Standard Deviation
SSRT	Stop Signal Reaction Time
UK	United Kingdom
UPPS	Lack of Urgency, Perseverance, Premeditation and Sensation Seeking scale

Chapter 1 Aetiology of household financial behaviour

SUMMARY

- Household and individual financial behaviour relate to how an individual consumes and retains their financial resources.
- Sub-optimal consumption and savings are characterised as reduced financial capability, which is an umbrella term that denotes the behavioural and psychological requirements to making financially sound decisions.
- Educational endorsements are still used as a method of interventional policy to promote financial capability, however, educational policies may not necessarily produce desired outcomes. This may be due to how behaviour is understood generally and the assumptions made by financial capability.
- The COM-B model is a model to characterise and diagnose the components that lead to a given behaviour. The COM-B model is primarily utilised in healthcare but the principles hold for financial capability and provide a more overarching model of the underlying factors and causes behind sub-optimal financial capability.
- Individual differences in financial capability can identify and characterise motivational and psychological underpinnings that can lead to and predict sub-optimal financial capability, and can identify at-risk individuals requiring intervention.

1.1 What is household financial and saving behaviour?

Household financial behaviour describes how people, at the individual or familial level, use financial instruments and products to reach their objectives (Guiso & Sodini, 2013). Household financial behaviour relates to the consumption of financial resources and the extent to which financial resources can be retained. Understanding household financial behaviour is important because individuals are increasingly asked to take more direct responsibility for their financial future. For instance, people in the United Kingdom (UK) are now making more decisions about their retirement funds due to the shift from Direct Benefit pension schemes to Direct Contribution schemes (Lusardi, 2008). This shift in responsibility has meant that individuals are now required to reduce their financial consumption to set aside disposable income.

Much like how an individual's physical and psychological well-being can fluctuate (becoming positive or negative), financial well-being can too, resulting in either excess or deficits in financial resources. One's financial state can be captured by examining the difference between one's income (wages, net property income, investments etc) and monetary consumption (expenditures on goods and services). Where monetary consumption exceeds income, an individual is spending more than they can afford to, and begin to incur debt. When income exceeds monetary consumption, an individual has more money than they can spend and therefore accumulate disposable income or more commonly referred to as 'savings'. An individual's savings amount captures the difference between their income and monetary consumption, where increasing savings can be driven by either increasing one's income, or decreasing one's monetary consumption.

In the current financial state of the UK, households are suffering from increased financial pressure, with rising debt and stalling income (Aviva, 2017). As a result, those in the middle and lower income brackets are starting to feel financially squeezed. A recent report from The Money Advice Service reveals that around 25% of the UK population, i.e., approximately 12.7 million people, fall under this category (Money Advice Service, 2016). The report also revealed that the mean amount of disposable income of financially-squeezed individuals rests at around £600 at any point in time. Approximately 3.2 million people have no disposable income at all. Notably, managing finances is often more difficult for these individuals than wealthier people, as one unexpected bill can lead to

turmoil when there is insufficient disposable income at hand. For instance, financially squeezed individuals often accept payday loans to cope with their financial situations. These loans feature astronomical annual percentage rates of charge (Bertrand & Morse, 2011; Bhutta, 2014; Stegman & Faris, 2003), which have been shown to leave consumers in a worse financial state (Financial Conduct Authority, 2015).

Individual and household saving behaviour (that is the behaviour of an individual or household trying to optimise the difference between their income and consumption) cannot be captured in raw values alone. Consider trying to compare the financial state of two individuals - it is difficult to take their savings at face value, as this does not account for differences in their income or monetary consumption. These two individuals could show identical savings, but one individual's income may be twice that of the other's; or one's consumption may be half that of the other's. Comparing raw, absolute savings gives a misleading picture and may distort the saving ability of households and individuals. The absolute values of savings must take into account income to portray a propensity to save, comparable across individuals. This is termed the 'savings ratio'. The savings ratio is the ratio of disposable income as a fraction of total income. Savings ratio is calculated by expressing the amount of savings as a proportion of income, standardising this across individuals, making it possible to compare how well individuals save. Calculating 'savings' and 'savings ratio' permits the analysis of an individual's or the public's financial well-being.

We can exemplify the savings ratio by examining the current savings ratio across the UK, where the level of savings has fallen to their lowest level since 2005. In 2017 the savings ratio was 4.9% (Chu, 2018). This value denotes that the average household only saved 4.9% of the average household income.

To help individuals move to a stable financial position, one must first understand and identify the determinants behind optimal financial behaviour. Over the last decade, there has been considerable interest on the determinants behind implementing and maintaining optimal financial behaviour (Atkinson, McKay, Collard, & Kempson, 2007; Dolan, Elliott, Metcalfe, & Vlaev, 2012; Drever et al., 2015; Elliott, Dolan, Vlaev, Adriaenssens, & Metcalfe, 2010; Gale & Levine, 2011; Mason & Wilson, 2000; Money Advice Service, 2014). Implementing and maintaining optimal financial behaviour is often referred to as being financially capable (Money Advice Service, 2014). The term 'financial capability' is now commonly used and has gathered considerable interest in the

last few years. For instance, a Financial Capability week was established in the UK recently.

1.2 Financial capability

The term ‘financial capability’ describes the skills, knowledge, attitudes and behaviours underlying well-informed choices to manage financial resources (Arnold & Rhyne, 2016; Atkinson et al., 2007; Mader, 2018; Mason & Wilson, 2000). Financial capability conceptualises what people know and can do in relation to financial services available to them (Caplan & Sherraden, 2018). People who manage their money more effectively are more ‘financially capable’ (Drever et al., 2015). In recent times, people are likely to require greater financial capability than in the past, in part resulting from factors like higher life expectancy, the shift towards Direct Contribution pension schemes, as well as the higher cost of education. In this financial climate, those who feel financially squeezed, with a narrowly greater income than consumption, must be financially capable to live well. By understanding what makes people financially capable, mechanisms can be identified and interventions can be designed and implemented to aid those in financial struggle. For this, we need to understand and explain financial capability.

Financial capability is often conceptualised from three behavioural components (Arnold & Rhyne, 2016; Mader, 2018; Money Advice Service, 2014). The first component is ‘Keeping track’ which denotes the abilities and skills behind monitoring one’s accounts. This involves, understanding the flow of finances, knowing the available account balance and understanding available financial products. The second component is ‘Making-ends-meet’ which denotes the abilities and skills to remain within ones constraints of income. The third component is ‘Planning ahead’ which describes the skills and abilities required to consider future events and plan for them.

1.2.1 Will financial education improve financial capability?

In order to produce interventions to increase people’s financial capability, interventionists need to understand the barriers and facilitators¹ of optimal financial behaviours. Such barriers and facilitators are often called behavioural mechanisms.

¹ Facilitators and enablers are used interchangeably throughout the thesis to denote the behavioural mechanisms that lead to optimal behaviour.

From a rational perspective, individuals may not make the best choices or decisions because of incorrect assumptions or beliefs. Put simply, the information that individuals are using is biased or inaccurate. Therefore, common-sense approaches to behaviour change assume that individuals do not possess the adequate information to make the optimal choice. For instance, it is difficult for anyone to save optimally, if they do not understand the different financial products, or even how to invest. From this conceptual standpoint, the ideal intervention approach would be to disseminate financial information to educate individuals.

Financial education² is already a common intervention approach, that has even been applied as policy intervention (Brown, van der Klaauw, Wen, & Zafar, 2013; Bruhn, Legovini, Zia, Leão, & Marchetti, 2014; Fernandes, Lynch, & Netemeyer, 2014). In this section we document the efficacy of educational approaches to increase financial knowledge to improve financial capability. Financial education can be assessed through comparison of financial literacy scores between individuals who attend financial courses and individuals who do not attend (through regression analysis). This can be done through experimental methods, either through randomised-controlled trials (where participants are randomly allocated to receive the educational training or not), or through quasi-experimental methods in which the allocation is not random but self-selected.

To determine if education increases financial capability, Gale and Levine (2011) reviewed previous evidence from financial education seminars and courses, and identified that improving financial education improves financial savings (Bernheim & Garrett, 2003; Lusardi, 2002). The researchers identified spill-over effects across an agent's social network and across society in general. Gale and Levine's finding is further supported by Hilgert, Hogarth and Beverly (2003), who showed that better financial practices were associated with higher financial knowledge scores.

In another line of research, Gutter, Garrison and Copur (2010) sought to see if different United States (US) State-level legislation affected students' financial behaviours differently. To do so, they conducted a quasi-experimental study, where they collected data on over 1500 college students' financial literacy, dispositions and behaviours. The researchers noted that states where there were more social-learning opportunities (i.e. learning from other people's behaviour), were associated with higher

² Financial education is operationalised as financial literacy (Huston, 2010), in the literature these two terms are used interchangeably.

levels of financial capability. They found students who received education were more likely to save, budget their finances and avoid risky credit behaviour. This was corroborated by the National Council on Economic Education (2007), which found that US states that offered mandatory, assessed financial education courses in their high schools created more students that budgeted, saved and avoided risky credit.

In a similar line of research, Brown, van der Klaauw, Wen and Zafar (2013) compared recent high school students' credit scores and debt delinquency rates from US States with and without mandated high-school financial education over 10 years. States that mandated such education, showed improved credit scores and reduced default rates, whilst states without mandated education demonstrated no significant change.

Further positive effects of lower cost educational interventions are demonstrated by Walstad, Rebeck and MacDonald (2010). This research found that a DVD-based financial education course led to significant improvements in financial knowledge; a finding further corroborated by Harter and Harter (2007).

Outside the US, Bruhn, Legovini, Zia, Leão and Marchetti (2014) conducted a large-scale assessment in 868 schools in Brazil, with approximately 20,000 students to examine the impact of financial education courses on financial capability. The study used a randomised-controlled trial to identify causal links between financial education and financial capability. The researchers noted that students who enrolled in the course went on to report an approximate 2.3% decrease in monetary consumption, and 1.4% increase in monetary savings, when compared to students who did not attend the course.

The benefits of financial education extend from students to adult populations. For example, Bayer, Bernheim and Scholz (2009) found that employer-offered retirement seminars promote pension participation and contribution rates. The effect is even greater for employees who are not at the higher-end of the salary range. This may be due to a larger proportion of employees at the lower end of the salary range attending the seminars compared to those at the higher end.

In summary, the above studies show financial education can promote financial capability. These insights demonstrate the effects of limited financial education and its impact upon household behaviour. Financial knowledge can be considered a precursor to financial behaviour where knowledge structures offer a better behavioural policy to reach one's financial goals.

1.2.2 The limits of education

Some leading experts disagree on the success of financial education programmes, with some research demonstrating little to no change in behaviour as a result of financial education. (Adams & Rau, 2011; Collins & O'Rourke, 2010; Hastings, Madrian, & Skimmyhorn, 2013; Hira, 2010; Thaler & Sunstein, 2008; Willis, 2009). These results raise concerns that educational approaches do not improve household financial behaviour. These concerns can be considered in two domains; methodological and conceptual or intellectual concerns. The following findings presented do not evaluate the previous studies given in section 1.2.1, but present general concerns.

First, let us consider the methodological issues in examining financial education policies as a means to improve financial capability. One issue is the operationalisation of measuring financial behaviour. Measuring financial behaviour requires either the use of objective measures of finances, such as bank account records or consumption-level data; or the use of self-report measures where participants declare their consumption, saving and financial behaviours. Objective measures offer high reliability and validity, but data is often expensive and time-consuming to collect; whilst data from self-report methods is quick and easy to collect, but can be questionable in its validity.

Many of the studies that investigate financial behaviour are more inclined to use survey methods for respondents to self-report financial behaviour, usually due to the large-scale samples employed (Brown et al., 2013; Bruhn et al., 2014; Gutter et al., 2010; Walstad et al., 2010). Self-reported measures are highly susceptible to numerous biases, predominantly social desirability effects (Van de Mortel, 2008) or even demand characteristics (Nichols & Maner, 2008). A study by Collins (2013) highlighted differences between data collected from the same participants using objective methods versus self-report methods. This study used a pre/post randomised-controlled trial, in which clients were randomised to attend a financial education course for twelve months. Collins used objective measures of financial data (checking and saving account balances) as well as a purpose designed self-report measure, which used categorical responses to questions such as "How much would you estimate you and your spouse/partner have in combined total savings and investments?". Collins found a greater effect of financial education for self-reported compared to objective measures, which highlights the social desirability issue, where people are more likely to declare a greater income when they do not have to prove them objectively. A social desirability bias could inflate the efficacy

of financial education studies that use self-report methods to measure financial behaviours.

A second limitation is that research is largely quasi-experimental in the sense that participants are not randomly allocated to groups (Hastings et al., 2013). Numerous quasi-experiments identify a positive association between financial education and financial capability (Bayer et al., 2009; Meier & Sprenger, 2008). The problem with using a quasi- vs truly randomised-experimental design is the potential for extraneous factors or the selection of participants to explain the findings independent of the intervention. As an example of an extraneous factor being a problem, research found financial education does improve financial savings, but when accounting for US state differences, the effects of education are diminished (Cole & Shastry, 2010). In other words, financial capability was not caused by the effects of state policy in financial education courses. For instance, examining the results of some of the research presented in the previous section (Bayer et al., 2009; Brown et al., 2013; Gutter et al., 2010), it is difficult to discriminate between the positive effects of financial education against any self-selection mechanisms that may lead more financially motivated individuals to sign up to such courses. Therefore one should be careful in drawing causal links between financial education and financial behaviour.

Compared to quasi-experimental studies, truly randomised-experimental trials have shown limited benefits in financial education. For instance, one study (Gartner & Todd, 2005), randomized first year college students to receive credit education. They found no statistical difference in participants' saving behaviour or timeliness of payments post intervention. Similar findings were demonstrated by Servon and Kaestner (2008) as well as Choi, Laibson and Madrian (2011). Quasi-experimental research does not provide causal links between financial education and financial capability, but does identify a relationship between the two concepts. Randomised-controlled trials identify small causal effects, suggesting that financial education is a causal factor but may not be the sole factor in financial capability. This is further epitomised in the research conducted by Fernandes et al. (2014) which found that studies that manipulated and randomised financial education attendance explained 0.06% to 0.12% of the variance for low income and general populations respectively. When measuring financial education there is a sharp rise to 1.27% and 1.80% of explained variance for low income and general

populations respectively. This difference highlights the concern of translating financial education into change in financial behaviours.

Conceptual concerns identify that the evidence for financial education is not coherent, and research demonstrates mixed results. For instance, Choi, Laibson, Madrian and Metrick (2002) measured the effectiveness of employee seminars. The researchers found that 14% of those attending seminars joined the savings plan, compared to 7% of individuals who did not attend seminars, despite all employees stating an intention to save. Such empirical evidence identifies that although a diminished literacy can affect financial behaviour, much more needs to be done to improve financial capability (Drever et al., 2015). A meta-review was conducted by Fernandes, Lynch and Netemeyer (2014) included over 200 studies investigating the effects of financial education on financial behaviours. The researchers found that financial education only accounted for 0.1% of the variance in financial behaviour. This extremely small explanatory power does raise concerns over the assumed benefit of financial education. This finding was further corroborated by Mandell (2008) who examined the effects of different financial education courses between 1997 and 2006 and found that there was no difference between the financial capability of people after having taken the course to those who never took the course. These results suggest that financial education (measured through financial literacy) is a factor in financial capability, but the intervention approach of providing financial education does not produce a financially capable cohort. This would perhaps suggest that there is something wrong with the underlying factor(s) involved in the lack of financial capability. We can draw from similar findings by looking at the role of education approaches in public health, which demonstrates that education methods increase knowledge but do not actively change behaviour (McCluskey & Lovarini, 2005).

These results highlight a lack of consensus in the effects of financial education, however, one should not completely discount financial education approaches. Some research has identified significant outcomes from financial education (Bayer et al., 2009; Brown et al., 2013; Bruhn et al., 2014; Gutter et al., 2010; Harter & Harter, 2007; Walstad et al., 2010), and we cannot discount the idea that people do require this information. These findings collated together identify a need for a more nuanced understanding of how financial education leads to financial capability.

1.2.3 What does financial education miss?

The mixed results from research exploring financial education as a means to improve financial behaviour, suggests that financial education is not the only factor and therefore its effects may be mitigated by one of multiple other factors required for behaviour change, the goal of policy implementation.

Behaviour change is inherently a multi-factorial process (Michie et al., 2013). Financial education is an inherent factor in financial capability but is not the sole factor. The distinction here is to separate the capacity to conduct a behaviour or action from the knowledge processes behind the behaviour. Put succinctly, just because an individual has the capacity to be financially literate does not guarantee improving their financial literacy will enhance their financial capability. Conversely an individual who is financially capable is not necessarily always financially literate.

Consider financial education like information in a computer. For the computer to produce any sort of output it must have the software and hardware capable of processing the information. Much like a computer, behaviour requires more than just information. The behaviour is an output of the individual. Therefore, to be capable of producing the desired behaviour, the individual must have all the necessary components required to produce the behaviour.

First, it is important to understand what is meant by capability. ‘Capability’ is defined as ‘the power or ability to do something’ (Michie, Van Stralen, & West, 2011). This definition demonstrates that capability relates to every component of a specific behaviour: psychological, physiological, and environmental. Capability includes the relevant knowledge and skills behind an action, but also includes the physical resources giving a person or a collective the ability to undertake a particular kind of behaviour. In summary, ‘capability’, or what defines a ‘capable person’, includes all the necessary and sufficient attributes that make it possible for an agent to execute a given action.

For instance, consider the example of catching a ball. It is not enough for an individual to understand how to catch the ball, or even be motivated to do so. The individual must be able to fulfil additional requirements, such as being able to view and identify the ball, and then pronate and contract their arms and cup their hands to catch it. These factors are physiological in nature and are mandatory to execute the behaviour. In addition, the individual must be able to compute the speed of the ball, its distance and trajectory. They must then move themselves to an approximate location that will intersect

with the ball's trajectory. All of the above components are necessary to catch a ball. Whilst skill training and practice will assist, if the agent's own physiology is unable to meet the demands of the task then they are incapable. This distinction is important for intervention and policy considerations. Similarly, within the financial setting, a consumer may possess great financial knowledge but lack the self-control and will power to avoid lavish expenditure. As such, this individual may end up living outside of their means, and would therefore not fit under the definition of being financially capable.

An additional issue with the financial education approach is the conceptual, underlying theoretical base that is being adopted, characterised by a lack of a psychological theory base. Behavioural economics and behavioural science can provide a unique insight into financial capability, by taking into account psychological constructs of behaviour and cognition, alongside economic theories of financial behaviour. In classical economics, economists are often concerned with the normative theory of how people should behave (McQuillin & Sugden, 2012), where sub-optimal behaviour is often regarded as irrational. However, a strongly grounded theoretical base can dramatically improve outcomes by utilising behavioural mechanisms to translate some theory of behaviour change into practice. For instance Karlan, McConnell, Mullainathan and Zinman (2010) utilised a behavioural economic approach grounded in theories of sub-optimal self-control. This allowed the researchers to integrate and suggest a model of behaviour that could codify interventional policies to be tested. The researchers ran a randomised-controlled trial in which individuals were randomised to a control or treatment group where they were sent SMS (short message service) messages through mobile phone channels to remind them to save. The researchers demonstrated the positive effects of SMS messages across three field experiments promoting savings behaviour in the Philippines. The results showed that those in the treatment arm produced a 6% improvement in savings, with a 3% increase in individuals reaching their savings goal, compared to the control group. In addition, account balances were shown to increase by 47% for those in the treatment group compared to the control.

In fact, empirical studies that utilise theoretically informed behavioural mechanisms, were more beneficial than financial education alone (Doi, McKenzie, & Zia, 2013; Hershey, Jacobs-Lawson, McArdle, & Hamagami, 2007; Howlett, Kees, & Kemp, 2008; Stawski, Hershey, & Jacobs-Lawson, 2007). The skills and knowledge educational interventions alone can promote may be insufficient to change behaviour. Other factors,

such as internal motivations and external opportunities to change people's behaviour should also be considered. (Dolan, Hallsworth, et al., 2012b; Dolan, Elliott, Metcalfe, & Vlaev, 2012a; Michie, Atkins, & West, 2014).

Theoretically informed interventions and policies provide a more coherent framework to translate hypotheses about behaviour into action. The term to denote a non-systematic, non-comprehensive approach to designing interventions is often referred to as an ISLAGIATT or "It Seemed Like A Good Idea At The Time" (Atkins & Michie, 2015). Here we should distinguish between conceptual and methodological dimensions. Within the conceptual sphere, ISLAGIATT's refer to common-sense models as opposed to a theory-driven approach. In this sense interventionists do not systematically understand or examine the underlying concepts driving the behaviour. In the methodological sphere, interventionists use intervention approaches based on what they assume to work, rather than a systematic approach based on identified determinants. A systematic, comprehensive approach pushes for interventionists to understand and diagnose the behavioural problem and then devise approaches that best fit given certain parameters.

Household finance policy can draw upon the health-care sector in their implementation of behavioural interventions and policy design. The health care sector is constantly pushing and setting the normative ideals of intervention design. For instance, take the Medical Research Council's (MRC) guidance on intervention design which underwent successive reviews and changes (Campbell et al., 2000; Craig et al., 2008; Moore et al., 2015). The MRC approach identifies the necessity in drawing upon a solid theoretical and empirical evidence base to justify the behavioural mechanisms and treatment effects put in place within a policy or intervention. This MRC guidance has been cited over 8000 times, which further supports the usefulness of this approach. Policy-makers and researchers within the finance sector can learn from the MRC guidance to improve the outcomes of their intended treatment effects through solid basis of psychological and behaviourally grounded theories.

A broader, more useful conceptual mapping of financial capability is required. This will provide a more valid understanding of financial capability, through a behavioural lens. This notion will put forward the idea that the way people manage their money, and their financial behaviour in general, are subject to the same wide range of influences, as other human behaviour. This presents a broader picture of the factors influencing

financial capability, based on a model of behaviour, which goes beyond skills and knowledge. As a result, financial advisory services, should be employing such interventions as new services for a greater benefit to its users. This can be captured by the UK financial capability week in the United Kingdom, which puts forward a behavioural approach to achieving financial capability.

1.3 Understanding and changing behaviour

An existing model of behaviour to help interventionists understand how to influence behaviour is called the COM-B model (Fishbein, Triandis, Kanfer, Becker, & Middlestadt, 2001; Michie, Van Stralen, et al., 2011), which is based upon scientific evidence stemming across multiple fields of human and animal behaviour (Michie et al., 2014). The COM-B model is one of the most cited models used by interventionists and policy-makers, cited over 2000 times. COM-B is an acronym describing specific components that generate behaviour. The COM-B model consists of Capabilities, Opportunities and Motivations, which interact to generate Behaviour. The term ‘behaviour’ refers to a specific behaviour one wishes to change. In the current manuscript the term ‘behaviour’ is meant to capture people’s financial capabilities (for more information on COM-B see Chapter 2).

Before advancing, please note that the COM-B model was developed independently from the financial capability literature, and so some confusion may arise due to the overlapping use of the word ‘capability.’ Within the COM-B model, capability denotes people’s physical and psychological capacity related to a behaviour. In the following section, I present determinants of financial capability, specifically savings behaviour, modelled through the COM-B model. These examples are not exhaustive but sought to capture a sufficient number of determinants to illustrate the complexity in behaviour change for improving financial capability.

1.3.1 Capability

The first factor of determinants for financial capability is ‘Capability’ which refers to the psychological and physical affordance of enacting the behaviour (Michie et al., 2014). Capability has multiple factors and it would be impossible to review all factors below. Some examples of different factors are provided to exemplify how multiple determinants

exist for household financial behaviour. This is not an exhaustive list and there are likely many other factors contributing to an individual's capability.

1.3.1.1 Physical Capability – Genetics and Intelligence Quotient (IQ)

Genetics are likely to play a role in the variation of people's savings. Genetic variation may play a large role in savings behaviour by modulating income and risk preferences (Cesarini, Johannesson, Lichtenstein, Sandewall, & Wallace, 2009), which can account for approximately 25% of risky financial decision making. These genetic predispositions can have demonstrative effects on savings and therefore can influence individuals' savings behaviour. A study which assessed the genetic component of savings behaviour in 14,930 twin pairs in Sweden found that 32-40% of the variance in savings was explained by genetic factors (Cronqvist & Siegel, 2015).

These genetic variations also play a role in income. One study by Taubman (1976) with a sample set of 4068 twins in the United States, found that genetic factors account for up to 50% of the income. As income is a prerequisite for savings, these genetic propensities have a knock-on effect in savings behaviour.

Research into intelligence has demonstrated that IQ has influencing effects on savings (Zagorsky, 2007). Researchers found that IQ raised income and consequently savings rates by over \$300 per year even with other factors remaining constant. However, the researchers also noted a non-linear relationship between IQ and financial stress, suggesting that though IQ can improve income and financial savings, it can also negatively impact financial health.

1.3.1.2 Psychological Capability - Parental behaviour

Parental behaviour may also play a role in financial behaviour, with people learning financial savings behaviour through modelling their parent's behaviour (Cronqvist & Siegel, 2015). Anecdotal evidence identifies that parents do generate some form of influence in their children's saving propensity, by providing weekly allowances, opening savings accounts and even providing tools such as piggy banks (Bisin & Verdier, 2005; Cavalli-Sforza & Feldman, 1981).

Charles and Hurst (2003) examined a panel-dataset of over 1500 parent-child respondents. This demonstrated substantial parental-child intergeneration similarities in savings, where age controlled models revealed that parental influences account for 5-

25% of the variance in savings behaviour. One of the issues of social behaviours, especially when clustered at the familial level, is that separating genetic from environmental factors is often almost impossible to do. However, investigation by Taubman (1976) demonstrated that familial environment accounts for 4-18% of the variance in income whilst controlling for other variables such as age, gender and genetics.

1.3.1.3 Psychological Capability - Knowledge

Please see section 1.2.1 to see how financial education has been shown to improve financial behaviours.

1.3.1.4 Psychological Capability - Literacy

Research has shown that the numerical literacy, i.e. one's numerical ability, is important in financial behaviours (Banks & Oldfield, 2007a; Gerardi, Goette, & Meier, 2013; Rowell & Bregant, 2012). For instance, one study identified that individuals with greater numerical ability are less likely to default on mortgage repayments (Gerardi et al., 2013). A second study identified that numeracy levels were strongly correlated with measures of retirement savings and investment portfolios, even when controlling for factors such as education (Banks & Oldfield, 2007a).

1.3.2 Motivational Factors

The motivational component of people's financial capabilities may be affected by their levels of extraversion, impulsivity, intentions, executive function, sense of control and opportunity. Each factor is reviewed below.

1.3.2.1 Extraversion

Extraversion, which is one of the big five personality traits (conscientiousness, agreeableness, neuroticism, extraversion and openness-to-experience), could be linked to savings behaviour. Extraversion is characterised as being associated with social potency and a heightened sensitivity for potential rewards (Elliot & Thrash, 2002; Lucas, Diener, Grob, Suh, & Shao, 2000). This psychological underpinning could affect an individual mindset by motivating more rewarding purchases leading to over-consumption. This is what Hirsh (2014) found when examining extraversion at three levels. The individual

over time level showed a decrease in savings for each unit of extraversion ($r(21) = -.50$). The state-level showed higher levels of extraversion were associated with lower savings ($r(45) = -.29$). Finally, the macro-level demonstrated again, a significant negative association of extraversion and savings amounts ($r(48) = -.29$).

1.3.2.2 Impulsivity/Self-control

Impulsivity is a multi-factorial construct, which is often characterised as the tendency to act without regard for consequences (Kulendran, Patel, Darzi, & Vlaev, 2016). There are multiple facets of impulsive behaviour that could potentially affect savings, where impulsive individuals find it difficult to inhibit automatic or dominant behaviours and intrusive thoughts (Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006; Kulendran et al., 2016). For example, an individual in the checkout line at a supermarket may see a bar of chocolate and feel an impulse to buy it. An impulsive individual would struggle to overcome that impulse and would therefore be more likely to purchase the chocolate bar (Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010a). Impulsive individuals also show a propensity for reward maximisation (Murray et al., 2014), which could reinforce impulsive behaviours further.

Impulsivity has been shown to influence savings through high levels of monetary consumption. Researchers have demonstrated that impulsivity is predictive of compulsive buying (Desarbo & Edwards, 1996; Lejoyeux, Arbaretaz, McLoughlin, & Ades, 2002) as measured through trait impulsivity scales such as Zuckerman's sensation-seeking scale. A result further demonstrated by Billieux, Rochat, Rebetz and Van der Linden (2008) who found that compulsive buying correlated with the UPPS's subscales (Whiteside & Lynam, 2001) of lack of urgency, lack of premeditation and lack of perseverance.

One study examined self-control by examining consumption reduction techniques in a sample household panel survey (Rabinovich & Webley, 2007). The researchers found that techniques that sought to improve self-control, such as implementation intentions, as well as formulating goals and plans improved savings rates. A measure of self-control that is regularly used are temporal discounting tasks that assess preferences of immediate smaller rewards against delayed larger rewards. This discounting index has been used extensively in addiction and obesity studies (Bickel et al., 2007; Coskunpinar, Dir, &

Cyders, 2013; Kulendran et al., 2013, 2016; Zhu, Cortes, Mathur, Tomasi, & Momenan, 2015).

Temporal discounting could perhaps impede savings rates by moderating monetary consumption through the policy of maximising immediate rewards. Research by Ersner-Hershfield, Tess Garton, Ballard, Samanez-Larkin and Knutson (2009) showed a relationship between temporal discounting rates and savings rates. The researchers asked participants to complete a self-continuity task, to assess how they see themselves in the future vs now; participants also completed a temporal discounting task and a self-report packet of financial behaviour. The researchers found that self-continuity predicted a decrease in temporal discounting rates, and higher levels of savings, whilst controlling for age.

This research was further corroborated by Ottaviani & Vandone (2011) who examined the effect of impulsivity on household financial behaviour in the context of debt. The researchers used the Iowa Gambling Task and the Barratt Impulsivity Scale to measure impulsivity. They found that impulsivity predicted unsecured debt, i.e. credit-card transaction behaviour. This result suggests that impulsive behaviour improves the propensity for monetary consumption, which in turn reduces savings rates.

1.3.2.3 Intentions and Goals

Other factors influencing monetary savings are intentions and memory. ‘Intentions’ are goal-directed actions in which an agent expresses an interest in attending a given target. Intentions can be considered to be a predictor of behaviour (Fishbein, 1975), where an agent looks to express behaviour in a goal-directed manner.

One investigation into psychological determinants of a financial savings buffer revealed intentions were a significant predictor of savings (Magendans, Gutteling, & Zebel, 2017) across a sample of student and working age populations, demonstrating generalisable results.

Goals have been shown to predict monetary savings in retirement (Stawski et al., 2007). The researchers found that setting clearly defined goals was a significant predictor of increased retirement savings. These findings were further corroborated by Davis and Hustvedt (2012), who found that behavioural control and behavioural intention were the best predictors for optimal retirement savings, amongst a sample of 328 individuals who completed a personal finance course between 1982 and 2007. These results highlight how

goal-directed behaviour is imperative in savings, whereby intentions and goals are important in directing behaviour and in behavioural maintenance.

1.3.2.4 Executive function

One key psychological concept is the notion of executive function, the ability to integrate behaviour and motivation in light of goals and intentions. Executive function may play an important role in monetary savings and in diminishing monetary consumption as it is involved in self-control (Baumeister, 2002; Baumeister & Vohs, 2003; Diamond & Lee, 2011).

Karlsson, Gärling and Selart (1997) performed two experiments using Swedish undergraduates investigating if the propensity to consume varied with current income. The researchers found consumption rates were higher during an income increase than income decrease despite the same amount of money being available. This would suggest that cognitive control is diminished when opportunity costs are reduced.

In a different study (Selart, Karlsson, & Gärling, 1997), researchers examined working-age and student populations and found that monetary consumption was higher for lump sums than for future monthly increments, despite the total increase being equivalent. Such findings describe how executive function in maintaining goal-directed behaviour can be undermined when opportunity for reward-seeking arrives.

1.3.2.5 Sense of control

A person's locus of control is the extent to which an agent believes they have a direct effect on the outcome of events in their life. For instance, some elevators contain a "close door" button despite them not actually having any impact of closing the doors at all. This still gives the user a perceived sense of control. A perceived sense of control is important in health and wellbeing – a greater perceived sense of control is associated with better health and well-being, even amongst individuals in lower-income brackets (Lachman & Weaver, 1998). The effects of a perceived sense of control is important in how we behave, which consequently has implications in the financial domain. Livingstone and Lunt (1992) investigated the role of psychological factors in savings performances. The researchers recruited over 250 participants to complete questionnaires regarding psychological characteristics as well as economic variables. The research demonstrated

that savings rates were associated with a sense of control, with those who felt less in control having demonstrably less savings than those with a higher sense of control.

1.3.3 Opportunity

The opportunity component of financial capabilities may be affected by an individual's social network (social opportunity) or through instances that occur spontaneously (physical opportunities). Examples of each factor are reviewed below.

1.3.3.1 Social Factors

In an exemplar study demonstrating the role of opportunistic factors (Parker, Michael, & Wilcox, 2003), researchers ran an experimental design of 'families'. Individuals were placed in three-member families, in which second and third generations could observe and/or communicate with past generations. The results show that those who took advantage of the opportunity to learn performed significantly better in savings. These results stipulate how social opportunities improve performances and are an inherent factor in monetary savings.

Gutter, Garrison and Copur (2010) examined the effects of incidences of social learning within one's network. The researchers collected data on over 1500 college students pertaining to their financial literacy, dispositions and behaviours. They also asked participants how frequently their friends and family had engaged in some financial behaviour and if they had observed their behaviour. The researchers found that higher incidences of social learning improved financial behaviours and that this was higher for parents than for friends.

1.3.3.2 Physical opportunities

Physical opportunity are characterised as the local opportunities and options that afford themselves to the individual. Opportunities can be both positive (affording enablers and facilitators) and negative (affording barriers). For instance, an individual who struggles with self-control would want to see themselves commit to reducing consumption; whilst opportunity to learn money-management skills may improve household savings behaviour. Researchers collaborated with a commercial bank in the Philippines and designed a savings account that did not permit users to withdraw any deposits (Ashraf,

Karlan, & Yin, 2006). In this study, 202 individuals were randomised to one of two conditions: to either receive the savings product or to a control group. The researchers found a 47% difference in average savings balance at six months, and 82% at twelve months between the two groups, respectively. By reducing the opportunity to spend, participants in the intervention group were able to improve their savings by a significant amount, in comparison to the control group.

1.3.4 Individual Differences

It is important to note and consider that there is variation in household savings and consumption behaviour across the population and amongst individuals. These constructs can often have considerable explanatory power, but sometimes, less attention is paid due to the considerable statistical power often required to examine differences (Martin & Kraemer, 1987). An initial starting point is to examine behaviour that far exceeds the normative behaviour of the population. Compulsive shopping behaviour, for example is not a current psychiatric disorder registered in the current Diagnostic and Statistics Manual. However, it is currently receiving considerable interest and debate (Black, 2007a; Black, Gabel, Hansen, & Schlosser, 2000; Desarbo & Edwards, 1996). Compulsive shopping behaviour is typically displayed as an overarching obsession and need to shop that is typically exacerbated in stressful states (Black, 2007b; Desarbo & Edwards, 1996; Filomensky & Tavares, 2015; Racine, Kahn, & Hollander, 2014). These individuals typically demonstrate high levels of impulsivity (Desarbo & Edwards, 1996; Lejoyeux et al., 2002). Compulsive shoppers commonly exhibit higher levels of sensation seeking, which depicts reward seeking behaviour.

Compulsive shoppers also typically demonstrate a lack of perseverance, with a tendency to switch, rather than maintain their goal-directed behaviour. They also exhibit high levels of negative urgency, a tendency to act rashly when in a negative emotional state; and a lack of premeditation displaying a tendency to act before conscious thought (Billieux et al., 2008). Here, these individuals isolate and identify extreme levels of hyper-consumption, and are a result of underlying psychological characteristics.

These psychological components are hugely important. For instance, the varying degrees with which individuals compute future reward has implications on savings (Ersner-Hershfield, Wimmer, & Knutson, 2009). The researchers found that the degree of consistency in self, predicted a decrease in temporal discounting rates, and higher

levels of savings, even controlling for age. This suggests that self-control and individual's computation and processing of the future, are important not only in their behaviour but the outcome of those behaviours.

Furthermore, an individual's impulsivity has an effect not only on their health (Claes et al., 2006; Kulendran et al., 2013, 2016), but also on their financial state. Researchers found that higher levels of impulsivity predicted propensity for unsecured debt in credit-card use behaviour (Ottaviani & Vandone, 2011). In addition, impulsivity is also associated with reward maximisation (Murray et al., 2014) - the degree to which an individual pursues momentary reward in competition with goal-directed actions. Reward seeking behaviour has been identified in compulsive shopping as a result of dopaminergic neuropharmacological treatments in Parkinson's (Ondo & Lai, 2008; Valerie Voon et al., 2006).

Psychological processing of goals is important to overcome these behavioural predispositions. For instance, setting savings goals has been shown to significantly improve retirement savings (Davis & Hustvedt, 2012; Stawski et al., 2007). Setting outcome goals and behavioural goals, i.e. distinctive processes which refer to the outcome, whilst the behavioural goal dictates the action plan to ascertain the outcome, are important in persevering and maintaining goal-directed actions. By setting the intention and goal, the agent is then able to maintain some sense of trajectory and purpose behind their behaviour. This can help to overcome competitive motivational barriers.

As such, variation in how individuals process their state and propensity for a given action has knock on consequences in their behavioural outcomes. These individual differences require further study as the field is still relatively in its infancy when applied to financial behaviours. However, by examining individual differences, one can ascertain those at-risk and in need of interventional efficacy.

Chapter 2 Theory and Frameworks

SUMMARY

- Designing interventions are a complex and in-depth process.
- Policy-makers and researchers can utilise frameworks and guideline processes to build and specify simple and complex interventions.
- The COM-B approach allows for multiple behaviours to be understood in aggregate and influencing effects to identify and target key parameters to leverage behaviour change.
- Use of the MRC's guidelines for complex interventions can help to structure a robust approach and provide a more likely success in intervention implementation.
- Step-wise consideration of the interventional processes yields multiple checks and balances to authenticate, test and confirm interventional policies.
- Behavioural diagnostics are an important start and provide high utility in constructing the intervention, through the selection of interventional policies and behavioural change techniques.

2.1 Understanding and changing behaviour

To design effective interventions, one needs to fully understand the contextual behaviour in question (Atkins & Michie, 2015). This requires an overarching view of the problem behaviour in terms of its determinants, which can be conceptualised as the barriers to and facilitators of the behaviour. Here, the barriers denote determinants that decrease the likelihood of engaging in optimal behaviour and facilitators denote determinants that increase the likelihood of the behaviour occurring (Michie et al., 2014).

In this aspect, we need a complete and overarching understanding of financial capability. The financial education approach is rooted in an assumption of information deficit, in line with rational agency. However this approach is a common mistake in policy and intervention design, which is based on a common-sense approach (Kelly & Barker, 2016), rather than a deeper understanding of behaviour.

A similar approach was undertaken in the public health domain, which sought to change people's behaviour to improve and maintain their own health (Kelly & Barker, 2016). Public health efforts have found that educating the populace is necessary but not sufficient in changing behaviour (Corace & Garber, 2014; Feldman & Sills, 2013; Kollmuss & Agyeman, 2002; McCluskey & Lovarini, 2005; Mellanby, Phelps, & Tripp, 1992; Nichols, 1994). Education-based approaches in public health efforts have demonstrated an improvement in knowledge, but little change in behaviour (McCluskey & Lovarini, 2005). Conceptually, knowledge structures are required for behaviour, but do not generate behaviour themselves. There are additional requirements to change behaviour. The financial education approach has not been designed sub-optimally. In fact, based on the underlying assumption of rational agency and information deficits, this approach is a valid intervention option. The issue is that the underlying assumptions and logic model of change do not fit with empirical evidence on behaviour change. In other words, the financial education approach has attempted to change behaviour but is not based on a behavioural perspective; there are additional requirements to satisfy the need for behaviour change (Atkins & Michie, 2015; Michie, Stralen, & West, 2011).

These additional requirements can be understood through a grounded behavioural perspective based on empirical evidence from the behavioural sciences which constitute a range of disciplines, such as economics, neuroscience, psychology and cognitive science. Within behavioural science is the sub-specialty of behaviour change science, a growing field that aims to study and understand how to change behaviour. Through a

theoretical approach, grounded in empirical evidence-based theory, interventions can often lead to long-term effectiveness and sustainability of the proposed policies (Michie & Prestwich, 2010). We can improve our understanding of financial capability by taking a more behavioural perspective, which may afford additional intervention approaches.

Interventions to change behaviour and improve behavioural capability work on several levels – structural or environmental, psychological, and behavioural (Abraham & Michie, 2008; Michie, Van Stralen, et al., 2011; Webb & Sheeran, 2006). Interventions can be defined in one of two ways. ‘Simple interventions’ denote the employment of a single behavioural mechanism; whilst ‘complex interventions’ involve multiple behavioural mechanisms (and in some cases multiple intervention approaches) (Moore et al., 2015). In taking a complex intervention route, multiple determinants of sub-optimal financial capability can be targeted simultaneously as informed by recent comprehensive models of behaviour and behaviour change (see Vlaev & Dolan, 2015).

We have already discussed the problem of ISLAGIATT’s (Atkins & Michie, 2015), where interventions that are designed from an erroneous assumptions can lead to poor efficacy (Michie, Van Stralen, et al., 2011). Interventions that do not resolve the determinants of sub-optimal performances will not be effective in producing behaviour change.

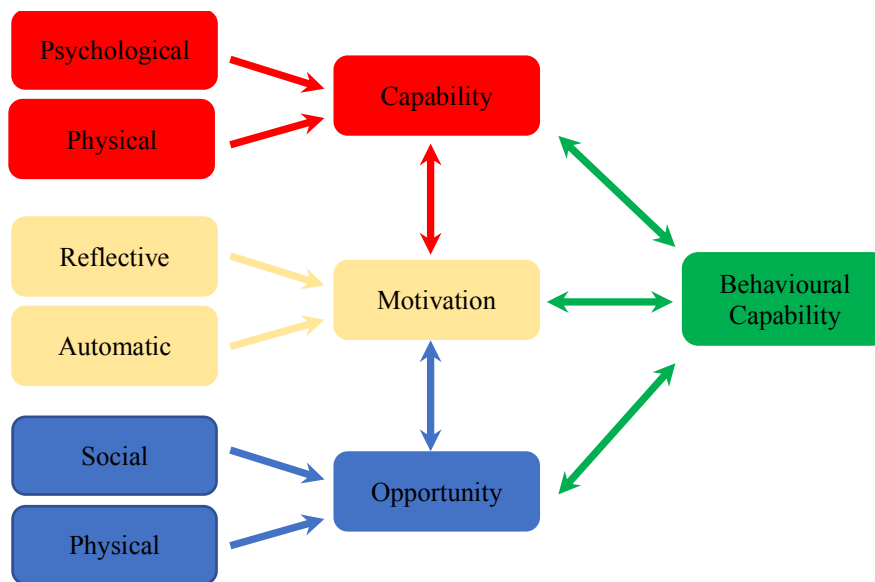
This chapter discusses a model of behaviour change to identify behavioural determinants of sub-optimal performance, in addition to introducing a framework for intervention design for the construction and implementation of the intervention. This chapter draws from the literature of behaviour change within the healthcare setting (Atkins & Michie, 2015; Insel, Einstein, Morrow, & Hepworth, 2013; Koshy, Car, & Majeed, 2008; Kulendran et al., 2013, 2016; Michie et al., 2014; Michie & Prestwich, 2010; Pearson, 2012; Strandbygaard, Thomsen, & Backer, 2010; Vervloet et al., 2012; Zygmunt, Olfson, Boyer, & Mechanic, 2002), to denote practices and processes in behaviour change.

2.2 Model of behaviour

A recent and integrative model to understand behaviour and designing behaviour change intervention is the COM-B model (Michie et al., 2014; Michie, Van Stralen, et al., 2011). The COM-B model is based upon a consensus of behavioural theorists (Fishbein et al., 2001) and a principle of common US law. The consensus identified the follow for any

behaviour to occur: the skills necessary to perform the action, the intention to enact the behaviour and no constraints that prevent the behaviour from occurring. A similar set of reasoning is also laid out in common US law, which dictates that in order to prove someone guilty of a crime, they must have the means to engage in the crime, the motivation to commit the crime and the opportunity to enact the crime. The COM-B model puts depicts human behaviour as an interaction of these three systems, termed as Capability, Motivation and Opportunities, which interact together to generate behaviour. Thus to implement effective financial capability, and to change behaviour, policy-makers must influence these components (see Figure 1 below).

Figure 1; COM-B Framework (Michie et al., 2014)



The COM-B model utilises a bottom-up approach to behaviour, offering a more encompassing view of behaviour where individual facets acting as enablers or barriers to a given behaviour can be identified. This allows for more detailed and more effective intervention methods. The COM-B model was chosen due to a high citation count, over 2000, and due to the diagnostic capability. By relating the model to defensible principles used within common US law, the COM-B model is therefore an extremely useful and parsimonious model of behaviour. There alternative models that could be used, such as EAST (Behavioural Insights Team, 2014) or even the Theory of Planned Behaviour (Ajzen, 1985). However COM-B was chosen due to its relative simplicity whilst explaining and accounting for multiple factors; in addition to the ease with which it can

be employed. EAST (Behavioural Insights Team, 2014) is a helpful toolkit, but is not comprehensive or detailed enough to assist in a comprehensive behavioural diagnosis, furthermore although models such as the Theory of Planned Behaviour (Ajzen, 1985) are often used within health psychology, these types of models has seen much contention (Sniehotta, Presseau, & Araújo-Soares, 2014; Sniehotta, Scholz, & Schwarzer, 2005).

Capability is defined as an individual's psychological and physical capacity to engage in the activity concerned. Psychological capability includes having the necessary knowledge and skills and also possessing the capacity to engage in the necessary thought processes such as comprehension, reasoning and so on (Michie et al., 2011). Psychological capability refers to the ability to perform – and subjective self-efficacy, i.e. whether an individual believe they can do things). For example, in order to help people living within their means (budgeting), interventions could involve using behavioural tools to aid budgeting – online or using a spreadsheet/diary, or perhaps earmarking money for different outgoings by separating them into different accounts or stacks.

Physical capability can be denoted as the physical skill development, which is the focus of training. A key issue here is whether individuals are being limited by their physical ability, such as, those may have difficulty getting to banks in rural locations.

Motivations are defined as cognitive processes that direct behaviour, which includes reflective motivation and automatic motivation. Recent evidence from the psychological and neuro-scientific disciplines have converged on a description of neurological functioning comprised as two distinct systems (or sets of systems)(Aunger & Curtis, 2016; Daw, Gershman, Seymour, Dayan, & Dolan, 2011a; Dolan & Dayan, 2013; Evans & Stanovich, 2013, 2013; Gillan, Otto, Phelps, & Daw, 2015; Kahneman, 2011; Rangel, Camerer, & Montague, 2008; Vlaev & Dolan, 2015). Evolutionarily older 'System 1' processes described as automatic, uncontrolled, unconscious and affective (Daw, Gershman, Seymour, Dayan, & Dolan, 2011a; Dolan, Hallsworth, et al., 2012; Dolan & Dayan, 2013; Kahneman, 2011; Vlaev & Dolan, 2015). Whilst 'System 2' processes are described as reflective, controlled, effortful, conscious and rational (Evans, 2008; Rangel et al., 2008; Strack & Deutsch, 2004). This thesis employs the dual-process paradigm as a unified framework for population behaviour change, with the additionally of a more nuanced account of how the automatic system controls behavior. Reflective motivations involve evaluations, goal-setting and planning. Evaluative mechanisms compares

positive and negative attributes of something. Goal-setting involves considering achievable outcomes (long or short-term). Planning denotes creating a structure and plan to achieve said outcome by specifying where, when, and how to execute an action. Automatic motivations are associative in nature and comprise a class of mental phenomena such as habits, impulses, heuristics and biases. Consumer behaviour has been empirically demonstrated to be highly influenced by automatic processes (Baca-Motes, Brown, Gneezy, Keenan, & Nelson, 2012; Bargh, 2002). Those processes are predominantly influenced by the context, in line with the behavioural economics approach embodied in the MINDSPACE toolkit (Dolan, Hallsworth, et al., 2012; Dolan, Elliott, et al., 2012). MINDSPACE is a mnemonic that reflects a comprehensive account of the most robust effects on behaviour that operate largely through the automatic psychological processes. Thus the automatic motivations can also be broken down into more basic motivations that drive human behavior.

Table 1: MINDSPACE framework

MINDSPACE influences	Automatic Motivations and Behaviours
Messenger	Individuals are heavily influenced by the source of communication, influencing whether to engage or reject the information purely because of who has said it. For example, it matters who told us to keep track of finances, invest or take out pension.
Incentives	Consumers' responses to incentives are shaped by predictable mental shortcuts such as strongly avoiding losses and ignoring/discounting future benefits or losses.
Norms	Individuals are strongly influenced by what others do – such an automatic conformity with social norms (desire to be like those around us) is a driver of behaviours across many domains. For example, people will budget if they have friends or family budgeting too.
Defaults	Individuals often go with preset options (Evans & Stanovich, 2013; Thaler & Sunstein, 2008). When offered with the choice of an active decision to do nothing, individuals often seem to remain in

	the default ‘do nothing’ category (Choi et al., 2002). For example, consumers could receive prompts and reminders to promote checking of their account more regularly.
Saliency	Consumers’ attention is drawn to what is novel (messages in flashing lights), accessible (items on sale next to checkouts) and simple (a snappy slogan). For example, a simple way to motivate people to keep track of finances is by making the reminders and statements salient and attractive.
Priming	Consumers are often influenced by sub-conscious cues (Wansink & Kim, 2005). These could be sounds, sights and smells that draw us in or repel us. For example, credit borrowers may only pay minimal payment on credit card bill as the amount has been suggested or primed (Stewart, 2009)
Affect	People exhibit affective responses to words, images and events, which can impact their decision-making. These responses can motivate or inhibit behaviour change.
Commitments	Individuals seek to be consistent with our public promises, and reciprocate acts. If people proclaim they will do something, they are more likely to execute the behaviour (Giné, Karlan, & Zinman, 2010). For example, someone may check balance (keep track) regularly after telling others she will do so.
Ego	People act in ways that make them feel better about themselves, maintaining the impression of a positive and consistent self-image (Alicke & Govorun, 2005). For example, individuals could be informed that keeping track of monetary consumption projects an impression of being on top of things.

Opportunities are defined as all the factors, social and physical, that lie outside the individual that make the behaviour possible or prompt it. Social opportunity is afforded by the cultural milieu that dictates the way that people think, including the shared values and practices that characterize institutions and groups. This happens when our social network provides new instances of engaging in some behavior. For example, knowing

about sales and offers can reduce monetary consumption for necessary expenditures, and being informed of new financial products can help households reach their financial goals.

Physical opportunity refers to the infrastructure or technology available for people, such as levels of access to financial services or products. For example, enabling individuals to keep track of their finances would require access to account information either through an ATM, smartphone or computer.

One paper (De Meza, Irlenbusch, & Reyniers, 2008) investigated some of the psychological and behavioural factors of financial capability. The study uses a large-scale review of the current financial literature working under a behavioural economics framework to identify key underlying psychological factors. The researchers propose six key behavioural themes that fall into many of the MINDSPACE categories that underlie automatic motivation of financial capability.

However one key limitation is that this study only examined automatic motivation, but did not approach other factors such as reflective motivation, opportunity and even psychological and physical capability. A second shortcoming is that the study only disseminates findings about barriers to financial capability, and ignores enablers of behaviour.

It is important to understand which COM-B factors are the most influential of financial capability, to then be targeted in an intervention or policy. This theoretical framework ensures that the most appropriate intervention is implemented from a better understanding of the role of various determinants in financial behaviour. For example, some people may be motivated to budget and keep track of their finances, but lack the physical or social opportunity (i.e. structural and cultural barriers). Therefore, reflective motivational techniques such as ‘providing information on consequences’, ‘prompting specific goal setting’, and ‘prompting review of behavioural goals’ should be encouraged (Abraham & Michie, 2008). Influencing automatic motivations is another key lever to improve behavioural and financial capability. For example, information about ‘social norms’ have powerful, automatic influence on behaviour ; for instance, financial advisors could provide information about what other individuals in a similar situation are doing with their finances).

2.3 Intervention process

To change behaviour in a long-term capacity requires what are termed as complex interventions, these utilise multiple BCT's through mechanistically targeting multiple factors. There is a large literature on BCT's (Abraham & Michie, 2008; Michie et al., 2013, 2016; Michie, Johnston, Francis, Hardeman, & Eccles, 2008), of which Vlaev and colleagues have already put forward theoretical applications of such techniques (Dolan, Elliott, et al., 2012; Vlaev & Elliott, 2017). Financial capability can utilise emerging evidence and frameworks from all areas of behavioural change science.

An excellent reference point to use is the framework processes for health care, where the utility for behaviour change is paramount both for the individual's own wellbeing and for the state. The most commonly used approach within healthcare is the Medical Research Council's (MRC) framework for complex interventions (Campbell et al., 2000). This process is closely resembled by an alternative framework recently put forward (Aunger & Curtis, 2016). Both frameworks identify a step-wise process, which starts from a literature review, followed by an identification of behavioural processes, to mechanistic assessments, pilot trials and finally large-scale randomised controlled trials.

The MRC guideline (Campbell et al., 2000), was introduced as a formal process to design and characterise interventional processes in healthcare. The guideline was constructed to help clinical research in behaviour change to designing interventions as a procedural step-by-step manner in which to improve the success rate of interventions and to reduce waste across primarily monetary and temporal dimensions.

The MRC process can be utilised as a sequential or iterative process, and is constructed of five phases. The first is the 'pre-clinical phase' which denotes the exploration of theoretical domains surrounding the behaviour, hypotheses of behavioural mechanisms, the prediction of major confounders and finally the strategic design of the intervention. This is followed by a behavioural modelling process in which it is important to diagnose the characteristics that define and cause sub-optimal behaviour. The modelling phase can be often referred to as formative research, which assesses and evaluates the sub-optimal behaviour.

The formative phase can be executed through qualitative or quantitative research. Such techniques can be utilised through observations or even through empirical datasets, experimental tasks, questionnaire methods and interviews. The purpose is to generate a contextual basis of evidence, which ascertains the barriers and enablers behind the

behaviour of interest. The notion of formative work is helpful in ascertaining the basic building blocks of behaviours to understand potential barriers and enablers to any behaviour. Behaviour in itself is multi-factorial, the reasons for why a consumer may spend their month's income instead of saving could include factors such as, amount of pay, size of family, cost of rent, addictions, social rank motivation or even social norms. Therefore, understanding these base units of behaviours are paramount to designing effective interventions and policies.

Qualitative research, uses in-depth investigation in the psychological underpinnings of the given behaviour in how individuals construct and make sense of the world. Peñalozza and Barnhart (2011) undertook a qualitative investigation to understand credit and debt behaviour in the United States amongst a white, middle-class population. The researchers used a thematic analysis to categorise and comprehend the experiences of their participants. Here the researchers find that debt was something most people do not typically understand until this was experienced, this is important for intervention and policy implementation as distributing information about the impact of debt to reduce consumer debt levels may not necessarily translate to positive effects.

Quantitative research can offer a computational tool to discern the sub-optimal behaviour, this can be highly valuable where researchers can construct models to parameterise sub-optimal behaviour. This gives an objective method to identify the sub-optimal behaviour. For instance Koehler, Langstaff and Liu (2015) ran a simulated savings task, the 'Game of Life' with individuals, where participants were asked to complete a behavioural simulated retirement savings game. Participants were allocated an income which they must budget to provide retirement savings. This method allowed Koehler and colleagues to identify key predictors of retirement saving behaviour which isolated barriers of individual differences of risk attitudes as well as temporal discounting levels. The researchers found that consumption was correlated with rates of temporal discounting ($r = .21, p = .012$).

Another example is in the use of big data, a term that denotes large-scale datasets, to understand behaviour. Gathergood, Mahoney, Stewart and Weber (2017) utilised credit-card data to understand how consumers paid off multiple credit-card balances. When examining the data, the researchers found sub-optimal repayment strategies with people accumulating debt by not removing the total amount due. These individuals were in essence accumulating debt despite being able to pay off the total amount. The

researchers examined the behaviour and showed that consumers match the payment to the share of balances across cards, described as a 1/N heuristic. Even with utilising machine-learning algorithms, the models attribute weighted the balances as the most important and interest rates as the least important. This sort of procedure allows the researchers to not only diagnose the sub-optimal behaviour, but also to come up with a targeted policy implementation.

After the behavioural diagnosis is complete and the causes of sub-optimal behaviour are identified, the MRC guidelines move towards an exploratory trial, which looks to operationalise the outcome variable for a feasible protocol that can be evaluated. This allows researchers to test the intervention or policy and examine the implementation behaviour. This phase is incredibly important in identifying the pitfalls and areas that require improvement in the intervention or policy.

For instance, a pilot trial or feasibility study can allow researchers to assess the intervention through an acronym known as the APEASE criteria (Michie et al., 2014), which denotes Aceptability, Practicality, Effectiveness/cost-Effectiveness, Affordability, Safety/Side-effects and Equity. Each component provides a useful evaluation of the intervention, for instance the intervention may be incredibly acceptable and effectiveness but may not be practical or even remotely affordable.

After interventions have been assessed and these insights are addressed, a definitive randomised controlled trial is the next step, which is a fully defined, appropriately statistically powered and operationalised using a theoretically defensible outcome measure. However, sometimes a randomised controlled trial may not be feasible, as such, alternative methodological processes are advised such as natural experiments analysed through discontinuity regression or frequentist statistics for quasi-experimental designs.

Finally the last MRC phase is the long-term implementation of these ideas into a sustainable practice. Both in the aspects of replication to ensure that the behavioural mechanisms in place is reliably instigating behaviour change. As well as sustainable practices in place that would then deliver the intervention without the requirement of researcher or policy-makers.

2.4 Future research: moving towards a unified strategy

The healthcare industry has a head start on behaviour change particularly in the United Kingdom, where the UK's National Health Service is under constant pressure with limited funding and staff shortages (Buchan, Charlesworth, Gershlick, & Seccombe, 2017). From this pressure, the UK has seen many governmental departments, such as the Department of Health, Public Health England, set up Behavioural Insight teams that use behavioural change techniques in policy setting. Focus and pressure have shifted from the institution towards the consumers or service users themselves. This provides policy-makers and researchers interested in improving financial capability, the groundwork to apply effective behaviour change within this domain.

With financial capability still growing, it is important to adequately understand the processes behind changing behaviour and techniques that can fast-track and provide unique insights, such as the use of big-data (Dayan & Abbott, 2001; Raghupathi & Raghupathi, 2014; Rutledge & Adams, 2015). These insights are starting within household consumption, predominantly in credit-card repayment behaviour (Gathergood et al., 2017; Gathergood, Stewart, & Weber, 2018; Quispe-Torreblanca, Stewart, & Gathergood, 2017). With big-data on consumers banking activity and historical data, policy-makers can implement highly efficient predictive models to ascertain the key barriers behind consumer sub-optimal behaviour. These insights can then develop into targeted interventional policies to deal with such behaviours.

The future of improving financial capability should hopefully move towards a unified trend through behaviour change science as a framework to govern the field, through the use of evidence-based techniques. Where behaviour change techniques are understood and applied either jointly through complex interventions, or targeted in simple single-mechanism interventions in specific contexts.

Chapter 3 Cognitive Control

SUMMARY

- Cognitive control refers to competing motivational systems that seek to influence behaviour, usually from top-down against bottom-up activation. Behavioural output seems to align with system that finishes the signal first.
- Cognitive control processes can be protected through stronger intentions and improving prospective memory through the use of implementation intentions. Implementation intentions seek to utilise *if then* rules to guide intentions and translate into behaviour change.
- The degree to which an individual is goal-directed has a substantial effect on cognitive control, with levels at the extremes identifying hyper-consumption (particularly in addicts).
- Impulsivity should be considered as a causal role in diminished cognitive control, impulsive individuals are shown to exhibit poor cognitive control, which can often lead to negative outcomes, such as overconsumption.
- Executive function can improve cognitive control, where working memory seems to protect goal-directedness, whilst attentional processes can often compete with cognitive control.

3.1 Introduction

Why do people choose one behaviour or option over another? For example, why would an individual choose to purchase a car over saving for deposit for a house? A popular rational model of decision-making is a multi-attribute model (Zanakis, Solomon, Wishart, & Dublisch, 1998), the multi-attribute model suggests that people compare the value of different attributes (such as colour, taste, shine, feel, power etc) of each choices, which are weighted by the subjective value to that person. This can be computed as the subjective utilities (SV) of attributes (α_i), weighted by the utility (u_i) of that attribute, through the typical model:

$$SV = \sum_{i=1}^n \alpha_i \cdot u_i$$

Once computed and assessed the agent would then summate these values to compute an overall utility value from the first to the nth attribute, the model assumes that agent seeks to maximise their utility so the choices will align with attributes that have the greatest weighting.

A similar model of choice behaviour is the expected utility theory (Tversky, 1975), which denotes that individuals seek to maximise their utility, which in most cases can be depicted as a diminishing marginal utility function of wealth (which denotes a risk averse preferences, whilst risk seeking is a convex function). Put simply, for someone living under the poverty line £100 holds significant increase in utility, yet for a millionaire, an additional £100 depicts a small increase in utility.

These models are provided to illustrate the subset of models that assume rational agency, in which an individual makes choices based on stable preferences that are dictated from computing the expected outcomes and associated utilities. There are countless other models that do not assume rationality, such as Decision by Sampling, Reinforcement Learning and even Range Frequency Theory (Huys, Guitart-Masip, Dolan, & Dayan, 2015; K. Miller, Shenhav, & Ludvig, 2016; Parducci, 1965; Stewart, Chater, & Brown, 2006). These models are based on empirical evidence of choice behaviour which illustrates that our decision-making is not always rational, rather our choices and behaviour are guided by internal drives and motivation (R. J. Dolan & Dayan, 2013; Vlaev & Dolan, 2015).

Our drives and motivation can often override the optimal choice (R. J. Dolan & Dayan, 2013; Gillan et al., 2015; Gollwitzer, 1999; Vlaev & Darzi, 2012; Vlaev & Dolan, 2015), where individuals make choices that go against their best interests. For example, consider an individual looking to put £50000 aside for a deposit on a mortgage, they walk 40 minutes to work every day. One day on their way home they see a car on sale for £20000. They love the aesthetics, the engine and make and model of the car. Purchasing a mortgage for a property is a major priority, but the car would be useful too. How can this individual keep with their long term goals and maintain their top priorities? One explanation for this is ‘cognitive control’; which is a conceptual psychological description regarding multiple competing motivational processes whilst retaining intentions towards goal-orientated outcomes (Dalley, Everitt, & Robbins, 2011; Otto, Skatova, Seth Madlon-Kay, & Daw, 2015; Ridderinkhof, Ullsperger, Crone, & Nieuwenhuis, 2004). These concepts are important as these psychological processes in how we process information can impact and moderate our behaviour. For instance, note how impulsivity in obese populations can predict their body mass index (Kulendran et al., 2016), weight loss after surgery and even relapse rates (Kulendran et al., 2013; Kulendran, Borovoi, Purkayastha, Darzi, & Vlaev, 2017). In addition, levels of goal-directedness has been shown to discriminate healthy from compulsive and addictive personality disorders (Doñamayor, Strelchuk, Baek, Banca, & Voon, 2018; Sebold et al., 2014; Voon et al., 2014; Voon et al., 2006). These concepts as illustrated below can moderate our behaviour, and therefore can have implications in motivation for behaviour change; thereby impacting upon intervention efficacy, as a result of competing processes interacting.

The Stop Signal Task (Logan, Schachar, & Tannock, 1997) is an excellent illustration of how two conflicting processes interact and produce differential outcomes based on the agent’s goal. In the Stop Signal Task participants are asked to identify a set of stimuli. For instance, identifying if an arrow displayed on the screen is pointing left or right, or distinguishing the shape of the stimuli (square or circle). A proportion of trials (typically set at 25%) carry an additional signal referred to as the ‘stop signal’, this is usually in the form of an auditory beep. On these trials the participants must inhibit their response. Therefore on these Stop trials, individuals are presented with a congruent vs incongruent dilemma.

The Stop Signal Reaction Time (SSRT), is the computed parameter given to denote the stopping time needed to cancel a prepotent response in conflicting trials when participants are asked to inhibit their response after the Go signal initiates an action (Logan et al., 1997; Verbruggen & Logan, 2008). The SSRT parameter is generated from conflicting motivational processes called the horse race model (Logan, Zandt, Exeter, & Wagenmakers, 2014; Verbruggen & Logan, 2008). The conflicting systems comprise of one initiating in response to the prepotent actions of identifying the stimuli, the other in response to the stop signal processing. These competing signals create a cognitive control issue (Claes et al., 2006; Logan et al., 2014; Verbruggen & Logan, 2008). When the goal is to identify the stimuli, participants exhibit almost similar reaction time and error rate performances across trials, however when the goal of the trial is to inhibit their prepotent actions, error rates are significantly higher as participants typically find it difficult to demonstrate response inhibition (Verbruggen & Logan, 2008).

This result is due to competing motivational processes of Go and Stop behavioural activation; when these systems conflict, the winning action is a result of the agent's computation of action values (i.e. the system that finishes the processing signal first generates the behavioural activation) (Logan et al., 2014).

Cognitive control processes has been described recently by use of dual-process theories, stemming from an associative, fast-paced, habitual system, and an effortful, reflective, goal-directed system, which is a prominent idea across psychology, behavioural economics and cognitive neuroscience (Balleine & O'Doherty, 2010; Daw, Niv, & Dayan, 2005; Dolan & Dayan, 2013; Evans, 2008; Evans & Stanovich, 2013; Kahneman, 2011; Otto et al., 2015; Skatova, Chan, & Daw, 2013; Wood & Runger, 2016). Many instance of irrational or sub-optimal behaviour is typically exemplified through cognitive control problems, where in competing motivational systems produce conflicting desires, such as above instance in which the desire to choose the car but still maintain intentions to save for the deposit.

Below are some of the most frequently cited factors that play a role in cognitive control, however, note that this is not an exhaustive list as there are many factors at play.

3.2 Intentions

A prominent idea of cognitive control and goal-orientated processes is the notion of intentions. Intentions and beliefs, can be regarded as programs of behaviour (Calnan &

Rutter, 1986; Calnan & Rutter, 1986; Fishbein, 1975, 1979). Intentions to act can sometimes be a necessary first step in behavioural activation (whilst associative and Pavlovian responses can also initiate actions) (Calnan & Rutter, 1986b, 1986a; Fishbein, 1975). Intentions can be mapped onto internal and external needs and drives (West & Brown, 2013). For instance, walking into a dark room creates a need to provide light; whilst internal drives of hunger and thirst yield a drive that needs satiating. In behaviour change, intentions are often considered a required component to initiate the behaviour change process (Fishbein, 1975).

However, the link between intentions and actions is often very weak, for instance a major study reviewing the role of intentions in behaviour (Webb & Sheeran, 2006), the study found a large to moderate intention (Cohen's $d = .66$) translated only to little to moderate change in behaviour (Cohen's $d = .36$). This diminished effect of intentions would suggest that intentions in and of themselves can often struggle to influence behaviour change, and additional influences can be added to promote behaviour change to make it more likely through cognitive and motivational factors.

3.3 Goal-directed actions

The ability to sustain one's goal is also an integral aspect of cognitive control. For instance in one study, researchers found that proposing a savings goal and creating a plan by implementing a set of rules produced a 68% chance of predicted probability of savings, compared to 45% without any such plan (Rha, Montalto, & Hanna, 2006).

One computational refinement of the dual-process theories of goals and habits, derived from computational neuroscience and animal behaviour is Reinforcement Learning which suggests that two modes of choice arise from distinct strategies of learning action values (Daw et al., 2005), a model-free system, that is computationally efficient, and a model-based system, which requires heavy resources and attention (Daw et al., 2005; Vlaev & Dolan, 2015). In this theory goal-directed actions stem from model-based learning, which reasons prospectively about the value of actions using a learnt model of the environment and the agent's goals. Whereas habitual choices stem from model-free learning which denotes learnt action values based on past utilisation, these values are then entrenched with those actions, often referred to as cached values (for more information please see Appendix E on the computational assays behind reinforcement learning).

Through these computational assays, a weighted computation of model-free and model-based reliance can be calculated; this produces a weighting parameter which describes deficits in goal-directedness (Gillan, Kosinski, Whelan, Phelps, & Daw, 2016; Robbins, Gillan, Smith, de Wit, & Ersche, 2012; Rouault, Seow, Gillan, & Fleming, 2018; Sebold et al., 2014a). This weighting parameter has been shown to differentiate clinical populations from healthy subjects (Rouault et al., 2018; Voon et al., 2014). For instance, Voon and colleagues compared choice behaviour across a range of psychiatric disorders such as OCD, meth addiction, alcoholism and Binge Eating Disorder against a healthy control set. The results identified group differences in the degree of goal-directedness, with binge eating disorder, OCD and meth addiction identifying poorer goal-directedness than healthy controls.

A subsequent study by Sebold and colleagues (2014a) investigated the link between alcohol consumption in alcohol dependence and the weighting parameter for choice behaviour; the researchers found diminished effects of goal-directedness with increased consumption suggesting an underlying tendency to form strong habits or addictions when goal-activation is poor.

These results suggest that cognitive control issues, i.e. instances of sub-optimal behaviour occur where goal-activation is poor and a reliance shifts to automated entrenched values derived from model-free learning. This is further corroborated from research that indicates goal-directedness protects against the formation of sub-optimal habits (Gillan et al., 2015).

Research has demonstrated that higher levels of goal-directedness was in fact predictive of savings behaviour, (Lee & Hanna, 2015) where greater levels of goal-directedness predicted higher savings rates. Furthermore, goal-directedness was shown to depreciate monetary consumption where individuals with stronger saving goals were able to reduce their consumption compared to individuals with weak goals (Peetz & Buehler, 2009).

Future research is required to see if deficits in goal-directedness are the result of neurological pathways or are learnt responses to sub-optimal samples. If the former it may be difficult to influence goal-directedness, however this may be corrected from a pharmacological standpoint (Wunderlich, Smittenaar, & Dolan, 2012). If it is the latter, then this could be overcome through simple behavioural training, there is some evidence to suggest that this could be the case, where behavioural training does demonstrate greater

effects than pharmacological interventions in OCD (Chamberlain, Blackwell, Fineberg, Robbins, & Sahakian, 2005).

3.4 Prospective memory

Prospective memory is a factor of intentions and goal-directed behaviour and is defined as the ability to recall future intentions (Gordon, Shelton, & Bugg, 2011). Prospective memory is a necessary factor in cognitive control wherein the recollection of future intentions is important to initiate the behaviour (Insel, Einstein, Morrow, Koerner, & Hepworth, 2016). For example, consider an individual trying to remember to bring in a home-made lunch, the intention in and of itself is poor unless the individual recalls the intention to do so. In fact, research into prospective memory has identified it as a predictor of goal-directed actions (Gollwitzer, 1999; Judah, Gardner, & Aunger, 2013; McDaniel, Howard, & Butler, 2008). For instance in one study seeking to improve uptake in flossing behaviour, researchers attained measures of prospective memory from participants using the Prospective subscale from the Prospective and Retrospective Memory Questionnaire (Smith, Sala, Logie, & Maylor, 2000), with flossing behaviour measured through self-report via text-messaging. The researchers found that higher levels of prospective memory was predictive of increased flossing behaviour. This suggested that individuals with higher levels of prospective memory were more likely to recall future intentions which translated into an increased probability of behaviour change.

This finding is further reinforced from the use of implementation intentions. Implementation intentions depict conditional rules of behaviour based upon contextual cues (Prestwich, Paschal Sheeran, 1900; Braver et al., 2014; Gollwitzer, 1999; Rabinovich & Webley, 2007). These are frequently referred to as ‘if then’ rules, where, if an agent finds themselves in the given context, ‘ α ’, then perform action ‘ π ’. For instance, one implementation intention to increase keeping track behaviour may be: if, I am on my computer using Facebook, then, I will check my bank account. Implementation intentions have been shown to increase the likelihood of goal-pursuit, where individuals who make implementation intentions were three times more likely to complete their goals (Gollwitzer & Brandstätter, 1997). This finding is corroborated by a meta-review of 94 studies utilising implementation intentions (Gollwitzer & Sheeran, 2006), the authors found a moderate to high effect size in completion of goal-directed actions when engaging in implementation intentions (Cohen’s $d = .96$). Prospective memory can be

regarded as an integral factor in behaviour change, akin to intentions; however the link between prospective memory and behaviour is indirect and therefore requires additional components within the intervention or system to enable the intentions and engineer behaviour change.

3.5 Impulsivity

How individuals respond to choice is also an important factor in cognitive control, for instance consider the car vs. deposit example; one major aspect that could determine which option is chosen, is whether the individual acts before they can process the hypothetical outcomes, this is often referred to as impulsivity (Claes et al., 2006).

Impulsivity, has many domains but the most commonly observed or investigated in response inhibition (i.e. the ability to withdraw a prepotent response) (Adam R. Aron, Fletcher, Bullmore, Sahakian, & Robbins, 2003; Logan et al., 2014; A. Osman, Kornblum, & Meyer, 1986), the desire for rewards (idea of reward sensitivity) (Ablner, Walter, Erk, Kammerer, & Spitzer, 2006; Berridge, Robinson, & Aldridge, 2009; Büchel et al., 2017; Ondo & Lai, 2008; Valerie Voon et al., 2006). Research into response inhibition has mostly been engaged in the clinical disorders where the translation of impulsivity to behaviour is easier to observe (Chamberlain et al., 2005; Kulendran et al., 2013, 2016; Miller, Derefinko, Lynam, Milich, & Fillmore, 2010; Morein-Zamir et al., 2012; Penades et al., 2007). For instance, obese individuals typically show lower rates of response inhibition (i.e. higher levels of impulsivity) than healthy individuals (Nederkoorn, Guerrieri, Havermans, Roefs, & Jansen, 2009), in fact this relation is also explains differences in BMI scores (Kulendran et al., 2016). In one study examining response inhibition, researchers looked at weight over time (through BMI) and snacking preferences over a one year period. Participants were asked to complete the Stop Signal task at the start of the study. The researchers found that the interaction of response inhibition and high preference for snacks predicted weight gain (Nederkoorn, Houben, Hofmann, Roefs, & Jansen, 2010).

Only one researcher documents assessments of impulsivity in compulsive shoppers through neurocognitive assessments using the Stop-Signal Task (Derbyshire, Chamberlain, Odlaug, Schreiber & Grant, 2014). The researchers compared twenty three compulsive shoppers against matched healthy control. Compulsive shoppers demonstrated higher rates of response inhibition than healthy controls. Compulsive

shoppers also made riskier gambling choices and demonstrated poorer working memory. These results are indicative of an impulsive behavioural pathway that seems to underlie impulse control disorders and addictions (Everitt & Robbins, 2005; Grant & Chamberlain, 2014; Racine et al., 2014; Robbins & Clark, 2015). Temporal discounting could also explain deficits in savings rates by moderating monetary consumption through the behavioural policy of maximising immediate rewards. in temporal discounting rates, and higher levels of savings, even controlling for age.

Furthermore, research has shown higher reward sensitivity predicts sub-optimal behaviour (Büchel et al., 2017; Ondo & Lai, 2008). A case often an observed phenomenon in cases of addiction (Bickel et al., 2007; Vuchinich & Simpson, 1998). For instance, in one study examining differences in obese populations, a reward sensitivity parameter was able to differentiate populations based upon the BMI levels (Kulendran et al., 2016). In one meta-review, reward sensitivity coefficients were shown to exhibit a moderate differentiation parameter in stratifying addiction disorders from the healthy population (cohen's $d = .58$) (MacKillop et al., 2011). Reward sensitivity could perhaps impede savings rates by moderating monetary consumption through the policy of maximising rewards.

These results suggest that when goal-activation occurs, there are competing motivational systems arising from neurological pathways that drive behaviour. If the competing impulsive system overpowers the level of goal-activation then cognitive control becomes diminished. This response is exacerbated by impulsive individuals, who seem to possess a prepotent response or predisposition for reward seeking behaviour. However, there is evidence that impulsivity can be reduced (Kulendran et al., 2013), which has translational impact on financial behaviour, particularly consumption (Black et al., 2000).

3.6 Executive function

Executive function here refers to the storage, processing and updating and attentional processes (Royall et al., 2002). Working memory, a factor of executive function, has been shown as an important component in goal-directedness. For example, in one study, researchers compared assessments of working memory in substance dependent disorders against healthy control participants, and found that greater consumption was

differentiated by measures of executive function such as working memory (Verdejo-García, Bechara, Recknor, & Perez-Garcia, 2006).

In one further study, the researchers compared working memory with performance in a gambling task, they found sub-optimal decisions were more common amongst individuals with poorer working memory (Hinson, Jameson, & Whitney, 2002). The impact of poor working memory is also found in day-to-day life, wherein a longitudinal study examined the frequency of mind wandering or day-dreaming as measured through a personal digital assistant was predicted through deficits in working memory, as measured by the complex memory-span task. As such, this describes a level of protection from working memory towards goal-activation. Put succinctly, the literature would suggest that working memory translates as resources towards a given behavioural process, those with greater working memory are able to spare working memory to protect goal-orientated actions against competing motivations.

For instance, in one study examining executive function and savings behaviour, as measured through the ELSA (English Longitudinal Study of Aging), a British household panel survey. The researchers found that higher executive function predicted greater savings (Banks & Oldfield, 2007b). This finding is further supported by Cole and Shastry (2009), who examined cognitive ability through the Armed Services Vocational Aptitude Battery (ASVAB). The researchers identified greater cognitive ability was predictive of higher financial capability, through the knowledge and use of specialised financial instruments.

In a different study (Agarwal & Mazumder, 2010), researchers examined cognitive ability (again measured with the ASVAB) with household financial behaviour. The researchers find that cognitive ability protects from financial mistakes in credit-card behaviour, in addition to reducing error in property valuation for accurate loan and credit applications, resulting in lower annual percentage rates. The researchers highlight how cognitive ability protects from sub-optimal financial decisions.

Furthermore, the role of attention as a top-down process can influence which part of the world (or our visual environment) that we opt to process in more detail. For instance, in one study, researchers examined the attentional behaviour, through the use of eye-gaze detection, in adults with binge eating disorder. The researchers found a top-down propensity for attenuating to food-related stimuli in real world scenes, patients with

binge-eating disorder also attenuated faster to the food-objects than did healthy control (Popien, Frayn, von Ranson, & Sears, 2015).

Further results in eye-gaze detection of consumer behaviour reveals how our attentional processes can drive our decisions. For example, research in attentional processes of shopping behaviour has identified how products that receive greater attention are more likely to be purchased (Armel, Beaumel, & Rangel, 2008; Atalay, Bodur, & Rasolofoarison, 2013). Furthermore, in a binary choice task between familiar and novel products, individuals displayed an increased propensity to attend to and select the familiar option (Krajbich, Armel, & Rangel, 2010).

These results can demonstrate how despite goal-activation may be directed towards a given output, alternative motivational inputs, competing behavioural systems can lead to cognitive control problems. This competition seems to be moderated by Executive functions such as working memory.

SUMMARY

- A qualitative investigation of financial capability was undertaken following a sample of 72 participants across the UK for three months.
- This study uses secondary qualitative data, mapping this to the COM-B framework to offer a new take on how these factors influence and lead to sub-optimal behaviours and how these categorical systems identify the behavioural change techniques implemented in future policies and interventions.
- For Keeping Track, the key factors was mental accounting and numeral literacy, people would separate funds into different physical accounts to limit their consumption; yet this will prevent them from optimising their financial management, as this ignores the principle that money is fungible.
- Sub-optimal financial behaviour in making-ends-meet was characterised by automatic motivation, where most of the sample sought to purchase goods and products that would increase their social rank amongst their peers, this was reinforced through a dopamine response that is often observed in addiction behaviour.
- Sub-optimal behaviour in planning ahead was mostly regarding the processing of future events, the typical problems were temporal discounting, poor planning, evaluation and goal-setting.
- These issues ascribe a key set of behavioural mechanisms that explain sub-optimal financial capability. This offers a more coherent picture of the causes of sub-optimal financial capability and also explains where

4.1 Introduction

The current study employed a behavioural and ethnographic approach to understand and improve people's financial capability. This study examined people's naturally occurring household financial behaviours using observations and in-depth interviews. The insights provided by the observations and interviews were then fit into the COM-B framework to precipitate enablers and barriers of people's financial capability.

4.2 Method

This current study's method uses secondary data from qualitative observations and interviews of people's financial capabilities (Money Advice Service, 2014). Qualitative data provides an in-depth view of behaviour and cognitions to understand the behaviour through the participants' perspective. This provides a more detailed understanding of the processes involved in optimal and sub-optimal financial capability. This is an integral component in intervention design, to inform the intervention design and implementation (Gittelsohn et al., 1999, 2006). This formative work is conducted in line with the MRC approach for complex interventions (Craig et al., 2008).

The frequency count of the thematic analysis is then fed through a statistical analysis to identify key barriers and enablers, by assessing the distribution of the frequency of barriers and enablers across the COM-B model against a flat, uniform distribution. This process allowed for an in-depth understanding of the behavioural, cognitive and environmental processes that enable or act as barriers to financial capability, whilst identifying which particular factors to intervene on.

4.2.1 Advantages

It is noted that the following study uses secondary data collected by Ipsos MORI and the Money Advice Service (Money Advice Service, 2014). This was used as it provided an in-depth behavioural analysis of how individuals and household manage their finances, specifically in the context of financial capability. This therefore provided a unique dataset of in-depth understanding of financial capability, through a behavioural lens under the COM-B model. As a result, the dataset would allow a behavioural diagnosis to identify which behavioural factors contribute the most to optimal financial capability.

The sample population recruited for the interviews were representative of the population, as recruited from across the UK across different income brackets and demographic strands.

Furthermore access to qualitative datasets that match in regards to theoretical approaches and methodology are incredibly difficult to gain access to and therefore was a unique opportunity to use this dataset. Therefore this opportunity meant I was able to analyse the dataset without spending the months to find participants, collect and thematically analyse the dataset. I was therefore able to save an abundance of time that to focus on implementing the interventions.

Thirdly, the dataset was collected by the Money Advice Service for the purpose for designing interventions to increase financial capability (Money Advice Service, 2014). This meant that the function of the dataset aligned with the study research aims, providing me with a method to undertake formative research without the resource costs associated.

4.2.2 Disadvantages

One major concern with using secondary data, is the lack of control in the measures and data provided. One is unable to ascertain new information or clarify any existing trends or findings. This meant I was unable to ask participants any further questions than were otherwise already provided, preventing me from going any further in-depth.

Secondly, another issue is the validation of the thematic analysis, as this was conducted previous to my statistical analysis, the thematic analysis could demonstrate different themes if conducted by myself or another researcher. This therefore may have modified the behavioural determinants identified and could feasibly alter the content of the interventions. However, Ipsos MORI had multiple researchers on the project who all contributed to the thematic analysis and therefore should reach a consensus; however parameters of inter-rater reliability was not provided, meaning the degree to which the research team reached a consensus is unknown.

4.2.3 Participant recruitment

A total of 76 participants were recruited using opportunistic methods, through advertisements online, in newspapers and magazines as well as through telephone contact, across the United Kingdom's four countries and to vary across ages and socio-

economic classes. Of these 76 participants, 50 were located in England, 13 in Scotland, 8 in Wales and 5 in Northern Ireland. A breakdown of the sample demographics are described in Table 2.

Table 2; Demographic breakdown of participant families

N	Age	Socio-economic Class
18	45-64	Upper Middle class
15	Older group (more retirees)	Non-working
14	25-44	Lower Middle class
13	Slightly older	Working class
9	Young	Working class
8	Young	Skilled Working class

4.2.4 Materials

Observations and interviews according to a discussion guide designed to understand three components of people’s financial capability: Keeping Track of Money, Making-ends-meet, and Planning Ahead. Participants’ spending activities were monitored via spending diaries which were given to half of the sample (see 1.1.1.1Appendix A, 1.1.1.1Appendix B, Appendix C and Appendix D)

4.2.5 Procedure

A researcher from Ipsos MORI visited participants twice over a three-month period from August to October 2012. At each visit the researcher recorded observation notes and interview responses and transcribed. Each visit constituted one interview with the whole household (the duration ranged from three to eight hours). The first visit familiarised

participants with the structure and aim of the study, and captured participants' attitudes and perceptions towards money. The second visit captured how households discuss financial issues and how money is associated with their current goals and ambitions that they would like to obtain in the future.

4.2.6 Thematic Analyses

This study analyses the secondary data obtained from the interview transcripts and observations. The secondary data consists of the theme-level data, from which frequency counts were computed at each aspect of the COM-B framework (Table 3). The frequency count were analysed to identify and diagnose the barriers and enablers to financial capability.

As described above in Section 4.2.2, no validation checks were provided for the secondary data. This meant that the themes identified in the thematic analysis could be interpreted in another way if conducted by a different researcher. However, Ipsos MORI conducted the research with multiple researchers, all of whom contributed to the thematic analysis. However the inter-rater reliability parameters are not provided regarding the degree to which the researchers agreed with each other.

Therefore under a pragmatic approach, it is assumed that the validation checks of the coding have been conducted, with a reasonable ICC inter-rater agreement; $0.4 < \kappa < 0.6$. The pragmatic approach is an attempt to make use of the dataset without requiring further constraints, where Ipsos MORI were unable to provide any additional information due to their governance policy on data protection and storage.

4.2.7 Secondary Data

The interview transcripts and observations first went under a thematic analysis, coded onto three individual spreadsheets, for each component of financial capability: Keeping Track of Money, Making-ends-meet, and Planning Ahead. For each participant, coding was conducted on both enablers and barriers of financial capability. These codes were then fed into the COM-B framework (Capability-psychological, Capability-Physical, Opportunity-social, Opportunity-physical, Motivation-reflective, and Motivation-Automatic). The automatic motivation concepts were further coded onto each MINDSPACE concept (Messenger, Incentives, Norms, Defaults, Salience, Priming,

Affect, Commitment, and Ego). Reflective motivation was comprised of three constructs: evaluation, goal-setting and planning. Evaluative mechanisms compares positive and negative attributes of something. Goal-setting involves considering achievable outcomes (long or short-term). Planning denotes creating a structure and plan to achieve said outcome by specifying where, when, and how to execute an action. The coding was conducted by Ipsos MORI and were provided as completed. It is noted that the interrater reliability is impossible to calculate or validate these methods, and there is likely to be subjective judgements that were involved in the thematic analysis. However this analysis took a pragmatic approach, and assumed that the coding was within reasonable inter-rater agreement, in order to understand and identify the key barriers and enablers to financial capability.

The data contained in the spreadsheet were then analysed using descriptive and inferential statistics. Each count of the barriers and enablers were tabulated across the COM-B model, to produce a distribution of themes of enablers and barriers across the three domains of financial capability. The descriptive and inferential statistics was implemented using the frequency data for each of the barriers and enablers across the different themes.

The inferential statistics are conducted using one-way chi-squared tests comparing the expected and observed frequencies in each theme. Here, expected frequencies carries a flat, uniform distribution with each element of the COM-B model being weighted equally. For each one-way chi-squared, significant variation from uniform expected distribution was then followed down the hierarchical structure of the COM-B framework, for instance if Capability was significantly more frequent than Motivation or Opportunity, then a further test would be conducted comparing physical and psychological capability. This was computed for each hierarchical stage of the COM-B framework, comparing the highest three factors: Capability, Motivation and Opportunity, to individual components within each factor, i.e. Social and Physical Opportunity. This method isolated key behavioural barriers at a more specific level, as opposed to a general overview of behaviour.

4.3 Results

I highlight the findings of the interviews and observations in the Money Lives project (Money Advice Service, 2014), in addition to isolating and diagnosing the factors

underlying sub-optimal financial capability. This is achieved through examining the distribution of enablers and barriers, identifying key behavioural processes that contribute to sub-optimal behaviour. While many barriers and facilitators were identified, the results focuses on the most prominent barriers and facilitators.

4.3.1 Participants

Throughout the study four participants dropped out, which provided a sample of 72 participants.

Table 3; Frequency of enablers and barriers in financial capability

	Keeping Track		Making-ends-meet		Planning Ahead		
	Barrier	Enabler	Barrier	Enabler	Barrier	Enabler	
Capability	Psychological	15	25	21	26	13	26
	Physical	8	3	6	1	2	3
Opportunity	Social	6	6	14	26	10	15
	Physical	3	9	11	9	8	4
Motivation	Messenger	4	4	1	3	3	2
	Incentives	3	6	5	5	5	2
	Norms	1	1	9	6	0	9
	Defaults	3	5	6	1	5	0
	Salience	1	0	1	2	0	1
	Priming	0	0	1	0	1	1
	Affect	2	3	15	7	9	1
	Commitment	0	1	5	1	1	3
	Ego	1	2	12	6	2	1
	Evaluative	3	5	6	20	10	18
Reflective	Goal-Setting	0	0	1	5	3	20
	Planning	0	1	2	1	4	10

Figure 2; Distribution of barriers for Keeping Track

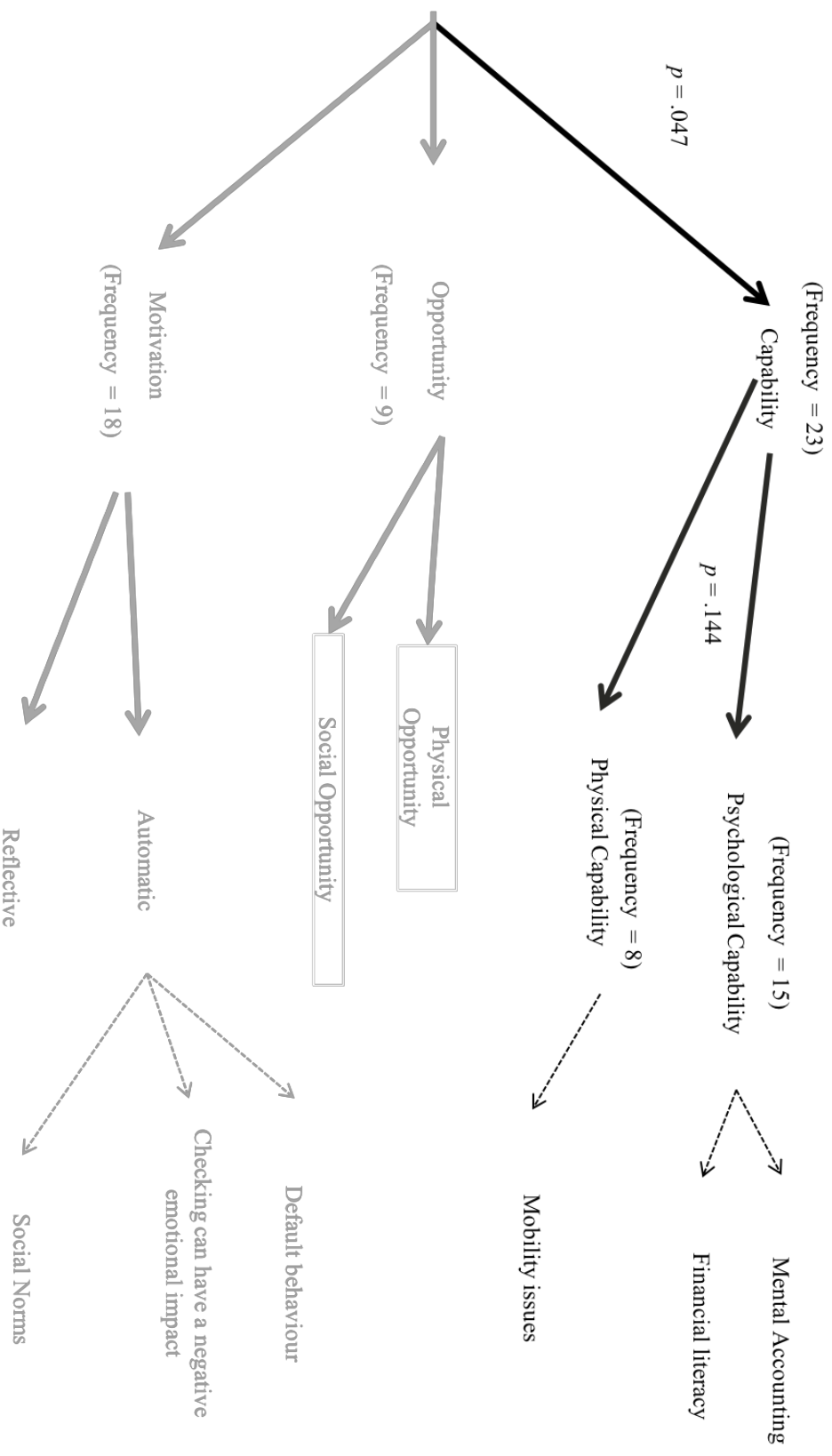
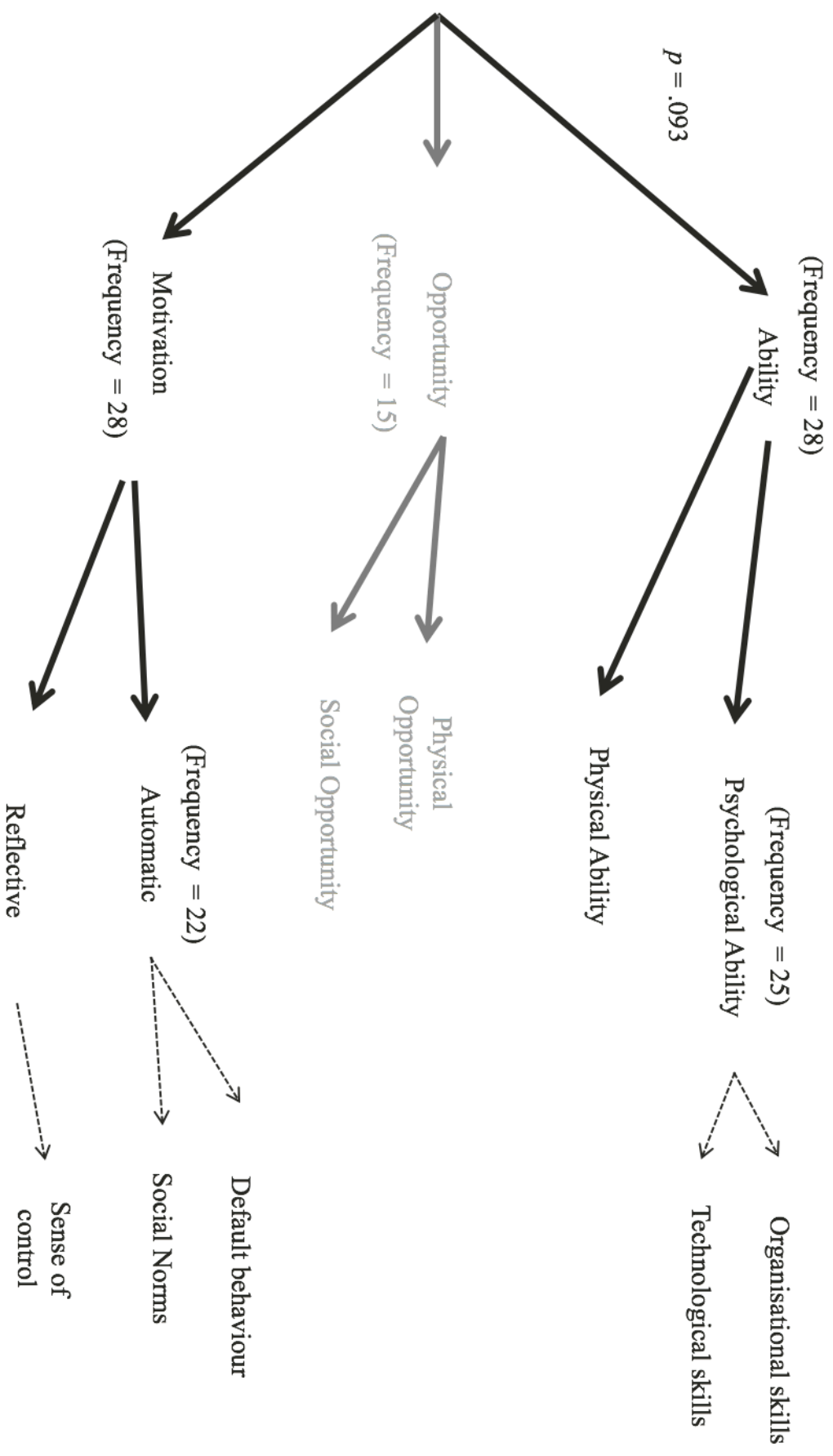


Figure 3 Distribution of barriers for Keeping Trac



4.3.2 Keeping track: thematic analysis

Participants identified more enablers (Total = 71) than barriers (Total = 50), where individuals were more likely to identify some of the key behaviours that help to remain in track of financial accounts. This would perhaps indicate that keeping track was easier to engage in than expected, that people found more affordances to engage in keeping track than there were difficulties in implementing this behaviour. This could also be a social desirability effect, where participants wanted to be seen as being on top of their finances (even if they were not) and wanted to avoid embarrassment of not knowing their own account activity.

4.3.2.1 Barriers

The initial analysis identified a significant difference between the observed and expected frequency distributions of barriers, $\chi^2(2) = 6.040, p = .047$. Capability (frequency = 23) and Motivation (frequency = 18) were shown to be more frequent barriers than Opportunity (frequency = 9).

This is illustrated in Figure 2 and 3, where the darker shade arrows demonstrate significant pathways. A secondary investigation to assess which capability factor was the most influential revealed an equal frequency of physical (frequency = 8) and psychological capability barriers (frequency = 15), $\chi^2(1) = 2.130, p = .144$.

The most frequent barrier was psychological capability (frequency = 15), typically exhibited as mental accounting. Previous research has linked mental accounting to consumer budgeting behaviour (Heath & Soll, 1996). Participants who resorted to sub-optimal mental accounting practices distributed their financial resources across physical attributes. For example, dividing cash across envelopes or spare wallet, an approach common amongst participants on lower incomes or state benefits.

“What we do is we work out what we are doing the next month on and then we go to the bank and take out all that money out as a lump sum and split it up into envelopes, so any money that is left in the bank is solely there for shopping. We find it more difficult when we are just working off the debit card, the debit card is very easy, where as if we have the cash there in our envelopes to use, we seem to live much better.”

Male, 45, Female, 41, Bristol, married, full time employment

Mental accounting is a sub-optimal strategy as money is fungible (Thaler, 1985; Thaler & Sunstein, 2008; Richard Thaler, 1999), £200 of money can contribute towards £200 of electricity or £200 of groceries. In doing so, individuals and households separate funds for saving from credit cards or debt, preventing them from adjusting or being flexible to maintain their financial goals.

Another example of psychological capability as a barrier is financial illiteracy; those who were struggling financially tended to not know or understand the different financial products available and lacked the skills to use these products to their advantage. To illustrate, one participant on a low income paid a monthly fee for a premium current account because he was unaware a free option was available. These individuals lacked an understanding about interest rates and the implications on future repayments, which led to some poor financial decisions.

“I don’t understand anything to do with money. All I know is that it goes into your bank when you get paid. I don’t understand interest or anything like that.”

Female, 21, Bangor, single, living with parents at home in full-time employment

Physical capability barriers were distinguished as physical and mental barriers, where those with physical disability (such as mobility issues) and/or mental disabilities (such as agoraphobia) faced some very practical barriers to keeping track of their finances as simply getting to the bank or ATM could be problematic.

To investigate which Motivation factor, automatic or reflective, a secondary investigation was ran, which demonstrated uneven distribution of barriers, $\chi^2 (1) = 6.720$, $p = .010$; where automatic barriers were more frequent (frequency = 15) than reflective (frequency = 3). However, further inquiry ascertained an approximately even distribution of barriers amongst automatic factors, $\chi^2 (8) = 9.600$, $p = .294$.

The results demonstrated how an individual’s automatic motivation was heavily influenced in their financial decision-making. Automatic motivation is fallible to numerous heuristic process and cognitive biases. One example of a barrier in automatic motivation is avoidance behaviour, where individuals would seek to avoid negative outcomes (Hart et al., 2009; Sweeny, Melnyk, Miller, & Shepperd, 2010), being fearful of checking their accounts. Research into avoidance behaviour has shown that higher levels of fear for negative outcomes drives information avoidance (Sweeny et al., 2010).

In the context of the present study, participants demonstrated avoidance in checking their accounts when they were aware this would identify: negative account balances, low account balances, impulsive and large spending. Participants would often seek to preserve their positive self-image than confront their current financial situation, avoiding the act of checking.

Such behaviour produced disastrous consequences when participants experience shortfalls. To illustrate, one participant confessed that he had previously not been concerned with keeping track of his finances; when his financial buffer was reduced he was forced to utilise his overdraft limit by two standing orders going out at the same time (car loan and insurance). He was made aware of the situation when his card was declined for petrol.

4.3.2.2 Enablers

A secondary analysis was conducted on the frequency of enablers across Capability, Opportunity and Motivation. The initial nested COM-B framework illustrated marginal differences in the distribution of the frequency of enablers across the COM-B factors, $\chi^2(2) = 4.761$, $p = .093$. Capability (frequency = 28) and Motivation (frequency = 28) were more frequent enablers than Opportunity (frequency = 15). As the results were only marginally significant no further analysis was conducted.

Psychological capability, characterised here as organisational skills, was the greatest enabler (frequency = 25) to keeping track, with ‘physical opportunity’ following as the second largest enabler (frequency = 9). Those more financially comfortable had developed meticulous spreadsheets in which they logged all activity. These individuals paid bills by direct debit and made use of online groceries sites. Participants on higher income brackets were knowledgeable in the account activity. For instance, receipts would be cross-validated with bank statements to monitor any transactions made.

“I spend £25 per week on food... I know because I record it... food can run away with you”

25, female, London, single person working full time, financially comfortable

Ways in which participants kept track of money was also driven by both social and physical opportunities. For instance, ease of access to ATMs coupled with technological developments such as apps for smartphones meant an opportunity to monitor finances activity regularly.

Automatic motivation can act as an enabler to promote keeping track of finances, one example is the illustration of priming; people could be actively persuaded towards a specific behaviour with a small prompt. Email reminders from respective banks or television adverts about fraud increased monitoring activity. This behaviour was seen predominantly for those with technological literacy, due likely to the increased physical opportunity to monitor.

Figure 4; Distribution of barriers for Making-ends-meet

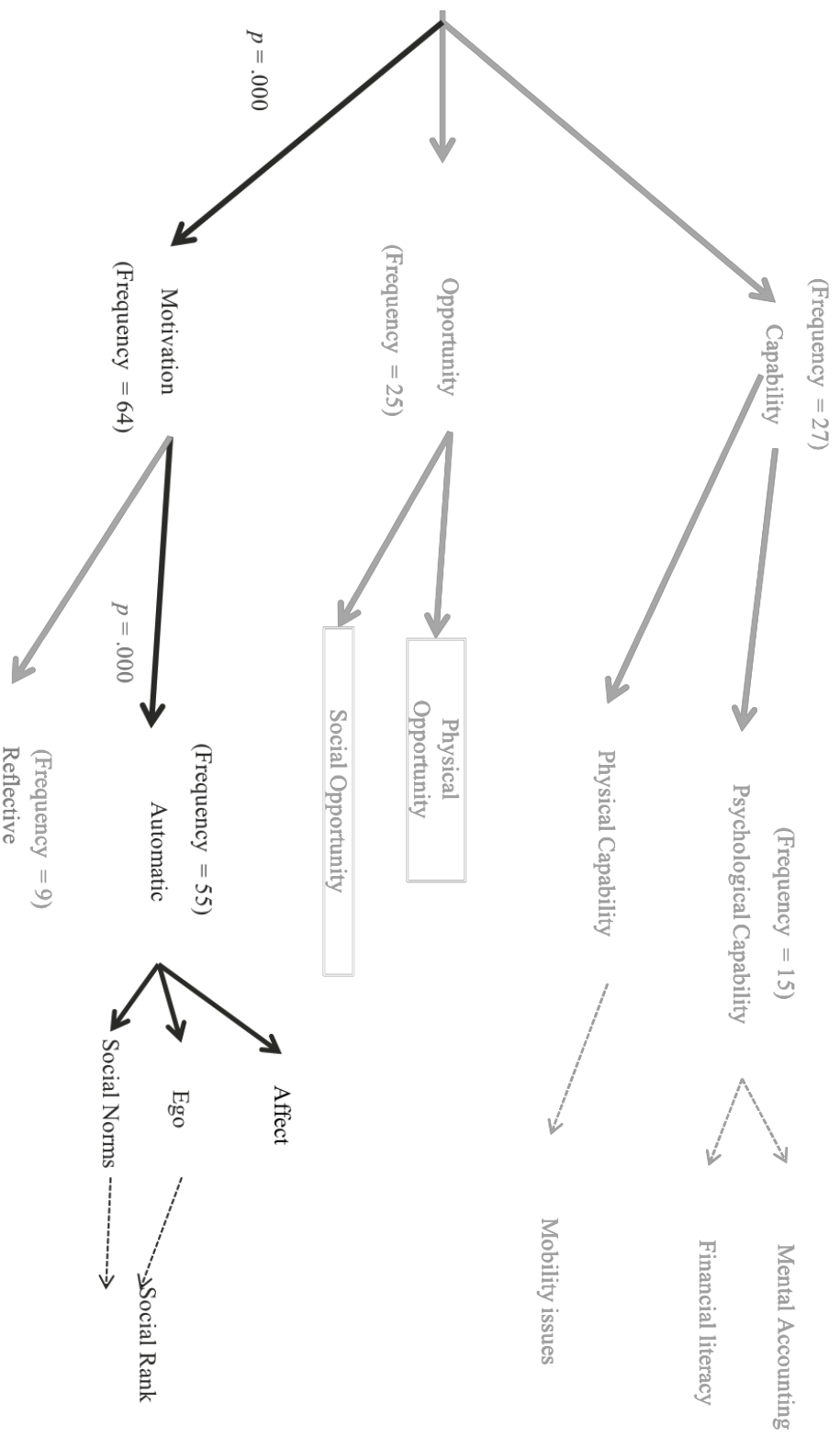
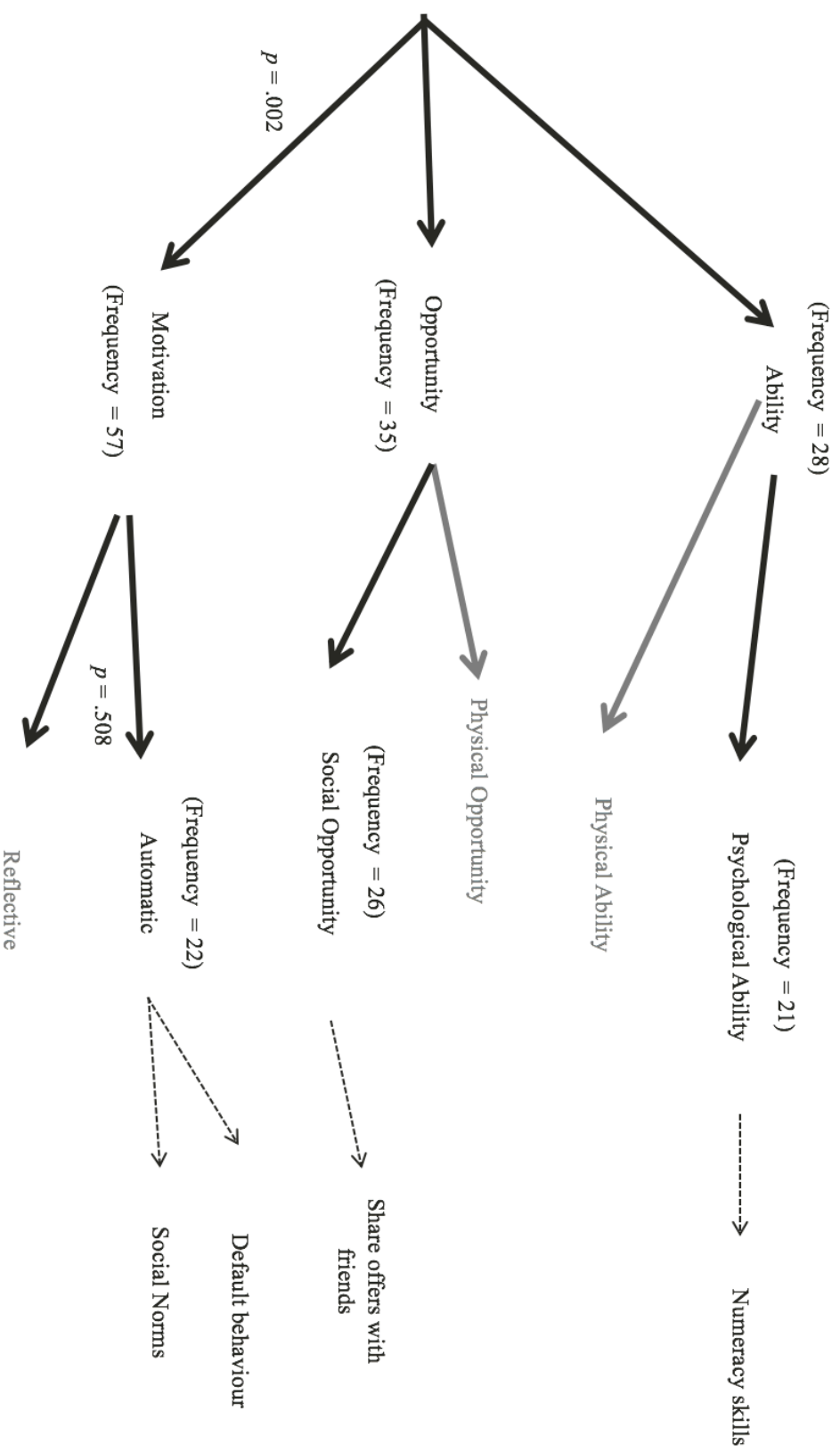


Figure 5; Distribution of enablers for Making-ends-Meet



4.3.3 Making-ends-meet: thematic analysis

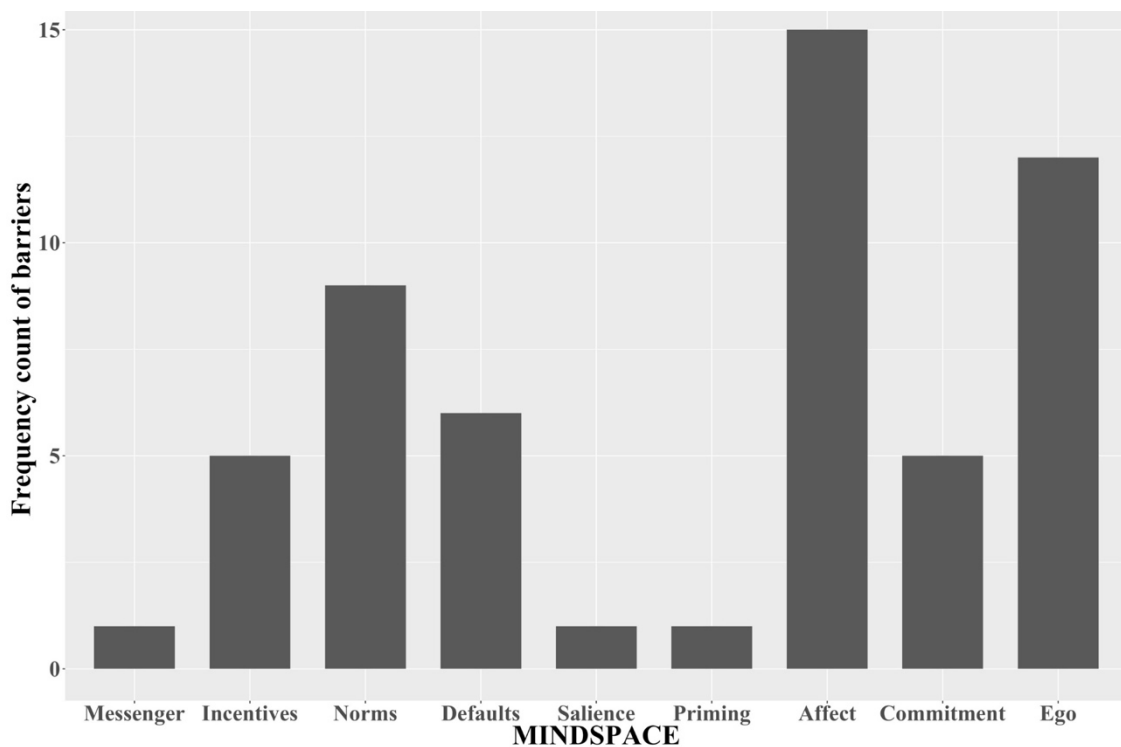
4.3.3.1 Barriers

A chi-squared analysis revealed a significant skew in the distribution of the frequency of barriers for Making-ends-meet across the COM-B framework, $\chi^2(2) = 24.948, p = .000$. The largest influence for Making-ends-meet was Motivation (frequency = 64), with Capability (frequency = 27) and Opportunity having roughly equal frequencies of barriers (frequency = 25). A more detailed breakdown of the prominence of these factors within affective motivation is illustrated by Figure 4, which details the most prominent barriers at the automatic level. A second chi-squared analysis was conducted to compare the frequencies of automatic and reflective motivation, revealed unequal distribution in frequencies, $\chi^2(1) = 33.063, p = .000$. Automatic Motivation was a more frequent barrier (frequency = 55) to reflective Motivation (frequency = 9). A final chi squared analysis compared within affective motivation comparing across the MINDSPACE categories, revealing a skew in the distribution of frequencies, $\chi^2(8) = 33.200, p = .000$, where Affective (frequency = 15) and Ego (frequency = 12) mechanisms are the largest factor of barriers to Making-ends-meet, with social norms following behind (frequency = 9), displayed more clearly on Figure 6.

Analysis of ego-based mechanisms revealed that one major factor of household financial management was maintaining a positive self-image, or preserving their ego. Research into ego-based heuristics has demonstrated that people want to have a positive self-image (Dolan, Hallsworth, et al., 2012; Vlaev & Dolan, 2015). Participants attributed a large weighting to their social status, where materialistic possessions gave an increase in relative rank position within their social network, empirical research has demonstrated that people are often impacted by their rank rather than absolute wealth (Boyce, Brown, & Moore, 2010). Social rank also influenced participants to demonstrate outward expressions of material wealth, regardless of their financial situation. Individuals who meticulously monitored their own finances were offset by the need to be of equal social rank to their friends and would strive to purchase similar things to their friends so as not to be outshined. People did not want to be seen as being too restrictive with their spending behaviours, an effect greater amongst younger participants. Investment into social rank was further reinforced by emotional gratification. Participants were spending because of

the affective reinforcement they received; spending the money made them feel good regardless of whether the item was necessary. Such rewards were reinforced by social gratification and through an emotional ‘hit’, acting as an operant conditioner . This emotional hit denoted a release of dopamine, a neurotransmitter linked to addicted behaviours and hyper-consumption (Blum et al., 2012; Daw & Tobler, 2013; Kim et al., 2011; Lawrence & Brooks, 2014).

Figure 6; Frequency of barriers in Automatic Motivation



Capability was still an important factor (frequency = 27). This was expressed typically in Psychological Capability (frequency = 15). Participants on low income or with limited resources were more likely to lack the necessary skills and knowledge (e.g. numerical literacy) to live within their means. As such, they were often left overdrawn or unable to pay for everyday necessities.

4.3.3.2 Enablers

Investigating the distribution of frequencies for enablers across the COM-B factors identified a non-uniform distribution, $\chi^2(2) = 12.168, p = .002$. Motivation was the most frequent enabler (frequency = 57), followed by Opportunity (frequency = 35) and

then Capability (frequency = 27). Further assessment of motivational factors identified no significant difference in the prevalence of reflective (frequency = 26) and automatic mechanisms (frequency = 31), $\chi^2(1) = .439$, $p = .508$.

Automatic Motivation did act as an enabler where relatives had a major influence on financial behaviour, both with conforming and opposing outcomes, where some participants mimicked their parental attitudes, whilst others rebelled against it. To illustrate, one participant associated his father's cautious approach to money management with being denied the things that he wanted and, as a result, was identified as a behaviour that should be avoided not emulated.

Opportunity was the second prominent factor to Making-ends-meet. Social opportunity was more frequent (frequency = 26) than physical opportunity (frequency = 9). Participants would seek advice and utilised their social network to make the most of purchases and benefits, with larger social networks issuing more social opportunities. For instance, participants would share buy one get one free offers with friends so as to reduce the cost of shopping. They would use their social network to improve knowledge of available benefits, by checking if they were eligible for the same benefits that their friends and colleagues were entitled to.

Figure 7; Distribution of barriers for Planning Ahead

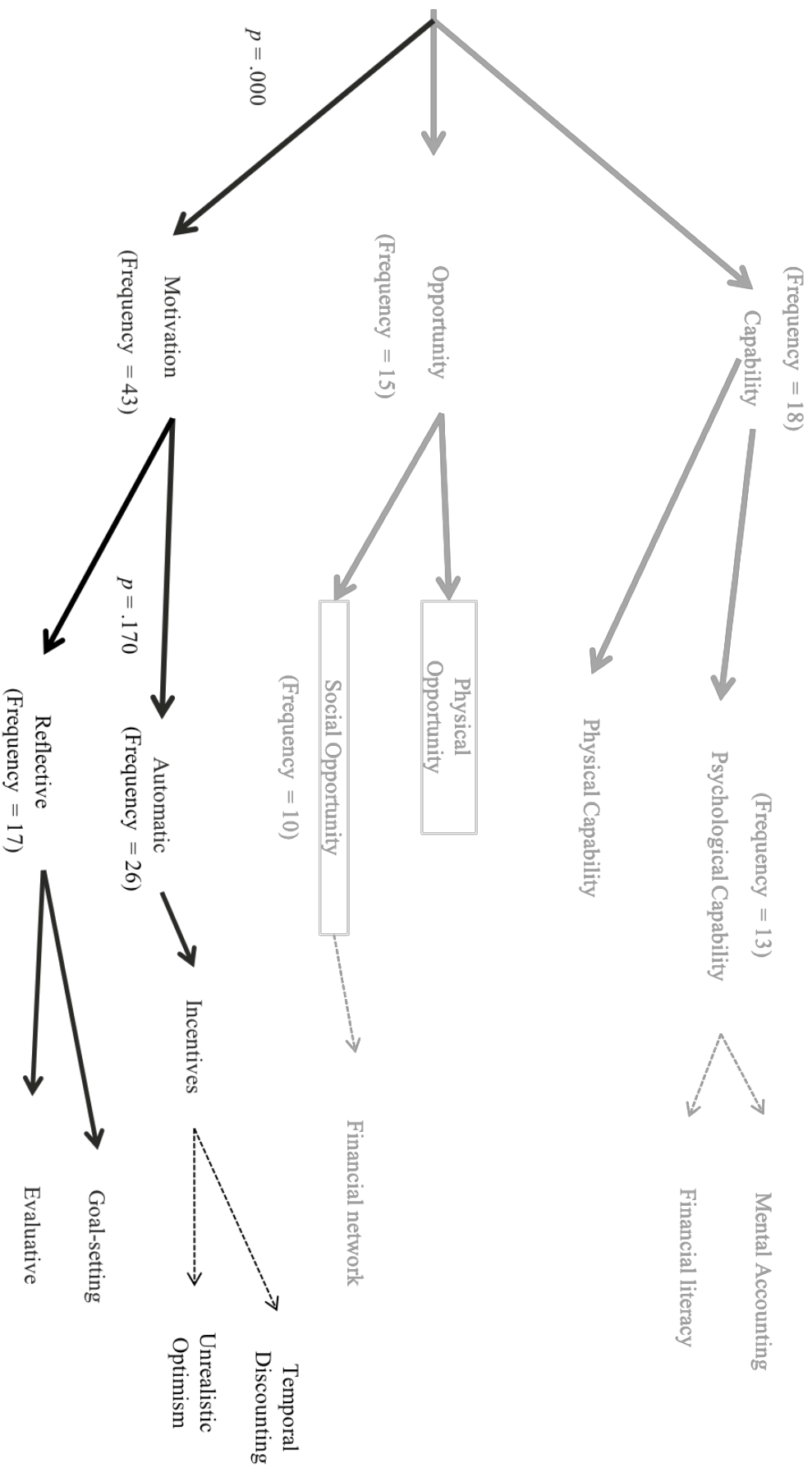
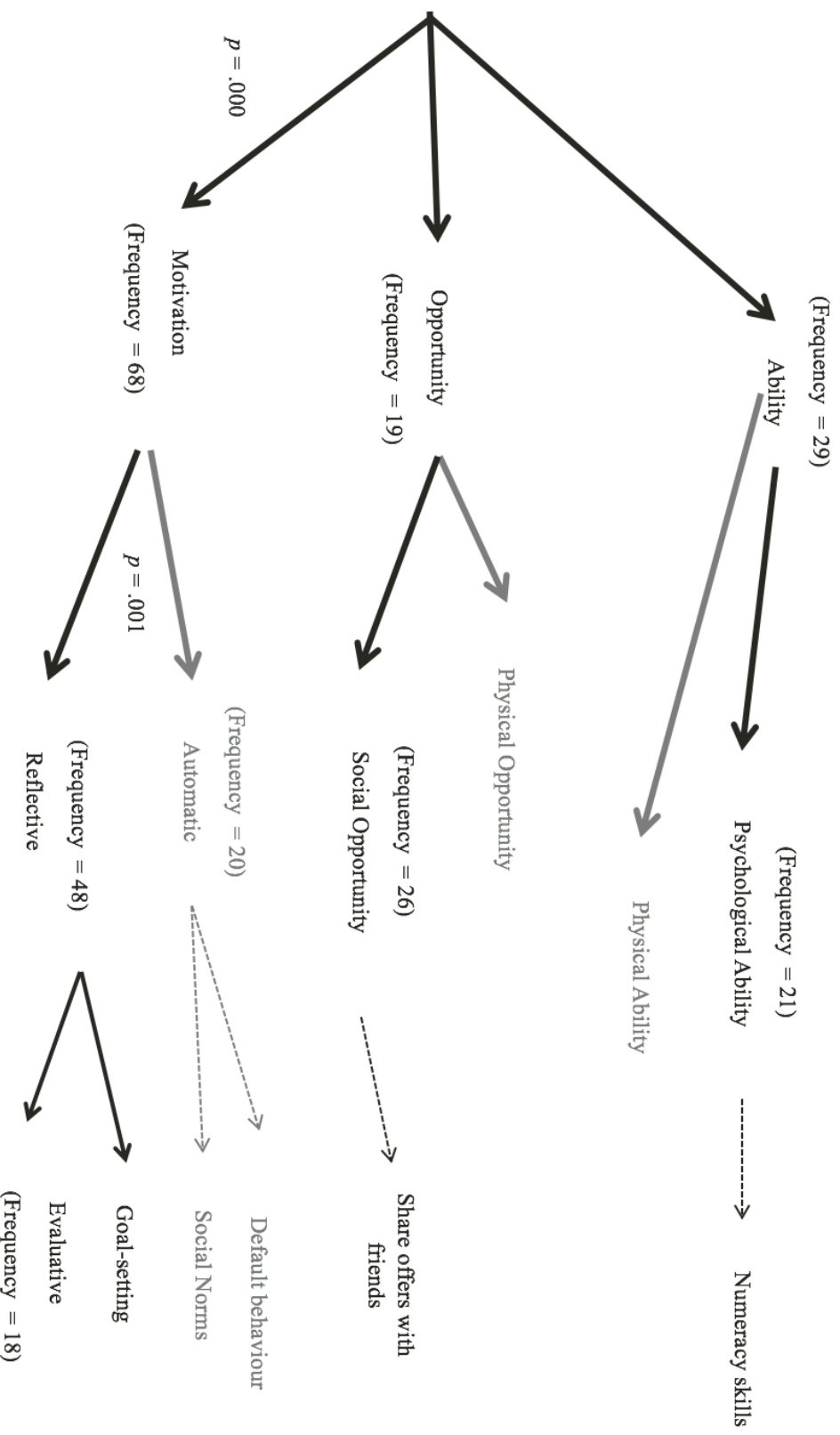


Figure 8; Distribution of enablers for Planning Ahead



4.3.4 Planning ahead: thematic analysis

4.3.4.1 Barriers

A chi-squared analysis revealed an significant, unequal distribution of frequency of barriers of the COM-B factors for Planning ahead, $\chi^2 (2) = 18.658, p = .000$. The most prominent was Motivation (frequency = 43), followed by Opportunity (frequency = 18), then Capability (frequency = 15). Further examination of motivational factors identified a non-significant difference between reflective (frequency = 17) and automatic factors (frequency = 26), $\chi^2 (1) = 1.884, p = .170$. This was exhibited in Figure 7, which identified motivation as the most prominent domain, but this did not differentiate between automatic and reflective mechanisms.

The most prominently reported barrier to planning ahead was Motivation, although Reflective and Automatic Motivation contributed equally. Participants were highly influenced by future states, for instance those with higher income levels were more likely to take out insurance to protect their future states and goals. One prominent barrier to planning ahead was inertia; many participants kept with their current default provider (insurance, mobile phone contracts, utilities) and choosing to auto-renewing, rather than comparing different quotes and shopping around which would reduce their monthly costs. The inertia bias prevents individuals and households from exerting some effort to reduce monetary consumption in the long-term.

Individuals who struggled financially often failed to set goals or plan for their future, regardless of income.

“We don’t invest anything longer than two years ahead”

59, female, Glasgow, married, retired, financially struggling

Participants demonstrated sub-optimality in their capability of future planning, participants demonstrated deficits in goal-directedness by not setting outcome goals. This meant individuals would often look for short-term desires (for example, end of the month payday spending), as opposed to saving goals. This meant individuals were pursuing short-term drives (purchasing goods to increase their social rank) rather than flexible

goals, which meant cutting back on expenses to be able to afford a new car or deposit on a house.

If a goal was set, participants would sometimes not plan effectively, often making an outcome goal (for instance put down a deposit for a mortgage) yet fail to specify an action plan of how to do so (for instance, set aside £2000 per month). This lack of planning meant that participants would often fail to reach their goal.

These individuals would often struggle with unexpected bills or situations and found it difficult to cope. These same individuals would often fail to evaluate their financial situation over varying points of time. Individuals who evaluated their current state from their outcome goal or reference point would often fail to reach their saving goals, because they were unable to identify any progress (or lack thereof and adjust their behaviour accordingly). The deficits in goal-directedness was associated with a propensity to engage in automatic motivational mechanisms. For instance, people display a preference for immediate over delayed rewards influenced their financial behaviour. This tendency to prefer smaller immediate over larger delayed rewards, is known as temporal discounting (Bickel, Koffarnus, Moody, & Wilson, 2014). Many participants described themselves as wanting to ‘live for the day’, and did not seek a lifestyle where they planned ahead. Such disparity across participants could be a result of individually constructed happiness concepts (Lyubomirsky, 2001; Lyubomirsky & Tucker, 1998). Temporal discounting, in addition to ego mechanisms (e.g. unrealistic optimism), acted as a barrier for future social care and support. Participants found it difficult to conceive the possibility for the requirement of future support. This was typical from individuals whose parents were still alive and independent, as they would construe that their own future would be similar to their parents.

4.3.4.2 Enablers

The frequency of enablers across the COM-B framework revealed a significantly non-uniform distribution of frequencies, with Motivation as the most prominent enabler (frequency = 68) than Capability (frequency = 29) or Opportunity (frequency = 19), $\chi^2(2) = 34.672$, $p = .000$. A second order analysis revealed that reflective mechanisms (frequency = 48) were more frequent than automatic mechanisms (frequency = 20), $\chi^2(1) = 11.529$, $p = .001$. Further investigation of reflective Motivation compared prevalence of enablers across evaluation, goal-setting and planning which revealed no

significant differences in the distribution of enablers across evaluation (frequency = 18), goal-setting (frequency = 20) and planning mechanisms (frequency = 10), $\chi^2(2) = 3.500$, $p = .174$.

Goal-directedness was the prime reflective mechanism that facilitated planning ahead, regardless of income. Individuals who set savings goals and planned appropriately displayed a greater sense of financial well-being and perceived sense of control. These individuals could also demonstrate flexibility when experiencing an unexpected bill or financial circumstance. Individuals who implemented action planning were also more commonly executing evaluative mechanisms, by actively evaluating these individuals were able to put in place appropriate mechanisms and sometimes identify circumstances ahead of time. For instance, some individuals put in place a financial buffer to protect themselves from unforeseen expenditure, or had savings for a specific goal. Risk aversion was demonstrated through these 'account buffers', brackets of savings to buffer against financial uncertainty. One participant stated that if she had less than £2,000 in her current account, she would be worried. The trade-off of interest against security identified a risk averse behaviour common amongst higher earning individuals to reduce financial uncertainty over increasing resources. This risk aversion meant that individuals would set aside funds for a financial buffer, rather than investing this sum and optimising their finances.

Goal-directed behaviours were also shown in long-term outcomes, such as their children's future. For example, participants were highly motivated to save for their children, stating this act was an investment in their children.

Those with higher income demonstrated a better knowledge of the kinds of products available to help them save for the future. ISAs, for instance, were perceived as being accessible and low risk.

Participants would routinely reduce physical opportunities to spend, by asking their family or social network to look after any spare money as a means of helping them to save. This behaviour was higher amongst lower income brackets. The person relied upon would be an authority figure meaning participants would more likely adhere to saving or reducing debt. Furthermore, one's physical opportunity, as described by the environment in which they generally work, heavily influenced financial planning. Sporadic employment, for instance, led to a fluctuating income making it very hard for

people to plan ahead as they often wouldn't know what they could expect to earn in the following weeks or months.

4.4 Discussion

The initial assessments detailed the major barriers and enablers to each of the components of financial capability. Keeping track of finances was highly reliant on Capability, predominantly Psychological Capability. Psychological capability was both a barrier and an enabler to keeping track of finances; psychological capability was characterized as a prominent barrier through mental accounting practices, which is sub-optimal as money is fungible, £100 towards clothes can still buy £100 of heating. However, Psychological Capability could promote people to keep track of their finances if they engaged in a highly organised approach. Participants who would actively manage their finances through meticulous spreadsheet often found any problems early, and due to the high frequency and regularity of monitoring could solve these problems with little difficulty. This was shown across income brackets.

Ego-centric and affective mechanisms were the most featured barrier of Making-ends-meet, whilst reflective and automatic motivations equally contributed as enablers of Making-ends-meet. Participants attributed a significant weight to their social rank and status, seeking to maintain and increase their social rank amongst their social network. Maintenance and improvement of one's social rank position was reinforced from affective reward that increased the weighting of social rank. This resulted in individuals and households spending money (in addition to their usual monetary consumption such as grocery and bills) to maintain or increase their social rank. Motivation at the same time acted as an enabler of Making-ends-meet, participants could also utilise their social network to conform to other's saving behaviour, or adopt their parental attitudes to purchasing and saving behaviour.

One of the most important drivers of planning ahead, and being able to imagine what may lie in the future, is the attitude and motivation people take on from their friends, family and their workplace. The greatest barrier and enabler of planning ahead was most prominently Motivation, with no discernible difference between reflective and automatic mechanisms; although reflective motivation was the most frequent enabler of planning ahead. Interestingly, people also exhibited unrealistic optimism bias, where they tend to underweight the probability of negative future outcomes (McClure, Wills, Johnston, &

Recker, 2011). Inevitable events such as funerals are typically accounted for, but medical issues or the loss of a job are discounted as an ‘unforeseen event’ and one which is unlikely for a participant to anticipate themselves experiencing. People who were highly goal-orientated and evaluative had much more success in planning for their future financial well-being. Whilst those who exhibited deficits in goal-directedness were often influenced by extraneous circumstances, and would underweight future events.

By using a frequency-based approach, this study was able to identify possible intervention designs based upon the most significant factors of the COM-B framework to each component of financial capability. As such the interventions could simultaneously reduce the impact of significant barriers and further accentuate the effect of enablers to each key component of financial capability.

4.4.1 Financial education

This study identifies why financial education could have inefficient effects, educational interventions target psychological capability, but as illustrated in the results that Motivation and Capability both are the primary drivers, this dissociation means that educational policies do not effectively translate into behaviour change. Due to the assumptions of behaviour that the educational policies take, motivational factors will not be effectively targeted, as such, the use the of education may not translate into cost-effectiveness policies. This has been illustrated from public health research in the dissemination of information to change behaviour (Corace & Garber, 2014; Kelly & Barker, 2016; McCluskey & Lovarini, 2005; J. Nichols, 1994). Educational policies do increase capability to implement a behaviour, but the additional requirements of opportunity and motivation to enact a behaviour are more important than the capability to do so. This does not mean that interventions should not focus on education, but that education is not the sole approach to be taken and increasing opportunity space and people’s motivations are usually more effective.

This study used a behavioural lens to offer a more coherent overview of the processes behind sub-optimal financial capability. This take uses grounded evidence-based theory (Michie, Van Stralen, et al., 2011) to invoke and understand the underlying behavioural mechanisms. By gaining an accurate picture of the effects and mechanisms, more effective interventions can be developed to counter these behavioural factors. Whilst at the same time, utilising the behavioural enablers to promote the target

behaviour. Thereby identifying why certain people succeed, can be utilised to support those struggling.

4.5 Conclusion

The reported studies utilized a wide-scale assessment of financial capability within the general population, with a large sample of 72 participants each with in-depth observations and interviews to provide a more comprehensive understanding of how people think about money. This investigation employs a comprehensive and systematic theoretical model that offers a more coherent approach of human behaviour (Michie et al., 2014). The study used a substantial sample, which was evenly sampled across geographic regions within the UK, across age and even socio-economic class. These observations provided a detailed insight into the factors that comprise the barriers and enablers of financial capability. These were systematically examined under specific interventions designed to modify behaviour for particular components of financial capability.

To the authors knowledge, this is to date the most large-scale in-depth assessment of financial capability behaviour within the UK through a qualitative investigation. The first study identified underlying mechanisms behind consumers poor financial decisions that left them struggling financially. The majority of consumers who struggle to monitor accounts are doing so due to an overreliance on mental accounting, although consumer's reliance on mental accounting is well understood in the literature (Heath & Soll, 1996; Reinholdt, Bartels, & Parker, 2015; Thaler, 1985). A novel finding identified through the use of the mapping onto the COM-B framework, is the influence that the desire to maintain and increase ones perceived social rank on monetary consumption . It is shown that shopping behaviour can reduce negative affect (Edwards, 1993; Rick, Pereira & Burson, 2014), however here the findings offer a mechanistic understanding behind debilitating spending. The findings suggest that consumers spend to increase/maintain their social rank amongst peers. Maintenance and improvement of one's social rank position was reinforced from affective reward, an emotional 'hit' that increased the weighting of social rank. This emotional hit codes for a dopamine release, which is the neurotransmitter associated with addiction and reward-seeking behaviour (Blum et al., 2012; Everitt & Robbins, 2005; Lawrence & Brooks, 2014; Murray et al., 2014). This finding provides a psychological understanding of the plausible underlying mechanisms behind overspending.

The principle of purchasing into one's social rank is not in itself sub-optimal, the sub-optimality is the extent to which the drive and cost to increase one's social rank is greater than participants can afford (in both financial and other resources). This is also valid for goal-directedness, or lack thereof. Deficits in goal-directedness does not by itself constitute sub-optimal behaviour, this is the extent to which the lack of goal-directedness prevents individuals from reaching a stable financial position.

The enablers of a given behaviour characterises the required training and behavioural change techniques to be employed in future interventions, by targeting automatic motivation or processes (habit-based interventions), or increasing goal-directedness and self-control through reflective motivation (goal-setting interventions). The enablers to a given behaviour identify the types of reinforcements that promote such actions (i.e. reflective mechanisms for goal-setting behaviour), as well as the methods in which interventions should utilise, for instance providing feedback on outcome of behaviour.

The barriers of a given behaviour, identify the reinforcement driving the sub-optimal behaviour, the traps people fall into when attempting to shortcut financially sound behaviours; as well as the frequency with which they do so. These rewarding mechanisms enforce habit associations into memory (Wood & R niger, 2016), leading to further execution of the behaviour. These rewards require little effort or contemplation from the individual, for instance affect has been shown to drive consumer purchase decisions (Garg, Wansink, & Inman, 2007).

This investigation identified that financial capability is dependent upon behavioural processes, not just knowledge structures. Secondly, social networks and psychological processes play a big role in financial capability. And finally, that becoming financial capable is dependent upon using a clear tangible attribute, such as savings.

Chapter 5 Intervention design and function

SUMMARY

- A small pilot was run to examine in-depth assessment of the interventions.
- Participants exhibited anxiety in the Substitution intervention, with even more reluctance for the Checking intervention because they are concerned with tangible results for savings. Checking intervention was dropped due to the lack of resources available to refine and employ the intervention.
- Data collection techniques result in moderate levels of adherence (73.75%) but do show missing data and will require larger samples that would take a long time to procure.
- Current intervention structure is too expensive to roll out and will require some other forms of retention and data collection strategies.
- Retention strategies need to be readdressed for a new retention strategy given the larger sample of the randomised-controlled trial.
- Behavioural tool needs to be redesigned for a more efficient data collection system. A web-based expense tracker was designed to replace the spreadsheet behavioural tool. This was to collect goal-setting data automatically.
- Automated emails will be sent to participants in the re-designed trial, with a link to the behavioural tools for both intervention groups.

5.1 Background

This chapter informs the reader how the findings from the study described in Chapter 3, informed the design of interventions to be evaluated against a control condition in a randomised-controlled trial (RCT), secondly, this chapter assesses the feasibility and acceptability of the RCT. The RCT trial is described in the next chapter.

5.2 Summary of formative research findings

Recent work (see Chapter 3) captures the barriers and enablers to financial capability in the United Kingdom's adult general population. As a reminder, within the study data from 72 participants were interviewed twice across three months to understand three key areas of their financial capability, including Keeping Track, Making-ends-meet and Planning Ahead. The obtained data was codified for each area separately. The coded factors included concepts described by the COM-B framework and the MINDSPACE toolkit, and each concept was sub-divided into enabling and facilitating aspects. The formative research results from the previous chapter are briefly reviewed below, as they pertain to each area of financial capability.

For Keeping Track, people's ability was highly reliant on their Capability, predominantly Psychological capability, in both the barrier and enabler aspects. As a barrier, Psychological capability was frequently identified as having a negative association of checking behaviour; where an individual learnt to associate negative reinforcer with the behaviour of checking their accounts. As an enabler, Psychological capability could facilitate people's checking if they engage in highly organised management techniques, i.e., creating spreadsheets often detected any problems early, where regularity of monitoring could solve these problems quickly and efficiently.

For Making-ends-meet, people's motivations contributed in both the barrier and enabler aspects. As a barrier, people's automatic motivation to make-ends-meet was the most prominent. This barrier materialised typically as people seeking to maintain and increase their social rank amongst their peers by purchasing items outside their financial means. These processes were exhibited in participants regardless of age. As an enabler, automatic motivation was characterised through the use of social norms, e.g., people

whose friends and parents had healthful financial attitudes and behaviours were able to take up those healthful attitudes and behaviours.

For Planning Ahead, people's motivations again contributed in both the barrier and enabler aspects. As a barrier, people exhibited an unrealistic optimism bias (McClure et al., 2011), where inevitable events such as funerals are typically accounted for, but unforeseen events medical issues or the loss of a job are discounted. As an enabler, people's reflective motivation was the key factor. For example, people who were more goal-directed by setting goals and action planning, had much more success in saving and were less influenced by extraneous circumstance.

5.3 Behavioural diagnosis of sub-optimal behaviours

The typical behaviours underlying the three domains of financial capability can be understood in terms of psychological and behavioural mechanisms of motivation that reinforce sub-optimal financial behaviours. These can be understood in regards to the dual-process theories of motivation and behaviour (Daw et al., 2005; Evans & Stanovich, 2013; Kahneman, 2011), this stems across reinforcement learning (Daw et al., 2005; Huys & Dayan, 2009; Otto et al., 2015), habit theory (Gardner, Lally, & Wardle, 2012; Lally & Gardner, 2013; Lally, van Jaarsveld, Potts, & Wardle, 2010) and goal-theory (Dolan & Dayan, 2013; Locke & Latham, 2002, 2006). One system is automatic and efficient, which is referred to as System 1 in bounded rationality models, or model-free learning in reinforcement learning. The secondary system is a goal-directed, computationally heavy system that requires more resources but can process more information in line with intentions and behavioural targets, this is referred to as System 2 in bounded rationality models, or model-based learning in reinforcement learning.

When examining Keeping Track, individuals demonstrate an aversion to checking their accounts, this aversion can be understood better as avoidance behaviour. Avoidance behaviour is the tendency to inhibit behaviour towards a given state. Here, individuals exhibit avoidance behaviour in checking their account balances, which can be understood as Pavlovian-instrumental-transfer (PIT). PIT is a model of learning, where a cue (conditioned stimulus) of spending (i.e. recalling past expenditure) is paired with a negative reinforcer (through affective responses of anxiety), which enhances the operant conditioning directed towards checking their accounts. This model explains how

individuals motivations can lead them to avoid checking their accounts due to the influence of negative affective responses.

Investigating the key factors promoting sub-optimal behaviour in Making-ends-meet, the most prominent behavioural triggers were of a consumption of financial resources to increase their social rank amongst their peers. This consumption was reinforced through a positive reinforcement signal of a dopamine release. The release of the neurochemical dopamine is associated with the feel-good, pleasurable feeling one feels when one's expectations are reached or surpassed (Blum et al., 2012; Kim et al., 2011; Ondo & Lai, 2008). This acts as a reinforcer of behaviour making it more likely to repeat actions (Daw & Tobler, 2013) and even to lead to addictions (Bickel et al., 2007; Blum et al., 2012; Everitt & Robbins, 2005). In this case the states that afford actions to increase social rank position become positively reinforced through, operant conditioning (Tricomi, Balleine, & O'Doherty, 2009), or model-free reinforcement learning (W. Wood & Runger, 2016; Zhu et al., 2015).

Model-free learning, a habitual model of learning under reinforcement learning, suggests that individuals form cached values of actions through learnt associations of sequential state-action pairings when there is a positive reinforcer. Here individuals learn to associate the state, in which they can purchase products that would improve their social rank, with the positive reinforcement signal of dopamine release. This makes them more likely to consume into their social rank, and thereby in each instance produces a reinforcement signal of dopamine

In Planning ahead, the motivational mechanisms were much more diverse than in Keeping Track or Making-ends-meet, the results demonstrate the individuals display deficits in goal-directedness as a typical illustration of sub-optimal behaviour. Deficits in strategizing and executing plans, these issues fit within the realm of goal-theory (Locke & Latham, 2002, 2006); which dictate how the use of detailed specified outcomes, in addition to specified behavioural plans can significantly improve the chances of executing and reaching said goals. In addition these processes can also be understood through model-based reinforcement learning (Daw, Gershman, Seymour, Dayan, & Dolan, 2011b; Wunderlich et al., 2012); which is a goal-directed reinforcement learning system. Model-based learning refers to the ability to use a learnt model of the environment and internal motivations to prospective action values to reach a given terminal point. Deficits in model-based learning given from a poorly constructed

cognitive model of the world, or from a poor policy, that is to say the selection of state-action pairings, can result in sub-optimal outcomes (Gillan, Kosinski, et al., 2016).

Secondly the results also show deficits in automatic mechanisms of temporal discounting in the desire for immediate gratification over optimal future endeavours, individuals are more likely to consume now for an immediate reward than delay gratification for more optimal outcomes. This is further exacerbated by the avoidance behaviour of debt, focusing primarily on purchases as gains. This system of processing meant individuals would often spend at will relying on their income to improve their reference point.

5.4 Intervention design and purpose

For each domain of financial capability, an intervention was designed to combat the barriers against and utilise the enablers to promote financial capability. Each intervention is described below.

5.4.1 Keeping Track - Checking Intervention

Intervention name: Checking intervention

Sequential list of actions:

1. Identify activities with intrinsic motivation
2. Rank them by frequency
3. Pick the most frequently executed that affords account checking immediately after the behaviour (such as use of mobile phone, laptop or computer, or nearby to an ATM or branch)
4. Pledge an implementation intention to check bank account after performing the activity

To compete with the aversive internal mechanisms that motivate avoidance behaviour, a contrasting positive reinforcing signal was required. This is a form of operant conditioning to overwrite the effects of PIT, by introducing a positive reinforcer to overcome the negative reinforcer. This technique has been often referred to as a ‘cognitive vaccine’ (Browning, Holmes, Charles, Cowen, & Harmer, 2012a).

An example of this technique can be illustrated in a behavioural training intervention known as attention bias modification, a behavioural training paradigm which uses probabilistic rewarding of the valence stimuli on select trials to alter behaviour by changing the affective responses to the stimuli in question. This intervention technique has been shown significantly improve depressive responses on Beck's depression scale and in cortisol levels compared to a control group (Browning, Holmes, Charles, Cowen, & Harmer, 2012b).

In this case, the behaviour of checking is to be completed after some activity the individual enjoys engaging in. This allows intrinsic motivation by the internal values of the individual to translate into meaningful signals of positive reinforcement. As such, the initial action participants must execute is to identify a list of actions that carry intrinsic motivation. The intervention would be better suited if the checking behaviour was executed through technological means, as this provides more opportunity and easier access to checking one's accounts, as well as, delivering multiple opportunities of rewarding signals.

The intrinsic motivation of the action increases the likelihood that the agent will repeat the behaviour, and the individual will be frequently engaged in (such as checking Facebook accounts or playing mobile phones games). As such, this can promote individuals to check their accounts more regularly and reliably. This therefore requires participants to then rank these rewarding actions by frequency, where the aim is to promote sustainable behaviour of checking financial accounts, developing a habitual routine of checking behaviour. This is reinforced by an intrinsic motivation from a prior action executed before checking. As such, this would require that the pleasurable action, affords the activity of checking account through either a mobile phone, laptop or computer. Participants must therefore select the pleasurable behaviour that provides the greatest affordance to account checking. Habit formation becomes more likely if the behaviour pairing is more frequent, i.e. the more opportunity to associate the behaviours, the greater the chance and strength of the association. Once the pleasurable behaviour is identified, participants will then make an implementation intention:

“Whenever I am [insert activity], I will check my account afterwards.”

Behavioural change techniques utilised: Habit formation, self-reward, self-incentive.

5.4.2 Making-Ends Meet - Substitution Intervention

Intervention name: Substitution intervention

Sequential list of actions:

1. Participants identify one key problem spending area
2. Identify a frequent consumption which is impulsive that feels good.
3. If the participant is unable to identify an impulsive purchase, then identify frequent unnecessary purchases
4. Break down the contextual cues (location and time)
5. Generate a list of possible alternative options that use the same cue (i.e. location) but do not constitute such a high monetary cost
6. Select one of the alternatives options that would provide the closest level of utility as from past purchase decisions.
7. Pledge an implementation intention to substitute purchase behaviours

To combat the consumption of financial resources to increase social rank, the key issues are the reinforcement signal associated with the actions and the drive to purchase into social rank. Subjective social rank is an important phenomenon, individuals have an inbuilt drive to compare themselves to others we see as similar (Stewart et al., 2006). For instance our perceived social rank explains how happy we are with our income (Boyce et al., 2010); it explains our belief of symptom severity in anxiety and depression (Melrose, Brown, & Wood, 2013), as well as our beliefs of alcohol consumption (Wood, Brown, & Maltby, 2012). There is an inbuilt tendency to compare ourselves to others, this drive is a powerful motivator where people are often driven to improve their social comparison (where a higher social rank means a better standing). As such, individuals will likely seek to improve their social rank and trying to subvert this would be a difficult phenomenon.

As such the intervention looks to utilise these rewarding mechanisms but to substitute the behaviours executed by the individual, this is termed as behavioural substitution. Here by retaining the given state, but modifying the action to maintain the outcome reward, participants can sustain their behaviour change whilst reducing their spending. The basis of this is to substitute purchase decisions for cheaper alternatives by reducing the associated costs. The rewarding signal from the dopamine release still ingrains a reinforcer on the behaviour. Therefore the initial action requires participants

to identify an area of overspending in which they can recognise a list of frequent impulsive consumptions that provides an affective ‘hit’ (dopaminergic response). Once this is identified, individuals must rank this list by trading-off the frequency of the purchase against the cost (i.e coffee purchases are more frequent than technological purchases). At this point, the contextual cues that prompt the behaviour can be identified, this is to help break down the action to specify the goal of behavioural substitution.

The intervention looks to sustain behaviour change in reducing the cost of consuming into social rank, for instance, the individual would choose a similar market alternative product at a lower cost. This intervention uses the signals the dopaminergic responses of social rank. The intervention uses the association that the individual builds between the given state they purchase the product with the dopaminergic response. Therefore by using the same context and responses, but modifying the action sets, one can reduce their monetary consumption, whilst within the parameters of their preferences and subjective utility. This process uses a bottom-up method of reducing monetary consumption, by reducing highly frequent small instances of consumption to form incremental amounts of savings. Once the frequent impulsive purchase is identified, the individual must then consider and generate a list of potential alternatives purchases, which are similar in as many aspects as possible, except for price (for instance, buying a hot chocolate over a luxury hot chocolate with whipped cream and marshmallows). Then from this substitution space, participants must select the most appropriate alternative, which trade-offs the choice-set from utility and price. This is a difficult process and, as such, the interventionists should be available to assist in this task.

For example, consider one individual purchasing household furnishings every week when with their friends, this could include: throws, photograph frames, ornaments and so forth. Instead of purchasing such goods the individual can instead look to change the option set within that given store, i.e. purchasing coffee for everyone at the café.

There may be instances in which individuals do not purchase into their social rank, or that the purchase itself does not afford a substitution; however a highly frequent purchase choice could be substituted that uses social mechanisms such as the social norm mechanisms. For instance, many individuals would be more inclined to purchase coffee whilst at work with friends than if they were alone. If an individual was to buy take-away as lunch every day from a café, for instance a burger, chips and drink, which may cost around £7, this could be substituted for a sandwich snack and drink at around half the

price. This produces an hypothetical saving of £3.50 for each instance. Suppose this is five days a week, this would calculate as £15.50 a week, £70 a month. These instances could therefore improve savings through small frequent substitutions.

To bolster the effects, prompts should be required as the given state is still the same. This may lead individuals to utilise the cached values of the sub-optimal previous, frequent purchase decision. As such, a prompt can be utilised to remind the participant about their substitution. In this instance a credit-card sleeve or wallet (with which a single card can be inserted, similar to that of given by the Transport for London’s Oyster card wallet) is a viable option, as this would be on their persons when making the consumption decision. In addition, the sleeve may also allow individuals to record instances of substitution, giving them a sense of control and pursuit of this behaviour.

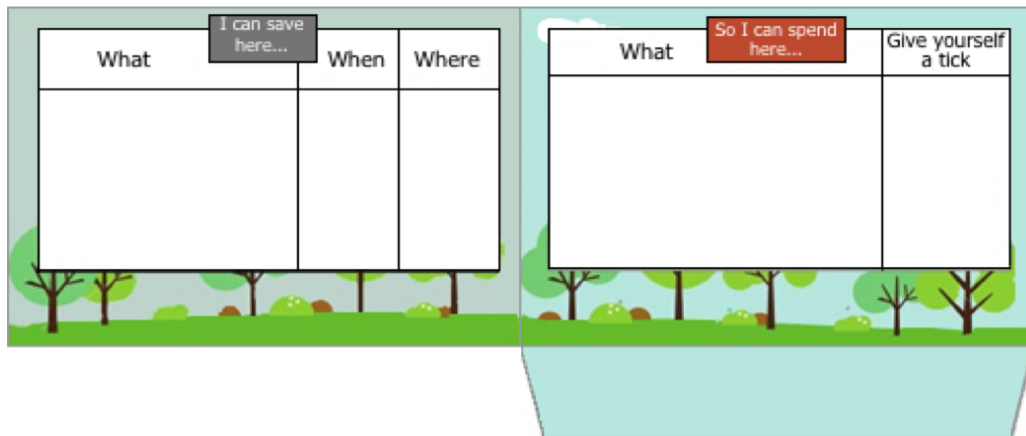


Figure 9; Credit-card sleeve provided as behavioural tool to participants

Once the substitution is identified, participants will then make an implementation intention:

“Whenever I am [insert context], if I have an urge to...[insert problem behaviour], I will [insert substitute behaviour] instead.”

Behavioural change techniques utilised: Self-monitoring of behaviour, feedback on behaviour, behaviour substitution, action planning, problem solving, habit reversal, self-reward

5.4.3 Planning ahead- Planning Intervention

Intervention name: Planning intervention

Sequential list of actions:

1. Participants set a savings goal to purchase at the end of the intervention period
2. Specify the name and cost of the goal
3. Select an image to solidify the goal as a concrete outcome
4. Set an action plan of how much to save per month
5. Specify monthly income
6. Monitor and record expenditure using the expense tracker
7. Use feedback information to update savings towards the goal from the potential saving calculated
8. Engage flexible behaviour by identify overspending and reduce consumption to reach savings goal

In the Planning ahead the key factors are typically how people who struggled financially often failed to think about future events, mostly discounting the likelihood of occurring, and deficits in planning and accounting for these issues. Furthermore, individuals were also more concerned with immediate rewards as opposed to delaying gratification for sometimes more optimal outcomes. As such, the function of the intervention is to train individuals to process future outcomes and to plan accordingly. Here a financial goal is to be set so participants can look forward to something at the end of the intervention, purchasing the goal is not mandatory but merely a motivational commitment device to drive behaviour with a reinforcer. The individual must then specify the financial goal (an outcome goal) in regards the type of product (i.e. laptop) and the cost of the product. Having specified goals provides a more effective route to completion that unspecified goals (Locke & Latham, 2006), as such the individual should specify the actual product itself, rather than the notion of a purchase. For example, “a Holiday to Greece with my girlfriend in October”, as opposed to, “Holiday”.

Once the individual has set their goal set, participants must then create an action plan, how will they seek to pay for the goal given their current financial situation and to predict their future state. To do this, participants must monitor their current financial state by tracking expenditure, and looking to reduce consumption from a top-down perspective. Here individuals may have an a-priori belief of their consumption across

categories (such as subscription, utilities, transport, food and so forth). Where the observed consumption exceed their prior expected beliefs, they should cut back, looking to optimise their consumption and contemplate how to reduce spending. To plan the behavioural goal, i.e. to set the action-plan of how to accomplish the outcome goal, by specifying the amount of money required in various time intervals, as well as strategizing how to identify the areas of overspending.

To assist in behaviour change, participants will be provided with a spreadsheet-based expense tracker, the tool will detail the outcome goal and associated costs, where participants can include a photograph or picture of the goal to make it more concrete and proximally visible (Locke & Latham, 2002). Furthermore, the spreadsheet will contain common spending categories to help participants track consumption and provide feedback of overconsumption.

The tool should also provide feedback by helping to reduce unrealistic expectations, by calculating an accurate depiction of potential savings given income and consumption levels. This can be fed back to the participant to provide a reference point so that the participant can evaluate their consumption and plan accordingly.

Figure 10; Spreadsheet based expense tracker tool given to participants

To see how much you could save this month, fill in the blue boxes

Monthly Outgoings	Total Monthly Outgoings	Monthly Income
Mortgage / Rent <input style="width: 100px;" type="text"/>	£0.00	<input style="width: 100px;" type="text"/>
Food & Supplies <input style="width: 100px;" type="text"/>		
Electricity bill <input style="width: 100px;" type="text"/>		
Gas bill <input style="width: 100px;" type="text"/>		
Water bill <input style="width: 100px;" type="text"/>		
Phone bill <input style="width: 100px;" type="text"/>		
Mobile bill <input style="width: 100px;" type="text"/>		
Council tax <input style="width: 100px;" type="text"/>		
Travel <input style="width: 100px;" type="text"/>		
Credit card bill <input style="width: 100px;" type="text"/>		
Loan repayments <input style="width: 100px;" type="text"/>		
Childcare <input style="width: 100px;" type="text"/>		
School fees <input style="width: 100px;" type="text"/>		
Pensions <input style="width: 100px;" type="text"/>		
Investments <input style="width: 100px;" type="text"/>		
Insurance <input style="width: 100px;" type="text"/>		
Leisure & entertainment <input style="width: 100px;" type="text"/>		
Holidays <input style="width: 100px;" type="text"/>		
Special occasions <input style="width: 100px;" type="text"/>		
Household maintenance <input style="width: 100px;" type="text"/>		
Subscriptions and donations <input style="width: 100px;" type="text"/>		
Other 1 <input style="width: 100px;" type="text"/>		
Other 2 <input style="width: 100px;" type="text"/>		
Other 3 <input style="width: 100px;" type="text"/>		
Other 4 <input style="width: 100px;" type="text"/>		
£66.00		

Outgoings
0%

**Potential to save
£0.00
This month**

It's always good to see what you are saving for.
Click here to go to Google, search for the image of the item you wish to save for, then paste here!

I am saving for:

It will cost:

I have already saved:

This month I will save

£0.00 To go!

Behavioural change techniques utilised: Goal-setting (behaviour), goal-setting (outcome), action planning, problem solving, feedback on behaviour, discrepancy of behaviour and goal, self-monitoring of behaviour, feedback on behaviour, self-incentive, self-reward

The relationship between the COM-B model, diagnosed mechanisms and the behavioural change techniques used are described further in Table 4.

Error! Reference source not found.. **Behavioural change techniques, behavioural diagnosis and COM-B factors**

Interventions	Identified Mechanisms	BCT	COM-B components
Checking	Avoidance behaviour, negative affect	Habit formation, self-reward, self-incentive	Capability, Motivation
Substitution	Hyper-consumption, behavioural repetition, social rank, ego, social reward, social incentive, cue signalling reward, diminished self-control	Self-monitoring of behaviour, feedback on behaviour, behaviour substitution, action planning, problem solving, habit reversal, self-reward	Motivation (automatic)
Planning	Deficits in goal-setting, deficits in action planning, lack of discrepancy between behaviour and goal, lack of problem solving	Goal-setting (behaviour), goal-setting (outcome), action planning, problem solving, feedback on behaviour, discrepancy of behaviour and goal, self-monitoring of behaviour, feedback on behaviour, self-incentive, self-reward	Motivation (reflective, automatic)

5.5 Pilot study

5.5.1 Introduction

The present small-scale, low-cost pilot study was conducted in collaboration with Kindred Media, a London-based public relations company. The pilot study aimed to identify the difficulties participants experienced in implementing the interventions according to several elements of the APEASE framework (Michie et al., 2014). The APEASE framework is an acronym in which each letter describing elements of an intervention that may affect successful uptake of an intervention: Aceptability, Practicality, Effectiveness, Affordability, Safety/side-effects, and Equity (Michie et al., 2014). The present pilot study assessed the interventions': Aceptability, Practicality, (likely) Effectiveness and Affordability. Equity was not assessed because the costs of recruiting a sample of participants representative of the general population consisting only those who felt financially squeezed was too high. Side-effects were also unable to be assessed, this was because only financial data collected was self-reported using pre-defined financial diaries. Participants were apprehensive to given any additional objective measures (like bank account records), therefore knowledge of spill-over effects, negative or positive was too difficult to obtain.

5.5.2 Method

5.5.2.1 Sample

Participants were recruited through media campaign run through magazines, local newspapers, an online advertisement and telephone calls. Participants were recruited as a representative sample of England across age, income bracket, education and geography. At the end of this process, thirteen participants had been recruited ($M = 41.69$ years, $SD = 15.11$ years, 7 Males). Of the thirteen participants, five worked full-time, two worked part-time, three set their own work-schedule (i.e., were self-employed), two were students, one was retired. All participants expressed a desire to improve their current financial situation.

5.5.2.2 Primary Outcome Measure

The primary outcome measure was participants' savings. Savings were measured through financial diaries designed as part of the formative research (see Appendix A and B). Participants were asked to submit the diaries on a fortnightly basis through e-mail to the experimenter, over four consecutive months, i.e., a total of eight submissions. As savings is self-reported there is likely for participants to inflate savings rates

For the analysis it was assumed that all expenditures during the trial were reported, and thereby the deficit between participants' incoming and outgoing money indicated their savings. Savings at baseline was subtracted from these amounts to calculate the change from baseline.

$$\text{Savings}_{i,t} = \text{income}_{i,t} - \text{consumption}_{i,t}$$

Savings at baseline was subtracted from these amounts to calculate the change from baseline. These amounts were then averaged to compute an average savings from baseline.

5.5.2.3 Secondary Outcome Measures

5.5.2.4 Savings

The secondary outcome measures included took accomplished two aims. The first aim was to assess features of the interventions' acceptability, practicality, effectiveness and affordability. The second aim was to assess features of the data quality. The specification of such is identified below.

5.5.2.5 Distance travelled to Savings goal

The spreadsheets that were submitted with the financial diaries were analysed to calculate distance to savings goal during the pilot study, which saw the amount previously saved that fortnight, t , as a fraction of the total cost of the goal, for each individual, i , which was calculated as:

$$\text{Distance}_{i,t} = \text{Previous Saved}_{i,t} / \text{Goal Cost}_{i,t}$$

In addition to, the intention-to-save, depicting the desire to save as a proportion of the total amount to potentially save. This is understood as the percentage participants who were invested in reaching their goal, the weekly values denote how strong a participant's intention is, whilst the average denotes their overall intention. This is used as a proxy of the implementation of the intervention with regards to participants' intentions to save, calculated as:

$$Intention_{i,t} = Amount\ pledged_{i,t} / (Income_{i,t} - Outgoing_{i,t})$$

5.5.2.6 Intervention's assessment.

To assess the intervention through the APEASE criteria, data analysis was conducted through a variety of means. To analyse acceptability, participants' responsiveness to the interventions were analysed through their performance as well as any subverted allocations. To assess intervention practicality, the tool usage and participants' overall reactions to the tool were used, in addition to diary submission and completion rates. Affordability was highlighted by examining the intervention process and the costings associated for the return in effectiveness. Overall effectiveness was examined by analysing the financial diaries to note change in financial circumstances since baseline. Intervention equity and safety were unable to be assessed, due to low sample size and the lack of fine grain data.

5.5.2.7 Data quality

Data quality was assessed by recording aspects of whether and when participants submitted their dairies, including the date the dairy was submitted and the completion of those submissions. Participants were required to complete as much of the diary as possible by stipulating any and all income (benefits, savings, taxes, salary), any and all expenditure (such as food, clothes, entertainment, house, transport, mortgage, services, utilities, credit-card payments and savings). Participants were also asked to declare any changes in circumstances that could have implications of their finances. Participants were also asked to declare their current life satisfaction score, as well as happiness levels.

Those in the Planning ahead group (described below) were also asked to also submit a spreadsheet via email at the same time as they submitted their diary entries.

5.5.2.8 Design

Participants were randomly allocated to one of three intervention groups, such that four were in the Keeping Track group, five were in the Making-ends-meet group and four were in the Planning Ahead group. No control group was utilised as the purpose of the pilot was to understand user experiences with the intervention.

Participants were given an overview of the intervention and any questions they had were answered to make sure they fully understood what they were being asked to do. All participants completed diary submission over the same four months, from the start of September till the end of December. Participants received fortnightly calls from the experimenter to remind participants to submit their data and discuss any issues or problems, as well as to motivate them to maintain their implementation of the intervention.

5.5.2.9 Interventions

The three interventions included the Checking, Substitution and Planning interventions respectively. The Checking and Substitution interventions were designed primarily using Habit Theory (Gardner et al., 2012; Gillan, Robbins, Sahakian, van den Heuvel, & van Wingen, 2016; Judah et al., 2013; Wood & R nger, 2016), while the Planning ahead intervention was designed primarily using Goal Theory (Locke & Latham, 2002, 2006, Michie et al., 2013, 2014). The three interventions are described below.

Keeping Track. Participants in the Checking intervention were asked to write a plan (problem solving, action planning) to check their accounts every day (habit formation), after performing an action they found rewarding (self-reward, self-incentive) (e.g., playing on their phone). Theoretically, after repeated pairings this rewarding action may become a ‘rewarding signal’ that helps reminded participants to check their accounts. Individuals then use the contexts and prompts that drive the impulses to execute the rewarding signal, to prompt account checking.

Making-ends-meet. Participants in the Substitution intervention were asked to write down a plan to change an expensive spending habit to a cheaper one on a small piece of

paper. First, participants needed to complete a reflective exercise (problem solving) about their monetary consumption. Participants were asked to reflect on spending behaviour and a frequent, impulsive purchase (e.g. purchasing household furnishings), characterised as a frequent purchase that they felt enjoyable and did automatically, without thinking. Once identified, participants needed to break down the context in which they execute this habitual purchase, context in this case was simplified in three dimensions, location and time. Participants needed to describe the location they tend to enact the expensive habit (e.g. at John Lewis) and when they tended to execute the behaviour (e.g. when with friends after yoga). Once participants had contemplated these particular components, they needed to identify a market alternative that would be less expensive (e.g. buying a coffee instead) (behavioural substitution, habit reversal)

These particulars were then entered onto a behavioural tool designed for use in this intervention, the tool is a credit-card sleeve (see Figure 11). Participants write down the expensive habit on one side and the alternative on the other. When participants enact a successful substitution, they are to mark this on the sleeve itself (self-monitoring of behaviour)

The piece of paper then folded to fit into a plastic card sleeve in which participants were asked to keep the debit/credit card they used more frequently. Theoretically, the card sleeve may become a cue that help participants self-monitored their behavioural substitutions, by providing themselves with feedback on their frequency of substituting.

I can save here...		
What	When	Where

So I can spend here...	
What	Give yourself a tick

Figure 11: Behavioural tool for the Substitution intervention

Planning Ahead. Participants in the Planning intervention were asked to set a savings goal they wish to work towards to purchase a concrete object in the future (for example a new laptop) (goal-setting outcome). A concrete product is much more

attainable than an idealistic concept, i.e. saving for a new car is easier to do than saving for a rainy day. Then to help participants achieve their goal they were given an excel spreadsheet (see

Figure 12) directing them to breaks down their income, spending, and goals by months. The spreadsheet also displayed information related to their goal, such as the cost of the goal, and how much money they had already saved to achieving their goal. Theoretically, the processes of putting together all this information (i.e., their income, spending, and goals) and seeing changes over time should be informative and motivating.

Figure 12; Behavioural tool for the Planning intervention.

To see how much you could save this month, fill in the blue boxes

Monthly Outgoings	Total Monthly Outgoings	Monthly Income
Mortgage / Rent	£0.00	
Food & Supplies		
Electricity bill		
Gas bill		
Water bill		
Phone bill		
Mobile bill		
Council tax		
Travel		
Credit card bill		
Loan repayments		
Childcare		
School fees		
Pensions		
Investments		
Insurance		
Leisure & entertainment		
Holidays		
Special occasions		
Household maintenance		
Subscriptions and donations		
Other 1		
Other 2		
Other 3		
Other 4		
£66.00		

Outgoings
0%

**Potential to save
£0.00
This month**

It's always good to see what you are saving for.
Click here to go to Google, search for the image of the item you wish to save for, then paste here!

I am saving for:

It will cost:

I have already saved:

This month I will save:

£0.00 To go!

5.5.2.10 Results

Of the thirteen participants, one participant withdrew from the Planning intervention (leaving three participants in the group) and a second from the Substitution intervention (leaving four participants in the group), and four participants in the Checking group. This resulted in a sample of eleven participants, mean age of 43.91 years (SD = 11.31 years), with 6 females and 5 males. Participants identified their financial goal was towards savings as opposed to reducing monetary consumption, checking accounts or even better financial planning.

The results section first examines the primary outcome, effectiveness determined through self-reported savings. The secondary outcomes including the acceptability and practicality affordability.

5.5.2.11 Primary Outcome Savings

Participants improved their savings, however there was large variation in the average change from baseline ($M = \text{£}372.45$, $SD = \text{£}597.79$). The distribution of the results fit with a pareto distribution, a diminishing function in which most of the wealth is handled by a minority of cases (Mandelbrot, 1960; Singh & Maddala, 2008). Participants were mostly pleased with their increased savings, however as illustrated in the distribution of savings rates, some individuals showed negative savings rates. The highest participants' average change from baseline savings was AI, and the lowest (i.e., highest deficits in savings) was RW.

Table 4; Savings during trial from financial diaries

ID	Group	Baseline Savings	Average Change from Baseline
AA	Making-ends-meet	£222.00	£250.50
AM	Planning Ahead	£191.00	£340.38
AI	Planning Ahead	£44.12	£1,548.11
BP	Planning Ahead	-£89.14	-£225.95
MS	Making-ends-meet	£211.00	£187.00
PR	Planning Ahead	£1,137.88	£292.91
RW	Keeping Track	£410.68	-£422.54
SB	Planning Ahead	£585.04	£319.08
ST	Planning Ahead	£163.00	£84.29
SM	Planning Ahead	£1,346.65	£1,400.22
WT	Planning Ahead	£1,850.00	£323.00

5.5.2.12 Acceptability

Those who were allocated to Checking intervention exhibited mixed perspectives. Some participants were very interested in improving their ability in keeping track, whilst others were more focused on improving their savings. Those in the Checking intervention did not have any tangible outcomes as a result of checking which made it difficult to motivate them to enact the checking. These implications are important for future considerations, where individuals are more interested in savings than other financial behaviours.

Participants showed marked anxiety towards the Substitution intervention, with two participants expressing intent to change interventions, and those in the Keeping Track intervention also showed marked avoidance towards such behaviours, with three participants subverting allocation and moving to the Planning intervention. Participants who were allocated to the Substitution intervention were unwilling to participate in the reflexive exercise to identify areas of over spending. This may be due to attribution errors where people wish to hold themselves in high regard and not admit to any mistakes, often referred to as a self-serving bias (Sherrill, 2007). The exercise suggests that the overspending is the fault of the participant and puts them in position to accept such behaviours. As such, it may be hard for individuals to bruise their ego in this given exercise, especially if they have the financial responsibility of the household. It may also be likely that some participants are not inherently overspending on any particular rewarding purchases and thus are not likely to see much improvement in the Substitution intervention.

Participants were often stating that they were already making lots of decisions to cut back on spending, such as “driving around town for the cheapest bargains” or “buying things we only need”. They did however express a disbelief in the mechanics of the Substitution intervention. Participants were unwilling to believe that bottom-up processes of highly frequent, small substitutions were comparable to top-down time consuming fortnightly tasks. When participants did discuss some routine behaviours, they were usually defensive about substituting any options stating these were small things they looked forward, misunderstanding the intervention design.

It is noted that the researcher is an important factor in the employment of the habit-based intervention, where researchers must assist participants in the intervention and this time constraint makes it difficult for execute the intervention. This is a factor in the

acceptability of the intervention as many participants would struggle to identify a substitution, and this may be a result of interactions with the researcher.

Those in the Planning intervention remarked the intervention design as much more of a common savings method, participants were more relaxed with the mechanisms of the intervention. However, the idea of using a spreadsheet to document monetary consumption was something participants seemed a little uneasy with. Participants questioned what level of accuracy was required, some participants wanted to skip the details of documenting their consumption, as they felt they already knew what to do. Participants' familiarity with this intervention may be what largely drew people to it. Those in the Planning intervention were happy with the details and completion of the spreadsheets; some participants lacked Microsoft Office and thus required some alternative software. However, participants were adamant that they willing to engage in the intervention and demonstrated enthusiasm. Note that participants were lost to attrition which is denoted in Table 6 below and explains from how the final allocation count below differs from the allocations shown in Table 5.

Table 5: Intended and subverted allocation

Intervention	Intended Allocation	Final allocation
Making-ends-meet	5	3
Planning Ahead	4	9
Keeping Track	4	1

5.5.2.13 Practicality

An additional investigation was conducted to assess participants' implantation of the intervention, the intention-to-save was a key starting point to identify how users of the Planning and Substitution interventions were completing the intervention in the real-world. Understanding how participants use their tools and participate in the intervention can help to redesign key aspects to further motivate and maintain behavioural integrity.

First the Planning intervention was analysed as the majority of participants had been allocated to this, producing the majority of the implementation data. Participants who don't invest in their behavioural goals demonstrate some level of reluctance can be

illustrated. These individuals mentally accounted these funds pledging the money only to be used for the goal. The average intention-to-save was 46.41% (SD = 30.65%), identifying that participants on average only pledge less than half of their available funds. This is likely due to mental accounting (Thaler, 1999). Mental accounting was shown in the formative research to be a big factor in financial decision-making, where those who resorted to mental accounting processes failed to save appropriately.

Through this, AI demonstrated the highest savings through the diary form, despite still withholding from contributing towards his savings goal. AM exhibited the highest motivation towards their goal. SB on the other hand made no indication towards their savings goal, as shown in Table 6 below.

Table 6; Intentions to save as percentage of available assets

ID	Proportion of used savings (% of available) for each fortnight									
	0	1	2	3	4	5	6	7	8	Average
AM	46.90	200.00	69.90	94.70	51.50	89.30	97.10	88.00	100.00	93.10
AI	3.30	8.00	6.80	9.80	6.30	9.00	5.90	11.20	12.60	8.10
BP	-	51.90	82.80	65.50	59.30	-	-	-	-	64.90
PR	78.40	122.70	3.30	32.10	100.00	0.00	100.00	100.00	-	67.10
ST	107.70	10.40	100.00	31.60	10.40	20.20	-	-	-	46.70
SB	-	-	-	-	-	-	0.00	-	-	0.00
SM	14.00	40.10	-	-	-	-	-	87.40	-	47.10
WT	30.70	-	-	48.60	50.80	65.90	45.10	24.80	-	44.30

*Note: ‘-’ indicates no submission was made

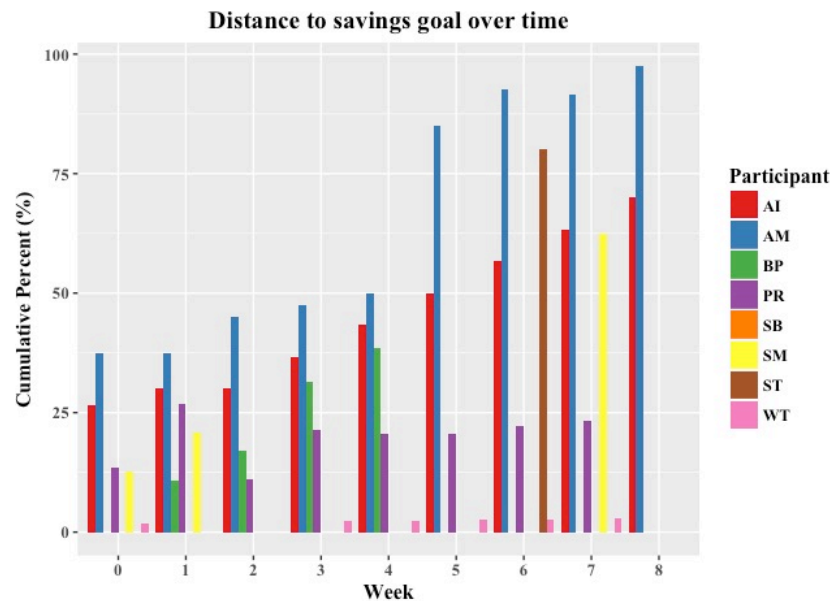
This table provides the percentage of resources allocated towards the savings goal for each fortnight, 100% indicates that an individual put all of their disposable income towards their goal, 50% denotes half of their disposable income went to their goal, and so forth.

One major concern is that individuals may have pledged funds towards their goal but not necessarily included this on the planning tool itself, this is almost impossible to identify without utilising bank records and setting up a separate savings account. This would require an association with a commercial bank with which is difficult to set up such an relationship.

An additional investigation was ran for the degree to which participants achieved their savings goal. The amount already saved for each time window (t) allowed a construction of cumulative distance towards the participants’ goal. As visible through Figure 13, most participants made progression towards their goal, the greatest cumulative

success was by AM, whilst AI came close second. ST had set a goal and returned information for one out of eight possible submissions. This may be due to biased reporting from ST to cover up loss of data or where ST is perhaps forgetting to submit the data. SB failed to submit any usable data, where the only data point was 0.00%.

Figure 13: Cumulative distance to savings goal

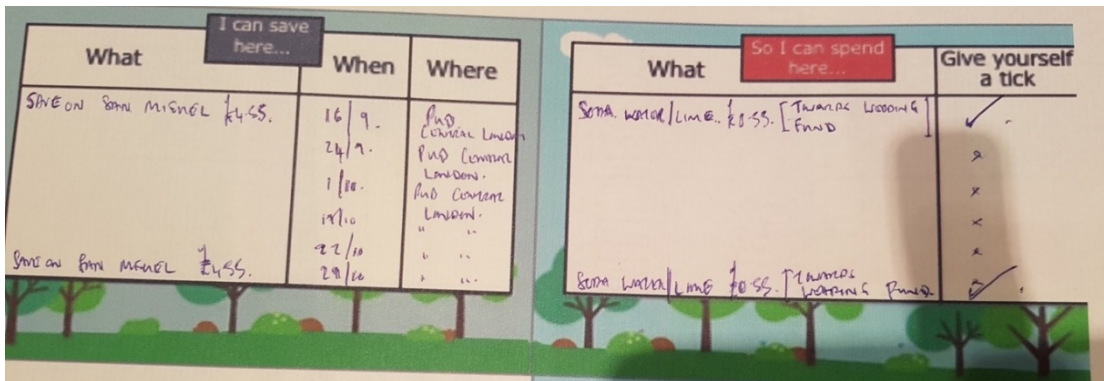


Out of the six participants assigned to the Substitution intervention, three subverted the allocation, one dropped out and another failed to submit any data. The individual chose to substitute pints from the pub for soft drinks. The individual recorded only 11 opportunities to substitute, but was successful on two of them.

“If I’m honest it’s catch 22 with trying to save cash through watching Liverpool. I get very nervous watching my team, and pint or 2 settles my nerves a bit. I’m very committed to saving money but I have struggled, and I actually think the stress of being well behind in my financial goals has often let me slip in to ‘***** it’ mode. “

-MS on the conflict of habit reversal/behavioural substitution

Figure 14: Substitution tool usage



There is a trade-off between frequency of purchase and price difference in market products, which has a very small margin of error. If the frequency is too low, there is no tangible outcomes in savings, and if the difference between the market products are too small then participants can feel like the substitutions are not worth executing. However MS did demonstrate an intent to save and to adhere to the intervention when describing their opinion of the Substitution intervention they said there was a spill-over effect.

“I’ve alluded to this in my diary entries, but it’s been a struggle saving for the wedding, having my tax bill looming, and having work cancelled. I may have come across as irresponsible in the spending on beers when it potentially could save money and help the long term situation. However this financial health challenge has opened up bigger conversations with regards to our spending and we have had success when reviewing (and often taking action) credit cards, bank accounts, TV provider, Car insurance and other areas where we can save. The health challenge has helped get the saving mode in to my conscience, but the area I was looking to tackle wasn’t quite the success I hoped for!”

-MS on the acceptability of the Substitution intervention

Those in the Checking intervention did not wish to take part in any conversation about their financial performance as they felt there was a disconnect between the intervention and financial savings. The lack of tangible outcomes is a large barrier to behaviour change (Lally & Gardner, 2013). This may have played a big factor in why participants did not wish to remain in this intervention, and why they would not want to discuss their financial status under avoidance of negative affective responses. Participants

can sometimes wish to avoid information that is negative. As such it is difficult to ascertain the implementations and practicalities of this intervention, however of note is to untangle the Checking intervention from improving savings, as individuals do sense a large disconnect between the two.

5.5.2.14 Adherence

To understand the practicalities in the implementation of the intervention regarding data collection methods, it was important to analyse and investigate the extent to which data could be requested and submitted.

Adherence firstly must be clarified into the processes and concepts it represents, firstly adherence can be defined simply as the manner to which an individual or agent acts in concordance with some specified plan or course of action (Vrijens, Urquhart, & White, 2014). Adherence contains three major areas: initiation, execution and discontinuation (Vrijens et al., 2012). Initiation referring to an agent starting the process, implementation or execution refers to the implantation of the behaviour, i.e. whether an individual takes their medication at the right time, or whether they forget to take their medications, whilst discontinuation refers to when an agent stops executing the behaviour altogether.

With regard to the pilot study, all participants demonstrated initiation of the behaviour. When examining the execution of the intervention, there was moderate levels of adherence across the sample ($M = 73.75\%$ $SD = 20.65\%$), however the execution of these submission were still poor with an average of 65.66% ($SD = 26.51\%$) of data being missed on each diary submission. This suggests inherent practical issues in implementing the current intervention infrastructure as means of data collection. It would not only be impractical but unethical given the volume of recruitment required to satisfy the loss from poor adherence. No participants demonstrated discontinuation.

Table 7; Adherence rates for submissions and missing data

ID	Submissions	Proportion of missing data
AA	33.3%	22.2%
AM	100.0%	100.0%
AI	100.0%	100.0%
BP	55.6%	55.6%
MS	66.7%	33.3%
PR	88.9%	88.9%
RW	77.8%	55.6%
SB	66.7%	66.7%
ST	88.9%	88.9%
SM	77.8%	66.7%
WT	55.6%	44.4%

Retention strategies consisted predominantly of fortnightly telephone conversation in which the experimenter would discuss the financial behaviours since last submission, the experimenter would also remind the participant for the diary (and/or tool) submission. This was seemingly for the pilot but in a scaled-up fully powered randomised-controlled trial, is unmanageable, and will likely require secondary and tertiary researchers to be costed in. Furthermore the cost of each phone call would be an additional purchase to be made which would require a set script.

5.5.2.15 Affordability

The largest costs incurred from the current intervention design stipulates that researcher and tool access are the greatest costs, the costs for the retention strategies as currently in-play would require costings for:

- Phone line/mobile
- Phone call duration
- Researcher time

This would require a script to constrain the durations and standardize across participants, but to implement on the scale of a powered randomised-controlled trial would require multiple researchers which would be very expensive.

Furthermore the intervention requirements make a spreadsheet based software essential, which could make technological issues regarding software access. If participants do not have access to such software, providing access may prove difficult as licenses need to be purchased which will incur additional costs. Especially at the scaled-up level this could likely be inconceivable to implement. The software usage mandates that files are stored locally on the participants computer or laptop, and as such make demands that participants are then responsible to submit the data. As seen above in adherence, loss of data is likely and therefore a better data collected system is required.

5.5.2.16 Safety/Side-effects

The data reported on the diaries was the only financial data collected, when conversing with participants in regards to any additional pieces of data, participants were extremely reluctant to provide any additional data through screenshots or bank statements. As such it is difficult to state any issues regarding side-effects of safety of the interventions.

5.5.2.17 Equity

As the sample size is small it is impossible to partition this into smaller populations to make comments pertaining to differential effects across populations. As such there are no comments to be made regarding equity.

5.6 Modifications to Interventions

These results were fed back into the intervention to inform the intervention process to deliver a more acceptable and practical intervention and translate these modifications into the intervention.

5.6.1.1 Problem solving in Habit-Based intervention

To diminish the feelings of responsibility, the intervention process took to separating purchases made in the last 30 days. Once a list was constructed participants were then asked to rate them by frequency and how pleasurable the purchase felt. If the participants were unable to identify pleasurableness, then they selected the most frequent purchase decision.

5.6.1.2 Interventions used in RCT

Many participants were put off by the Checking intervention and did not see the value of the intervention, placing a much higher weight on reducing consumption or generating savings. As such there was much disinterest regarding the Checking intervention and participants were not overly motivated to continue further in this group, nor recommend this to others. As such, the Checking intervention was dropped, leaving two intervention groups, the Substitution and the Planning intervention.

This provided an interesting case in which two interventions were used that opposed from distinct structural processes; one using a top-down goal-directed manner (Planning intervention), whilst the other used a bottom-up habit-based system (Substitution intervention). As such, these were renamed to the Goal-Setting intervention and Habit-Based intervention respectively. This was done to represent how these interventions map onto an axis of goal-directed to habitual actions, where these interventions sought the same outcome through opposing processes.

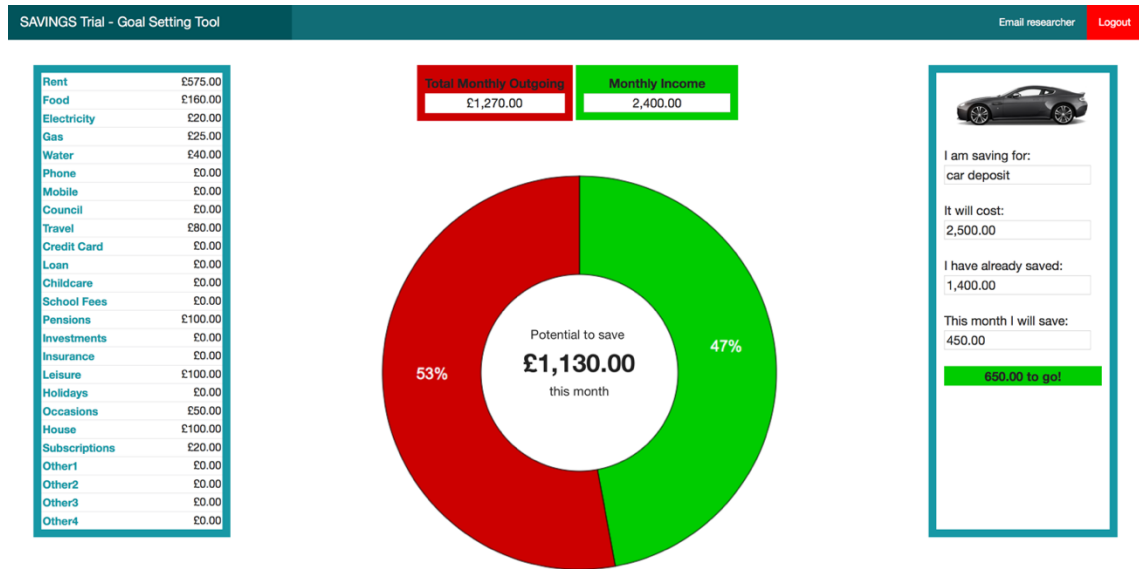
5.6.1.3 Use and submission of the behavioural tools

The submission and use of the credit-card sleeve did not produce any difficulties and the sleeves were retained till the end of the study, however to ensure constant access, an electronic copy of the sleeve will be uploaded online to a study website and sent to each participants in the Habit-Based intervention once per week.

Those in the Goal-Setting group needed to send each saved file every month to the experimenter. This would diminish the data collection as participants would likely not submit due to forgetting or the required effort, therefore, an automated version was required. This was placed on the Warwick Business School's servers. The web-based expense tracker (see Figure 15) was designed in a similar way as the original with a few modifications. Firstly, the online version used an autosave feature which saved any changes onto the Warwick Business School servers. Secondly, by using an online platform, participants could create their own accounts and passwords, which gave them ownership of the tool and provided secure storage and confidentiality. Thirdly, only select boxes would require input, reducing the chances of participants interfering with the tool. Finally, by making the tool online, this generates a web address, which can be sent out to

all participants in the Goal-Setting group and provides direct access to the tool by one click through an automated email.

Figure 15; Updated version of the web-based expense tracker.



5.6.1.4 Frequency of contacting participants

Contacting participant by telephone call was an sub-optimal solution, and was wholly impractical in terms of time and monetary considerations. This would require at least another two additional researchers which would far too costly to budget for. Therefore more automated processes should be considered.

The trial uses automatically generated e-mail system to generate and send emails as behavioural prompts and retention devices. This was done to minimise participants time demands in the intervention, and to provide a tool in which direct contact was accessible.

Emails were sent every Wednesday at 16:00 (local time), this was because this period was free for all participants as dictated by University scheduling. The Control group were sent an email to ask if they had any issues or concerns and to contact the research team. The Habit-Based intervention and Goal-Setting intervention groups were sent prompts to remind participants to use their behavioural tools.

Those in the Habit-Based intervention were provided with a link to the credit-card sleeve to print off, in addition to a reminder to use the tool. This was to ensure that participants had access to the credit-card sleeve to document and tally substitutions.

Those in the Goal-Setting intervention were given a direct link to the web-based expense tracker. The direct link provided in the email reduced the time and effort required to navigate to the behavioural tool, this increases the probability of participants utilising the tool and increasing the effects of the intervention.

SUMMARY

- Pre-post differences were calculated through a fixed-effects linear regression.
- Differences in monthly savings were conducted controlling for income as a predictor, in addition to using savings ratios or propensity scores which divided total monthly savings by income.
- Significant intervention effects were exhibited in all but one financial domain of Account Balances.
- Treatment effects significantly reduced monetary consumption whilst controlling for income in both groups.
- Treatment effects significantly improved monetary savings whilst controlling for income in Goal-Setting group in monetary savings.
- Treatment effects significantly improved account balances whilst controlling for income in both groups.
- Tool usage did not exhibit significant effects a main-effect in consumption or monetary savings, but does in Account Balances.
- Goal-Setting groups outperformed Habit-Based treatment effects in all but one domain of savings ratios in account balances.
- Fidelity results for the Goal-Setting group were favourable, but the goals were usually set too high for the participants and many struggled to attain their goals, despite saving considerable amounts.
- Those in the Habit-Based group exhibited a tendency to substitute behaviours rather than purchase choices within a defined context. This conceptual difference is likely to be one of the major factors why this group did not exhibit significantly different results from the Control group.
- The intervention was reasonable well received, and many participants identified the intervention did make them reconsider their purchase decisions, however several participants noted the effort sometimes would demotivate them to implement the intervention.

6.1 Background

This RCT, “The SAVINGS Trial”, uses two opposing interventions through distinctive behavioural processes to help motivate individuals to reduce their monetary consumption and improve savings. This was designed through formative research and feasibility work that led to the interventions (described below) being executed in a multi-site randomised-controlled trial.

6.2 Aims

1. Test the efficacy of behavioural interventions to improve financial capability
2. Reduce monetary consumption
3. Improve monetary savings and propensity to save

6.3 Design

Participants were randomly allocated to one of three conditions; a Habit-Based intervention, a Goal-Setting intervention or a Control condition. Randomisation occurred based on a blocking protocol, randomly allocating participants within each block to reduce allocation bias. Participants were randomly allocated in a 1:1:1 ratio.

6.4 Duration

The intervention period lasted 12 weeks for each participant. This duration was based upon research in habit formation, which demonstrated that a median time of 66-90 days was required to form automaticity of complex behaviours (Lally et al., 2010). In addition, the Habit-Based intervention required a high frequency of substitution consumption to generate savings. The additional 24 days was utilized to provide a temporal buffer to help generate significant differences.

6.5 Power calculation

The study was powered based upon a comparison of habit and goal-setting conditions. To estimate an effect size, a review of literature on studies of habit formation yielded an expected effect size of $d = .45$ after four weeks, and $d = .54$ after eight months (Judah et

al., 2013; Phillipa Lally et al., 2010; Lally & Gardner, 2013). This effect size is comparable to effect sizes construed from implementation intentions and goal-setting. For example, one meta-analysis demonstrated an effect size of $d = .36$ (Gollwitzer & Sheeran, 2006); whilst meta-analyses of goal-setting research with feedback has exhibited an effect size of $d = .63$ (Neubert, 1998). Therefore the following parameters were fed into the power calculation: $\alpha = .05$, $\beta = .80$; an estimated effect size of $d = .52$. This demonstrated a requirement of a minimum of 180 participants in a 1:1:1 allocation ratio. Assumptions of attrition were yielded at 25% based upon past research of randomised-controlled trials (Dumville, Torgerson, & Hewitt, 2006; Wood, White, & Thompson, 2004). This increased the sample size required to 225 participants in total. Power calculations were run using G*Power, a statistical power analysis software (Faul, Erdfelder, Lang, & Buchner, 2007).

6.6 Method

The randomised-controlled trial was run based on the MRC Complex intervention framework (Campbell et al., 2000; Craig et al., 2008). The trial was ran using university students from the University of Warwick (UK) and Monash University. Participants were recruited using the SONA system, an online platform to recruit individuals for participation in research.

6.6.1 Sample

The sample consisted of University students, the main reasons for this are that university students are very easy to recruit into the trial, given the use of recruitment platforms already present at most universities. Secondly, the costs of running a student-based study is much cheaper than a field-experiment with adult population as the student study would only require costs of recruitment, whilst the adult population would require a secondary facet of collaborating with and training service providers to administer the intervention. This would require further time and expenses.

The student population although seemingly may appear to differentiate financially from the general population of the UK, do illustrate barriers in financial capability, as identified by a recent study by the Money Advice Service (Money Advice Service, 2018). Specifically, the Money Advice Service Study found that 20% of students

find themselves frequently overdrawn, and 40% have gone past their overdraft limit or into an unplanned overdraft. The study further found that while 77% of students had at least a saving account, many no savings at all (31%). These insights demonstrate that the student populations do exhibit the same issues as in the general population in regards to making-ends-meet and planning ahead, as such, this creates a platform to run the trial through a more efficient route.

It is difficult to establish how generalisable to sample population is to the wider world, as the make-up of financial resources as distributed within the student population may indeed be different to that of the working-age population. However, the effects of the intervention should still hold as students are more likely to have no savings, 31% (Money Advice Service, 2018) than the general working age population, 6.29% (Money Advice Service, 2016). It is likely that the effects may differ for the general population than what is presented in this thesis, due to the difference of prevalence of sub-optimal financial capability amongst the student and general populations. This would likely mean that the effects may still be generalisable but the effects will reduce as one moves towards a population with greater prevalence of optimal financial capability.

6.6.2 Inclusion and Exclusion criteria

The students included in the trial had to fulfil the following criteria:

- Full-time student
- Proficient in English
- Own a credit or debit card
- No neurological disabilities
- No learning difficulties
- Normal/corrected-to-normal vision

6.6.3 Control Condition

A separate control condition was utilized as a reference for the comparison of the Habit-Based and Goal-Setting intervention. The Control group did not take part in any active behaviour change techniques, and instead continued their behaviour as normal. They submitted their transaction histories at the end of their pathway, at the same time as the intervention groups.

It is, expected that the simple inclusion of participants within the intervention is sufficient for some behaviour change to be observed, as suggested by the Hawthorne effect (McCarney et al., 2007), however, such outcomes are impossible to mitigate. The analysis accounts for this by estimating the effects of the intervention groups against the performance of reference Control group.

6.6.4 Habit-Based Intervention

The Habit-Based intervention follows the implementation of the Substitution/Habit-Based intervention previously described in Section 5.4.2. This intervention uses a bottom-up process to substitute impulsive, pleasurable consumptions for equivalent options at a reduced cost (for example, substitution of coffee for tea). Participants were given a credit-card sleeve as a behavioural tool to assist them in their substitution. This served as a reminder (when making the purchasing decision) and enabled the participant to record substitutions through self-monitoring.

6.6.5 Goal-Setting Intervention

The Goal-Setting intervention follows the implementation of the Planning/Goal-Setting intervention previously described in Section 5.4.3. Participants set a savings goal (outcome goal) for the end of the intervention. This had to be a specific goal such as a product they wanted to purchase (i.e. Macbook pro, instead of “laptop”) or an activity (“Trip to New York” instead of “Holiday”) and the total costs involved. The participants then set an action goal, outlining the monthly amounts and the behavioural execution required to reach this outcome goal. Participants were provided access to a web-based expense tracker which was a behavioural tool, to document consumption and identify areas of overspending. The tool also displayed potential savings through the calculated difference of income and total expenses that participants used to update their action goals.

6.6.6 Participants

397 participants were recruited through a multi-site RCT, with 210 participants recruited at the University of Warwick (UK), and 187 recruited from Monash University (Australia). Monash University were interested in collaborating in the trial and offered a platform to bolster the sample population, acting only as an additional site and

experimenter to recruit participants. The sample collected consisted of 260 female participants, 130 male participants and 7 of which preferred not to disclose their gender. The sample had a mean age of 21.03 years (SD = 2.64 years). Additional participants were recruited beyond the 225 mark (as per the a-priori power calculations) to account for the diminished statistical power of running a multi-site study. The breakdown of the sample population is given below in Table 8.

Table 8; Sample breakdown at population and site levels.

Variable	Total	Site	
		Warwick	Monash
Mean Age (years)	21.03	20.51	21.48
Age Standard Deviation (years)	2.64	1.41	3.31
Female (n)	260	123	137
Male (n)	130	85	45
Undisclosed (n)	7	2	5

6.6.7 Measures

There is a three-way trade-off between three issues: objectiveness, level of detail, as well as the time and complexities in collecting and analysing financial behaviour. For instance, one can use self-report measures, and ask participants to report their account balances or savings; but this can often be biased by problems such as social desirability and demand characteristics (Collins, 2013). An alternative therefore is to utilise transaction histories or bank statements, which offer a finer level of detail. However, it is likely participants have more than one account (for example, a separate current and savings account). This would require participants to submit multiple statements, however as identified in the feasibility study (see Section 5.5), participants' submission rates were poor (M = 73.75% SD = 20.65%). In addition, the time required to tabulate and analyse multiple statements for each participant (for example this could translate into a minimum of 794 statements if all participants had two accounts). This would take too long to analyse and detail, where many participants may only provide statements as downloaded in PDF formats. This would require all documents to be hand typed and tabulated. A much more efficient strategy, as employed in this study, is to utilise the most commonly used account, their

current account. This would then only require participants to only submit one single documentation, and would reduce the time taken to tabulate results. Of note, is that participants again still have more than one account and the current account may not truly reflect their savings. However, by examining changes in consumption, where in the intervention has participants seek to reduce monetary expenditure, monetary savings can be identified as the remaining disposable income. Furthermore account balances can also be used to monitor for stagnated savings.

Participants may move funds out of their accounts into a savings account, but as defined by the imposed definitions of credited (money into the account) and debited transactions (money leaving the account), any savings would be classified as a debit transactions, i.e. money going out of the account. This is of course, untrue, standing order and manual transfer do not denote monetary consumption, however by making this hard rule, participants transaction histories are codified into simple rules in which to analyse the accounts. By using a single transaction history, this is potentially the best three-way trade-off between objective data, level of detail and the time and complexities in collecting and analysing the data.

6.6.7.1 Outcome measures definitions and specifications

The main aim of the trial was the change in financial behaviours. This was examined in two ways, firstly examined through the raw differences of an outcome measure over time. Secondly, looking at the savings ratio, which denote propensity to save. Calculation of the savings ratio (also referred to as a propensity score) serves as an alternative specification which indicates the propensity to save as a function of income which was taken as the function below, from the 1st to nth month:

$$\text{Savings Ratio} = \frac{\sum_{i=1}^n \text{Savings}_i}{\sum_{i=1}^n \text{Income}_i}$$

For each area, raw differences and savings ratio, there are three domains of interest: monetary consumption, savings and account balances. Monetary consumption is of interest as the aim of the intervention was to reduce consumption through the use of behavioural change techniques. This reduction of consumption would therefore cause an increase in the amount of disposable income, which are termed here as monetary savings.

As monetary savings may be stagnated within the accounts, account balances were also subject to inquiry to ascertain if any trickledown effect is exhibited into account balances. The analysis was conducted using pre-post differences between the first month and the last month (Month₃ – Month₁). Looking at the raw differences and savings ratios in consumption, savings and account balances respectively. A month consisted of 28 days, starting from their enrolment day. This offset was to ensure that there was an equal amount of data from all participants, where a high proportion were not recruited into the trial at the start of a month.

Consumption was measured through the analysis of monetary expenditure leaving the account (defined here as debited transactions). Of note, however, is the likelihood that consumption is tied to income, where a larger income is likely to lead to higher consumption and a reduction in income over time could account for the reduction in consumption. Therefore, to account for any variation in consumption, income was included as an additional predictor. Consumption was calculated as the total expenditure from the account in each month. Here, decreases in consumption over time would be denoted through a negative sign, i.e. a decrease in consumption.

Monetary savings was defined as the monthly savings yielded from the account transactions, from the 1st to nth month, specifically:

$$\text{Saving}_i = \sum_{i=1}^n \text{Income}_i - \sum_{i=1}^n \text{Consumption}_i$$

Monetary savings was denoted as the difference in total income and total consumption of that month. Thereby, negative savings describe over-consumption or debt, whilst positive values indicate a surplus. Here, increased savings over time would be denoted through a positive sign, i.e. an increase in savings. Account balances were taken as their financial values, averaged over monthly windows. Positive values of account balances describe over-consumption or debt, whilst positive values indicate a surplus or savings. Here, increased savings over time would be denoted through a positive sign, i.e. an increase in savings.

6.7 Hypotheses

[i] Group effect

The treatment should cause a greater reduction in monetary consumption with increased savings and account balances, in comparison to the Control group.

[ii] Tool usage

Tool usage should predict a decrease in consumption, and show significant improvements in savings and account balances.

[iv] Group:Tool interaction

The interaction effect (group allocation in combination with tool usage) should predict reduced consumption, with significant improvements in savings and account balances.

6.8 Procedure

1. Participants were recruited through the University's online recruitment platform at both Monash and Warwick University respectively.
2. Participants were asked to read through the Participant Information Sheet, which detailed the structure, and gave a brief overview of the interventions. Once finished, participants were asked to sign and date a consent form.
3. Participants completed a demographics questionnaire to provide details about the sample population, through the Qualtrics platform, a web-based survey system. Participants were requested to provide their email addresses (this was mandatory as all future contact was through emails from the research team to participants). Participants could contact the researchers directly via email or mobile, however all contact from the research team to participants was through email.
4. Once participants had completed the questionnaire, they were put through a randomisation protocol with blocking (where block sizes varied between 3 to 12), in a 1:1:1 allocation ratio.
5. Participants were then given a break-down of the group they were assigned to and its requirements.

6. Those in the Control group were not asked to change their behaviour.
7. Those in the Habit-Based group were asked to complete a five minute task to help generate the behavioural substitution.
 - a) Participants were asked to identify recent purchases and rank them by pleasurable and frequency.
 - b) The system then selected the highest ranking cases in both domains, and asked participants to select one of these options.
 - c) Once selected, participants were asked to identify an alternative product to substitute this with. All participants were required to check this with the experimenter before continuing. Those having difficulty identifying a substitution were asked to generate options with the experimenter.
 - d) Once participants had set their substitution, they were provided with a credit card sleeve (along with a spare), a plastic clear wallet and a sharpie. The plastic wallet was given to protect the card, and the sharpie to ensure participants could mark the wallet or sleeve. Participants were asked to tally for each successful substitution.
 - e) Participants would then complete the credit-card sleeve by specifying the context, the pleasurable previous purchase and the substitution.
 - f) Once completed, participants then made an implementation intention to execute their behavioural substitution in the specified contexts.
 - g) Finally, participants informed that they would be sent a weekly email reminder and a link to print a new copy of the credit-card sleeve.
8. Those in the Goal-Setting group were asked to complete a five minute task to set up their goal-setting tool.
 - a) Participants were asked to use their university ID numbers as their login keys. This was put through a SHA256-HASH algorithm to compute a 64 character string, which was stored on the Warwick Business School servers. The raw

university ID numbers were immediately deleted from memory. This was to ensure maximum security and confidentiality.

- b) Participants were first asked to set up a password. On completion of the demographic questionnaire, the participants received an automated email with a password token link. The password token would then store the selected password through another SHA256-HASH to produce a converted 64-character string. Only the 64-length string converted password was stored with the corresponding converted ID on the Warwick Business School servers.
 - c) Participants were then able to log onto their account. They were then asked to set up their detailed outcome goal by identifying a purchase to make at the end of the 84 days. They were required to input details (name and price) of the goal, being as specific as possible.
 - d) Participants then found an image of the goal to store on the expense tracker online.
 - e) Participants were then asked to input their income amounts. For those on student loans in the UK, or receiving financial support from guardians or parents, income was calculated as their monthly budgeted amount across that term.
 - f) Participants were then asked to input their last month's expenses to gain an understanding of how the tool works and information was provided.
 - g) Finally, participants were asked to sign into the goal-setting tool at least once a week, and were informed that they would be sent a weekly email reminder with a link to the web-based expense tracker.
9. Once participants completed the breakdown of their allocated group, they were asked to sign a behavioural contract to submit their transaction histories of the intervention period, including account balances before and after the intervention. The participants were asked to provide two signed and dated copies with their mobile phone numbers written on each one. One of the copies was retained by the research team, and the

second by the participant. Only anonymised transaction histories were accepted and participants were told that if any personal information was present, the email copy was destroyed and the participant would be asked to re-submit with these details removed.

10. Participants at the University of Warwick were paid £5 for being part of the study, whilst participants at Monash University were provided with one course credit.
11. Participants in the intervention groups were sent weekly reminder emails with a link to the web-based goal-setting tool (Goal-Setting group), or to a printable copy of the credit-card sleeves (Habit-Based group).
12. At the end of the intervention period, each participant received an email with detailed guides on how to download transaction histories for their required time period. These guides highlighted how to obtain the above information for the most common high-street banks in the United Kingdom and Australia.
13. Participants at the University of Warwick who remained until the end of the study and submitted their transaction histories as required, were entered into 15 lotteries with a chance to win £25, whilst those at Monash University were provided with an additional course credit.
14. Once participants had finished the study and provided their transaction histories, they were individually thanked by the research team for their efforts. They were each given the opportunity to ask any further questions or request any details about their own performance.
15. Those who failed to provide transaction histories were given a reminder email one week later. This was escalated to a text message the following week, and subsequently to a phone call. Following this, no further contact was made.

6.9 Results

6.9.1 Summary

The SAVINGS Trial used two interventions in an aim to reduce monetary consumption, increase monthly savings and account balances across participants. This was calculated

through raw difference scores as well as savings ratio. As expected, the control group performed the worst when comparing all results, with little to no change in monetary consumption over time, and a significant decrease in savings and account balances. When comparing raw differences, the Goal-Setting group showed a significant decrease in consumption, with a significant increase in savings and account balances. The Habit-Based group also showed a significant increase in account balances, however, there was no statistically significant change in consumption or savings when compared to the Control group. This may be due to account balances will carry reduce variability due to this measure reflecting net changes, whilst consumption and savings level data is more variable and therefore requires greater statistical power to detect an effect.

When comparing savings ratios, the Goal-Setting group showed an increase in savings and no significant difference in account balances. The Habit-Based group showed no significant differences in any of these values. These results highlight how behavioural insights can be utilised to promote goal-directed outcomes to improve financial behaviours.

6.9.2 Attrition

Attrition rates were unequal between sites, with the Monash site experiencing better retention than Warwick. At Monash, 47 participants were lost to attrition at a rate of 25.13%, whilst at Warwick, 126 participants were lost to attrition at a rate of 58%. This unequal attrition rate can be attributed to various factors:

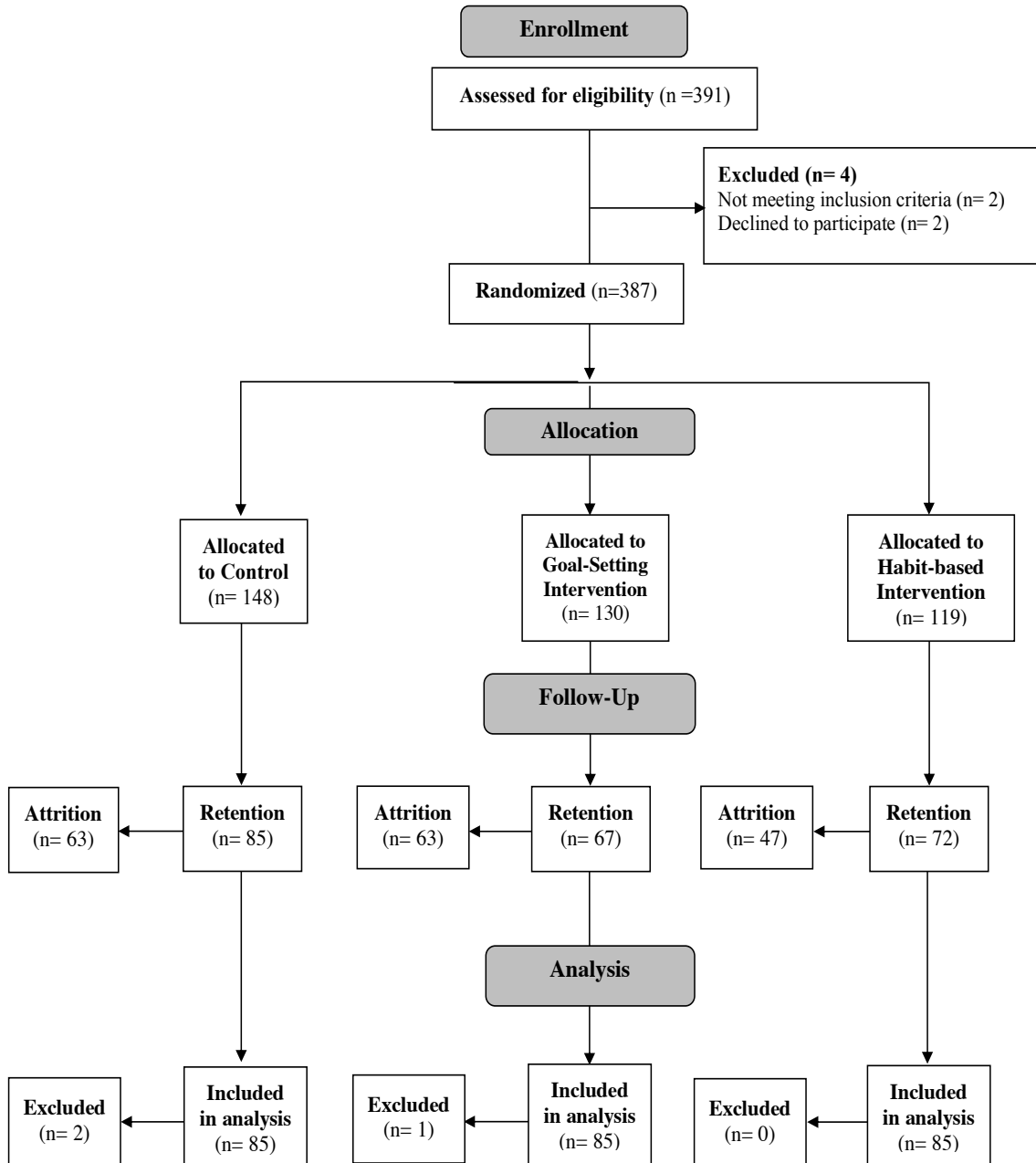
1. Participants at Monash were recruited in exchange for course credit and were given an additional course credit to finish the trial and submit their anonymised transaction history. The participants received one extra course credit in this study, when compared to other studies typically run at Monash, making the study more desirable to participate in. This could have contributed to the lower attrition rate.
2. The experimenter at Monash was also the course co-ordinator, ascribing a known relationship for participants which could have translated into trust. In contrast, there was no prior relationship or knowledge with the experimenter at Warwick. This could also partly account for the higher attrition rate at Warwick compared to Monash.

3. Those at Warwick were paid for their time (max pay-out £27), and the high pay-out may have alluded to a high degree of work (Promberger & Marteau, 2013) resulting in a 'crowding out effect' of intrinsic motivation. It is likely that the intrinsic motivation to continue with the study diminished despite the retention strategies put in place.
4. It is also likely that those at Warwick were not used to long studies that occurred over months and as such found it difficult to keep up with the requirements of the study.

Figure 16; Trial flow of the SAVINGS Trial



CONSORT 2010 Flow Diagram



The remaining sample consists of a majority of Monash participants with a smaller representation of Warwick students (Table 9). The full flow of the trial is illustrated in Figure 16, which details the randomization, attrition and exclusion of participants in the study. The attrition was equal across groups suggesting there was no bias in drop-out caused by the intervention effects at Monash, $\chi^2(2) = .280$, $p = .869$; or at Warwick, $\chi^2(2) = 2.850$, $p = .241$.

Table 9: Retained sample size in sites across sites

Site	Group	N
Monash	Control	50
	Goal-Setting	46
	Habit-Based	44
Warwick	Control	35
	Goal-Setting	21
	Habit-Based	28

6.9.2.1 Conversion of currency

To collate the results into one comprehensive dataset, participant transaction amounts and account balances from Monash were converted from Australian dollars (AUD) to British sterling pounds (GBP). This was conducted using daily historical exchange rates archived on the Bank of England website.

6.9.2.2 Model Specification

To depict the impact of the policy on monetary variables, a fixed-effects OLS model was used to predict monetary outcomes as specified below:

$$Y_i = \beta_0 + \beta_1 C_i + \beta_2 I_i + \beta_3 A_i + \beta_4 I * A_i + \varepsilon_i$$

Where Y_i is the outcome variable, C_i is a vector of control variables (such as age, sex, statement length and income), I_i denotes the frequency of usage of behavioural tools provided to those in the intervention groups. For the Goal-Setting group this denotes the number of log-ins into the web-based expense tracker; whilst for the Habit-Based group,

this represents each recorded substitution. Some participants did not return the tools and as such were left as missing. To produce more robust estimators, missing data in tool count was left intentionally blank. The prime reason is that by denoting missing tool counts as 0, whilst there a high probability that this missing value may should take a value other than 0, thereby biasing the regression coefficient. In other words, missing tool use data coded as 0 would bias the regression coefficient as the participant would have used the tool but this usage cannot be identified or proven.

The regression analysis follow a hierarchical regression, where the first model examines control variables, the second investigates tool use, the third examines the treatment effect of intervention allocation, and finally a fourth model investigates the interaction effect of tool use and intervention allocation. A result of the model specification due to tools only being provided to those in the intervention conditions, means that the main effects cannot be included in the fourth model.

A_i is a vector of factor identifiers that signify intervention allocation across sites. The model seeks to predict changes in monetary consumption, savings and account balances across groups controlling for site and income effects. To control for income, income was controlled in two ways. The first, as a predictor of differences between month three and month one; and secondly by using income within the dependent variable with savings as a fraction of income. This method is to reduce the bias from any omitted variance explained by income, where reduction in income would lead to reduction in consumption or savings.

Tool usage was only recorded by those who submitted records of usage. As such, individuals who were randomized to the intervention groups but did not provide usage data were excluded from the analysis completely, owing to a high degree of uncertainty. Not knowing if the participant had used the tool made the prediction of missing cases unreliable.

Regressions were ran using R, with the *lme4* package (Bates, Maechler, Bolker, & Walker, 2018), to control for heterogeneity, White's estimates of robust standard errors (White, 1980) were calculated using the '*HCI*' command in the *vcovHC* function under the *sandwich* package (Zeileis & Lumley, 2017).

6.10 Exploratory analysis

6.10.1 Descriptive Statistics

The sample population (after attrition) consisted of an average age of 20.594 years (SD = 3.84), 67 males and 146 females (4 reported did not disclose their gender). Age was equally split across groups, $F(2,214) = .60$, $p = .550$, gender, $F(2,214) = .60$, $p = 0.55$ and site, $F(16,200) = .69$, $p = .80$.

6.10.2 Transaction Histories

Across the 84 days, a total of 29,842 transactions (credit and debit) were completed, with an average of 95.57 (SD = 84.04) transactions per participant. The average transaction costed £1.40 (SD = £552.50). The average debit (consumption) from the accounts was £63.12 (SD = £415.64), with 23,170 debit transactions (77.64%), with a median transaction of £9.68. The average credit (income) into the accounts was £199.22 (SD = £847.36), with 6,672 credit transactions (22.36%), with a median transaction of £29.12.

6.10.3 Assumptions

To explore the effects of the intervention, monetary consumption, savings and account balances have been analysed. These measures were analysed in two key ways: firstly, as raw difference scores, and secondly, in propensity, as a relative factor of income.

Account balances were analysed in the same manner, but by using the end of month amounts. The monthly amounts were constructed as 30-day intervals from enrolment. This was to maintain consistency across participants, as recruitment was spread out across 2017 in the Warwick site, but was compacted within 15 days at the Monash site. Difference scores across all three outcome measures (consumption, savings and account balances) were calculated for each participant based upon the length of their statements as bounded by the dates of enrolment, such that $n \leq 84$. This was because some participants only submitted financial data for dates within the intervention.

Outliers were identified through z-scores, with any outliers being winsorized at the 95% level (Tukey & McLaughlin, 1963). This was conducted using the psych package on R (Revelle, 2018). The assumption of homogeneity of variance was tested using Levene's test through the car package on R (Fox, Weisberg, & Price, 2018).

6.10.4 Income over time

A major assumption of the intervention is that income does not vary. The interventions work by reducing consumption and thereby increasing levels of savings. Fluctuations in income could also drive consumption behaviour and consequently, savings behaviour. The intervention therefore, requires income to remain equal across groups and across time. This was tested through a repeated-measures ANOVA using SPSS v24, with total income as a dependent variable across the three months, with group and site as between-subject effects and age, sex and statement length as covariates. Mauchly's test of sphericity demonstrated an unequal covariance matrix, $W(2) = .91$, $p = .000$, as such Greenhouse-Geisser corrections were used. The model demonstrated no significant differences over time, $F(1.83, 380.19) = .15$, $p = .85$, or time*group interaction, $F(3.66, 380.19) = .98$, $p = .41$; or time*site interaction, $F(1.828, 380.19) = .25$, $p = .76$; or the three way interaction of time*group*site, $F(3.66, 380.19) = .914$, $p = .45$. These results support the assumptions of income remaining relatively stable over time and between groups. However there were significant differences in income between sites, $F(1, 208) = 14.92$, $p = .000$, with the Monash site demonstrating a higher income on average ($M = £2484.72$, $SE = £197.80$) than the Warwick site ($M = £1146.77$, $SE = £271.678$). As such, site effects were controlled for to remove the effects of such income inequality.

6.10.5 Outcome measures

When comparing outcome variables across groups, the inspection revealed homogeneity of variance across groups, for differences between month 3 and month 1 in monetary consumption, $F(2,214) = 1.29$, $p = .28$; as well as for the change in propensity to consume for month 3 to month 1, $F(2, 214) = 1.67$, $p = .19$. Homogeneity of variance was observed across groups for change in monetary savings between month 3 and month 1, $F(2,214) = 1.34$, $p = .26$; as well as for propensity to save, $F(2,187) = .45$, $p = .64$. Change in income was also examined, which demonstrated homogeneity of variance across groups, $F(2,214) = 2.66$, $p = .07$. Variance in account balances were shown to be homogenous across groups, $F(2,160) = 1.04$, $p = .35$; as well as for the propensity to save, $F(2,147) = 1.28$, $p = .88$.

When comparing outcome variables across sites, the inspection revealed homogeneity of variance for differences between month 3 and month 1 in monetary

savings, $F(1,215) = 1.08$, $p = .30$; but not for monetary consumption, $F(1,215) = 6.18$, $p = .014$. There was however significant heterogeneity of variance in propensity to save for monthly savings, $F(2,188) = 7.67$, $p = .006$; and for propensity to save as exhibited in account balances, $F(2,148) = 34.84$, $p < .0001$.

Inspection of the distribution of outcome measures across participants identified a symmetrical, leptokurtic distribution for all measures (Table 10). This observation is an expected artefact in distributions of performance and income (Mandelbrot, 1960). This symmetrical but leptokurtic distribution is explained by a model often seen in financial datasets described as the pareto distribution (Drăgulescu & Yakovenko, 2001; Mandelbrot, 1960; Singh & Maddala, 2008). The pareto distribution refers to the distribution of production/performance across a population, where there is large inequality in a given measure or performance/production (in this case consumption and savings). In this study, a large proportion of participants held onto small amounts of savings and consumption, whilst a small minority hold onto most of the wealth or consumption rates.

Table 10: Distribution characteristics by measure

	Month Difference								
	Consumption			Balance			Saving		
	3-1	3-2	2-1	3-1	3-2	2-1	3-1	3-2	2-1
Kurtosis	4.518 (0.33)	4.12 (0.33)	5.57 (0.33)	3.37 (0.38)	3.854 (0.38)	2.562 (0.38)	3.354 (0.33)	4.235 (0.33)	3.745 (0.33)
Skewness	-0.458 (0.17)	0.292 (0.17)	-1.631 (0.17)	-0.764 (0.19)	1.196 (0.19)	-0.243 (0.19)	0.372 (0.17)	1.195 (0.17)	-0.388 (0.17)

6.11 Model Results

Of all the 224 participants that had finished the study, only 217 submitted sufficient financial data that could be used within the analysis, as these seven participants provided incomplete statements that did not meet all twelve weeks of the intervention duration. Tool use was recorded as a frequency count, with any participants who had failed to

return a tool recorded as missing data, and therefore left as missing. This was to avoid assumptions in regard of any tool use that would be otherwise erroneous. This reduced the sample space of the regression models when including tool use.

6.11.1 Raw Differences

6.11.1.1 Monetary Consumption

The multi-site behavioural change intervention demonstrated significant reduction in total monthly monetary consumption between month three and month one.

Result 1. (a) No effect of tool-usage on change in monetary consumption

For the intervention groups, tool-use was not a significant predictor of change in monetary consumption ($\beta = -.5486$, p (one-tailed) = .317).

Result 1. (b) Goal-Setting group showed significant reduction in change of monetary consumption compared to the Control group, but Habit-Based group did not

Compared to the Control group, the Goal-Setting group showed a significant mean reduction (albeit at the 10%) in monetary consumption of £460.66 ($\beta = -460.65$, p (one-tailed) = .053), and the Habit-based group showed a mean reduction (albeit insignificant) in monetary consumption at £348.60 ($\beta = -384.59$, p (one-tailed) = .13). These results were obtained whilst controlling for change in income, change in transactions age, sex and the number of days included in the statement.

Comparing the coefficients for Goal-Setting and Habit-Based allocation under a two-tailed test, the analysis demonstrated no significant difference between the groups, $t(129) = .17$, p (two-tailed) = 0.86. As such, there is insignificant difference between the interventions for reduction in monetary consumption.

The results may have been worse for the Habit-Based group due to poor fidelity and implementation, where the parameters of the intervention were not executed properly by participants. It is possible that the way in which they executed their substitution was not what the intervention was actually designed for. For example, they may have sought to change between options that differ in contexts (i.e. bringing in lunch instead of buying lunch) rather than substituting options within a context (i.e. instead of a coffee, purchase

a tea). This distinction is important; substitution of behaviours as opposed to substitution of choices may have resulted in diminished effects, however, further examination would be required to investigate further.

Result 1. (c) The interaction of intervention allocation and tool usage did not demonstrate significant reduction in change in monetary consumption

An interaction of intervention allocation and tool usage demonstrated a reduction in monetary consumption for those in Habit-based group ($\beta = -0.880$, p (one-tailed) = .470) and the Goal-setting group ($\beta = -22.52$, p (one-tailed) = .22), however, this was not statistically significant.

Mean tool use was significantly higher for the habit group ($M = 12.25$, $SD = 9.08$) than the Goal-Setting group ($M = 7.33$, $SD = 5.83$), as expressed through an independent t-test, $t(44.984) = 2.77$, p (one-tailed) = .008, $d = .65$. Considering the Habit-based tool (credit card sleeve) was more likely to be retained by the individual at any given point in time, this may have provided them a greater opportunity to utilise it. In comparison, the web-based expense tracker provided for the Goal-Setting group required access to a computer or mobile phone, and there is a chance participants only accessed this tool when prompted to do so via email. The standard error surrounding tool use in the Habit-Based group does signify a very high degree of variance. This may be the result of insufficient submissions from the Habit-Based group, in addition to the confounding effect of substituting behaviours. Due to the substitution of behaviours, the credit card tool may have been unable to act as a prompt or feedback device, as the substitution may not have involved an alternative (cheaper) purchase.

Table 11: Regression results on monetary consumption differences

	Model 1	Model 2	Model 3	Model 4
Age	41.53 (59.61)	-30.60 (25.21)	43.19 (58.92)	-27.90 (23.31)
Sex	237.22 (296.36)	185.51 (272.18)	212.38 (297.82)	184.32 (268.99)
Days	-33.85 (21.42)	-31.79 (27.27)	-32.53 (21.32)	-24.08 (30.47)
Income	0.90*** (0.05)	0.93*** (0.05)	0.90*** (0.05)	0.93*** (0.05)
Transactions	17.591** (7.53)	18.83 (12.06)	17.86* (7.48)	19.20 (11.92)
Site	419.03 (260.15)	531.03* (284.58)	387.71 (256.14)	509.11* (295.73)
Tool		-5.49 (11.50)		
Goal			-460.65** (284.09)	
Habit			-384.59 (341.51)	
Goal:Tool				-22.52 (29.27)
Habit:Tool				0.88 (11.51)
Intercept	1342.63 (2117.35)	2675.77 (2396.72)	1510.87 (2052.35)	2053.16 (2606.55)
R2	0.73	0.80	0.73	0.80
N	217	92	217	92

Robust standard errors (White, 1980) are reported in parentheses.

* ,** ,***, significance at the 10%, 5% and 1% level respectively

6.11.1.2 Monetary Savings (i.e. income – consumption)

The multi-site behavioural change intervention demonstrated mixed effects in total monthly monetary savings between month three and month one.

Result 2. (a) No effect of tool-usage in change in savings

There was no effect of tool usage on monetary savings ($\beta = 7.96$, p (one-tailed) =0.34).

Result 2. (b) Only one intervention group demonstrated improvement in change in savings

Only the Goal-Setting group demonstrated a significant improvement in savings compared to the Control group ($\beta = 521.43$, p (one-tailed) = .005). The Goal-Setting group generated an increase in £521.43 compared to the Control group over the three-month intervention period. The Habit-Based group showed an increase of £251.32 over the three months, however this was not statistically significant ($\beta = 251.33$, p (one-tailed) = .11).

Comparing the coefficients for Goal-Setting and Habit-Based allocation under a two-tailed test, the results demonstrated no significant difference between the groups, $t(129) = 1.05$, p (one-tailed) = .30. This showed no significant difference between the treatment effects for improvement in savings.

Again, the Habit-Based group demonstrated weaker effects than the Goal-Setting group. This may have been due to poor implementation of the Habit-Based intervention. If participants were attempting to substitute behaviours entirely, it is likely that it would have been difficult to prompt or remind the behaviour, as they would not see their sleeve at the moment when it is most effective.

Result 2. (c) The interaction of intervention group allocation and tool usage demonstrated improvement in change in savings in only one intervention group

Compared to the Control group there was a marginally significant effect of allocation and tool use in the interaction term for Goal-Setting but not for Habit-Based participants. Each tool usage in the Goal-Setting group generated an additional £36.18 savings with marginal significance ($\beta = 36.18$, p (one-tailed) = .09). However, the Habit-Based group demonstrated an insignificant decrease in savings for each increment of tool usage, ($\beta = -2.58$, p (one-tailed) = .39). This is likely a result of a diminished sample size, which further restricts statistical power, or potentially due to the use of substituting behaviour, limiting the use of the tools.

Table 12: Regression results on savings rates over time

	Model 1	Model 2	Model 3	Model 4
Age	-15.39 (-32.22)	37.24 (22.91)	-19.11 (31.92)	32.76 (20.66)
Sex	-151.75 (194.52)	-219.88 (234.80)	-124.93 (191.82)	-217.90 (228.61)
Days	20.84 (14.51)	28.44 (21.74)	16.83 (14.11)	15.67 (21.96)
Income	0.17*** (0.04)	0.18** (0.06)	0.17*** (0.04)	0.19** (0.06)
Transactions	-13.07*** (4.97)	-13.52** (7.12)	-13.27*** (4.89)	-14.13* (7.16)
Site	-247.80 (183.98)	-521.43* (234.20)	-212.96 (179.27)	-485.13** (236.33)
Tool		7.96 (9.71)		
Goal			550.93*** (213.12)	
Habit			251.33 (202.42)	
Goal:Tool				36.18* (26.23)
Habit:Tool				-2.58 (9.46)
Intercept	-1028.10 (1368.40)	-2462.40 (1918.10)	-923.49 (1307.67)	-1431.10 (1893.10)
R2	0.181	0.231	0.206	0.258
N	217	92	217	92

Robust standard errors (White, 1980) are reported in parentheses.

*, **, *** , significance at the 10%, 5% and 1% level respectively

6.11.1.3 Account Balances

The multi-site behavioural change intervention demonstrated significant effects in account balances over the trial period. Of the 217 participants, only 146 had sufficient account balance data to be utilised across the three months.

Result 3. (a) No effect of tool-usage in change in account balances

There was a positive albeit insignificant main effect of tool usage on account balances ($\beta = 7.12$, p (one-tailed) = .15).

Result 3. (b) Intervention groups showed significant reduction in change in account balance compared to the Control group.

Compared to the Control group, there was a significant effect of intervention, with the Goal-Setting group showing a mean improvement in their account balances of £402.07 ($\beta = 402.07$, p (one-tailed) = .004). The Habit-based group showed a significant mean improvement (at the 10% level) in their account balances of £217.11 compared to the Control group balances ($\beta = 217.11$, p (one-tailed) = .07) with control variables included in the model. This result is of interest, given the significance of only one intervention group at the consumption and savings level. This result is likely due to group variations in income and less variation across account balances. This also could be due to the fact that the sample size was reduced (to 146 participants) when compared to the total population of the study ($n = 217$) as a result of excluding participants who provided inadequate transaction histories.

Comparing the coefficients for Goal-Setting and Habit-Based allocation under a two-tailed test, the resulting analysis demonstrated no significant difference between the groups, $t(101) = .86$, p (one-tailed) = .38. As such there is no significant difference between the treatment effects for change in account balances.

Result 3. (c) The interaction of Goal-Setting group allocation and tool usage demonstrated improvement in change in account balances

Compared to the Control group there was a significant interaction between intervention group and tool use in the Goal-Setting group, which indicates a savings of £18.99 for each time Goal-Setting individuals accessed their tool ($\beta = 18.99$, p (one-tailed) = .045). There was no significance in the interaction between tool-use and Habit-based group allocation ($\beta = -3.35$, p (one-tailed) = .35). This is likely a result of the use of substituting behaviour which has reduced the effects of the credit card sleeve as a prompt, thereby limiting the use of the tools.

Table 13: Regression results on account balances over time

	Model 1	Model 2	Model 3	Model 4
Age	17.70 (26.72)	7.76 (15.92)	10.34 (26.33)	8.93 (16.28)
Sex	-163.23 (126.15)	-208.46 (171.55)	-164.47 (119.27)	-206.17 (168.44)
Days	-19.11 (21.89)	-55.43 (39.32)	-24.09 (20.61)	-59.71 (38.58)
Income	0.66*** (0.24)	0.67* (0.36)	0.71*** (0.23)	0.64* (0.38)
Transactions	-3.18 (4.45)	-2.38 (4.14)	-3.42 (4.28)	-2.45 (4.14)
Site	92.93 (139.59)	127.68 (147.55)	117.14 (136.79)	134.26 (143.40)
Tool		7.12 (6.91)		
Goal			402.07*** (151.51)	
Habit			217.11* (147.34)	
Goal:Tool				18.99** (11.04)
Habit:Tool				-3.35 (8.65)
Intercept	1344.20 (1863.60)	4651.76 (3260.38)	1694.67 (1748.34)	4948.75 (3197.52)
R2	0.136	0.122	0.180	0.161
n	146	64	146	64

Robust standard errors (White, 1980) are reported in parentheses.

*, **, ***, significance at the 10%, 5% and 1% level respectively

6.11.2 Savings Ratio

To account for income, an alternative specification is to use monetary savings as a fraction of income. This is also referred to as a propensity score, denoting the propensity to save or spend conditional on income (Leff, 1969).

This analysis was conducted only on two of the three domains; savings and account balances. The reason for this is because of the mathematical calculation of the

outcome variable where consumption and income produce reverse effects, as demonstrated below.

$$\frac{Savings}{income} = \frac{income - consumption}{income} = 1 - \frac{consumption}{income}$$

Savings rates were calculated as specified above in Section 6.6.7.1. The construction of the variable yielded extreme values, and these were caused by large negative monthly savings divided over extremely small monthly income. These calculations yielded extremely large values with a large variance (M = -16.13, SD = 228.51). The values have a substantial range of 3524.11 (Min = -3099.07, Max = 425.04). Savings ratios for each month should predominantly lie between 0 and 1, however, overspending leads to large negative values (as these values can exceed income). These cases of overspending can then lead to large difference scores (as such the mean score = -16.13).

To reduce the large variability in savings ratio, a cube root transformation is used to transform the data to reduce variance and construct robust estimators. Cube root transformations have been used in literature for income transformations (Cox, 2011; Mirowsky & Hu, 1996), where research has demonstrated that this method offers one of the best transformation of monetary data, particularly income (Schwartz, 1985). The cube root transformation was executed on both savings and account balances.

6.11.2.1 Monetary Savings

Propensity to save demonstrated a diminished effect that showed improvement but mixed differences. 27 participants were excluded from this analyses as their income was 0 for at least one month, creating incalculable savings ratios.

Result 4. (a) Tool use was not a significant predictor on savings ratio

Frequency of tool use was not significant, ($\beta = -.01$, p (one-tailed) = .56). This may be a result of the low submission rates, which caused lots of missing values, reducing the sample size.

Result 4. (b) Goal-Setting group showed increased propensity to save, but not Habit-Based group

Treatment effects of the Goal-Setting and Habit-based intervention demonstrated improvement in savings. The Goal-Setting group showing a significant improvement in savings in comparison to the Control group ($\beta = .35$, p (one-tailed) = .048). The Habit-based intervention also exhibited an positive difference in savings in comparison to the Control group ($\beta = .017$, p (one-tailed) = .47), but this was insignificant. This is likely a result of poor implementation and does raise suspicions that participants enacted substitution of behaviour rather than substitution of options. This would diminish the results of the Habit-Based intervention as the likelihood of enacting an entirely different behaviour was not the design or purpose of the intervention.

Result 4. (c) The interaction of treatment effect and tool usage demonstrated no significant improvement in savings

There was no significant effect of an interaction between allocation to the Goal-Setting group and tool usage ($\beta = .004$, p (one-tailed) = .43); or for allocation to the Habit-Based intervention and tool usage ($\beta = -.017$, p (one-tailed) = .38).

Table 14: Regression results of monetary saving propensity differences

	1	2	3	4
Age	0.01 (0.02)	0.05* (0.02)	0.01 (0.02)	0.04* (0.024)
Sex	-0.23 (0.17)	-0.42 (0.26)	-0.22 (0.17)	-0.419 (0.26)
Days	0.04* (0.02)	0.07 (0.05)	0.03 (0.02)	0.07 (0.05)
Income	0.00008*** (0.00002)	0.00008** (0.00003)	0.00009*** (0.00002)	0.00008** (0.00003)
Transactions	0.004 (0.006)	0.01 (0.01)	0.004 (0.006)	0.001 (0.001)
Site	0.002 (0.228)	0.11 (0.40)	0.02 (0.23)	0.13 (0.01)
Tool		-0.01 (0.02)		
Goal			0.35** (0.212)	
Habit			0.017 (0.214)	
Goal:Tool				0.004 (0.02)
Habit:Tool				-0.02 (0.02)
Intercept	-2.92* (0.02)	-5.92 (4.18)	-2.68 (1.71)	-5.54 (4.04)
R2	0.072	0.120	0.088	0.128
n	190	80	190	80

Robust standard errors (White, 1980) are reported in parentheses.

* ,** ,***, significance at the 10%, 5% and 1% level respectively

6.11.2.2 Account Balance

Propensity to save as given in account balances demonstrated little to no differences between groups.

Result 4. (a) Tool use was a significant predictor on savings ratio

Frequency of tool demonstrated a significant improvement in savings, ($\beta = .051$, p (one-tailed) = .016), consistent with the hypothesis of the effects of the behavioural tool.

Result 4. (b) Intervention groups showed no increased propensity to save in account balances

Treatment effects of the Goal-Setting and Habit-based interventions showed insignificant findings. The Goal-Setting group showed a loss of the propensity to save in comparison to the Control group ($\beta = -.21$, p (one-tailed) = .52), as well as the Habit-based intervention ($\beta = .21$, p (one-tailed) = .25). This effect may be due to variance of account balances between individuals at the start of the intervention. For example, if one participant started with £2000 of savings in their account, and another started with £200 of savings in their account, the differences may influence their tendency to spend or save. In addition, there was a significant effect across groups, when comparing raw differences in account balance. However, when income was taken into account, the treatment effects disappeared.

Result 4. (c) The interaction of treatment effect and tool usage demonstrated improvement in savings.

There was a positive effect on the interaction between the Goal-Setting group and tool usage, however, this was not significant ($\beta = .04$, p (one-tailed) = .12). The Habit-Based intervention group and tool usage demonstrated a significant interaction effect ($\beta = .06$, p (one-tailed) = .02), stipulating that higher counts of tool usage indicated higher savings ratios in the Habit-Based group.

Table 15: Propensity to save in account balances from month three to one

	Model 1	Model 2	Model 3	Model 4
Age	0.03 (0.07)	0.03 (0.09)	0.02 (0.07)	0.04 (0.09)
Sex	0.28 (0.28)	-0.39 (0.45)	0.28 (0.27)	-0.38 (0.46)
Days	-0.03 (0.04)	-0.04 (0.11)	-0.03 (0.04)	-0.06 (0.11)
Income	-0.002*** (0.001)	-0.003*** (0.001)	-0.002*** (0.001)	-0.003*** (0.001)
Transactions	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)	-0.01 (0.01)
Site	-0.83** (0.41)	-1.17 (0.71)	-0.81* (0.41)	-1.14 (0.69)
Tool		0.01 (0.04)		
Goal			0.36 (0.38)	
Habit			-0.09 (0.36)	
Goal:Tool				0.06** (0.03)
Habit:Tool				-0.03 (0.04)
Intercept	0.86 (3.61)	2.78 (8.93)	1.38 (3.60)	3.90 (8.60)
R2	0.163	0.213	0.173	0.259
n	146	64	146	64

Robust standard errors (White, 1980) are reported in parentheses.

*, **, ***, significance at the 10%, 5% and 1% level respectively

6.12 Overall Results & Trends

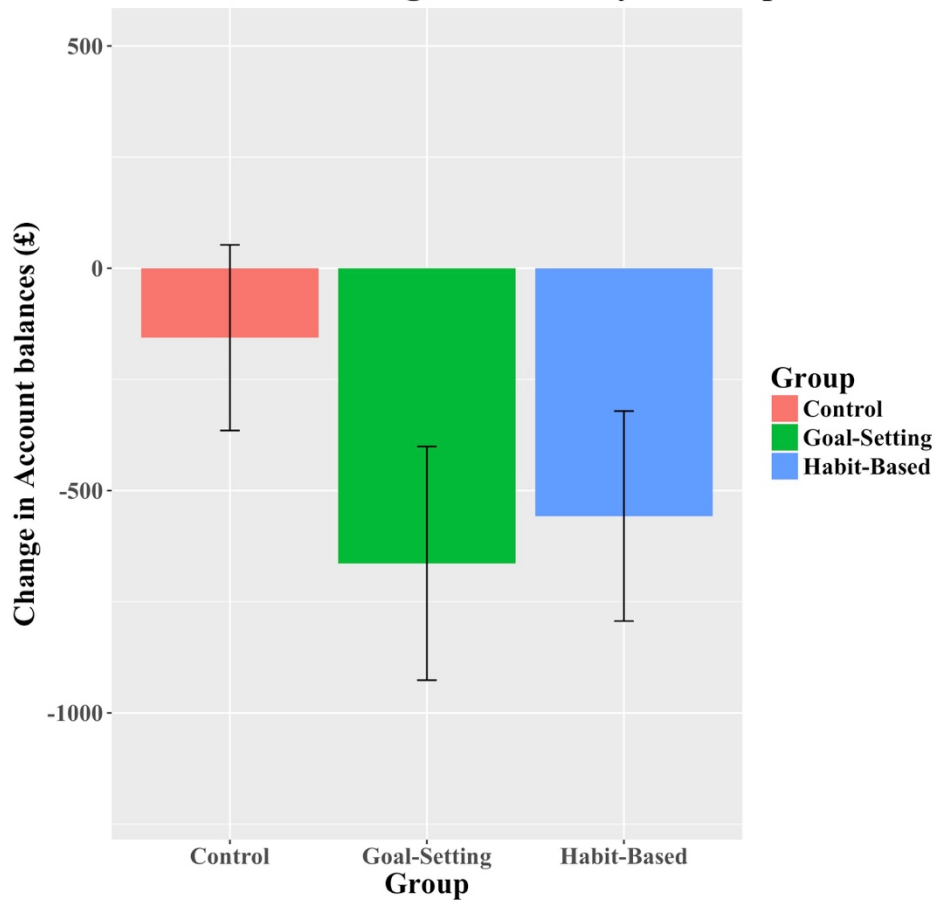
To understand the effects of the intervention, including the secondary analysis, a holistic discussion is presented. Firstly, the trends are consistent with the hypotheses for one of the intervention groups across both savings and consumption, for raw differences and saving ratios (save for change of savings ratios in account balances). In raw differences, those in the treatment groups typically demonstrate success within their respective domains (monetary consumption, savings and account balances); however only Goal-Setting group demonstrated consistent significance across most domains.

Increased tool usage did not predict significant change in outcome measures (except in predicting savings ratio of account balances), suggesting that tool usage does not directly produce effects upon savings behaviour. This may be a likely result of lack of data. Of the full 217 participants, 133 participants were randomised to the treatment groups. Of this, only 93 participants returned their tools. The mean tool use was 9.04 times (SD = 7.46 times) over the 84 days, which would suggest tools were used once every nine days; and this was unequally split between groups. There was a significant difference in tool usage, as described in Section 6.11.1.2. Mean tool use was significantly higher for the Habit-Based group (M = 12.25, SD = 9.08, i.e. once every seven days) than the Goal-Setting group (M = 7.33, SD = 5.83, i.e. once every twelve days), as expressed through an independent t-test, $t(44.98) = 2.77$, p (one-tailed) = .008, $d = .65$.

The lack of data back from participants and diminished frequency to which participants had used their tools suggest that it is likely there is a tool effect, but the study may just be underpowered to determine whether such an effect exists. These effects aggregated at the overall level in determining treatment effects, but the incremental differences were too small. It is possible that the design may not necessarily have fitted best with behavioural practices. This would perhaps suggest that “just-in-time” tools could prove to be more useful.

It is feasible that the frequency of tool-use required from the Habit-Based group is larger than obtained under the parameters of this study. As the Habit-Based intervention uses a bottom-up approach of savings through reducing monetary consumption, the frequency with which one substitutes purchases, produces only small incremental effects. For instance suppose a cup of coffee costs £3.30, and a tea costs £1.20; the marginal reduction in substitution is £1.10. If this was a daily purchase, a week would produce a savings of £5.50; a month would yield £55, and the intervention period would yield £165. But this would require 84 tallies to produce such an effect. As such it is possible that the tallies represent only a partial number of the actual substitutions made. Furthermore it is plausible that participants were put off by recording each tally, not considering the intervention as incremental effects, but rather the total required usage. This expectation may have diminished the interest and thereby execution of the implementation in the Habit-Based group.

**Figure 17: Raw difference in consumption, error bars represent s.e.m.
Treatment effects in change in monetary consumption**



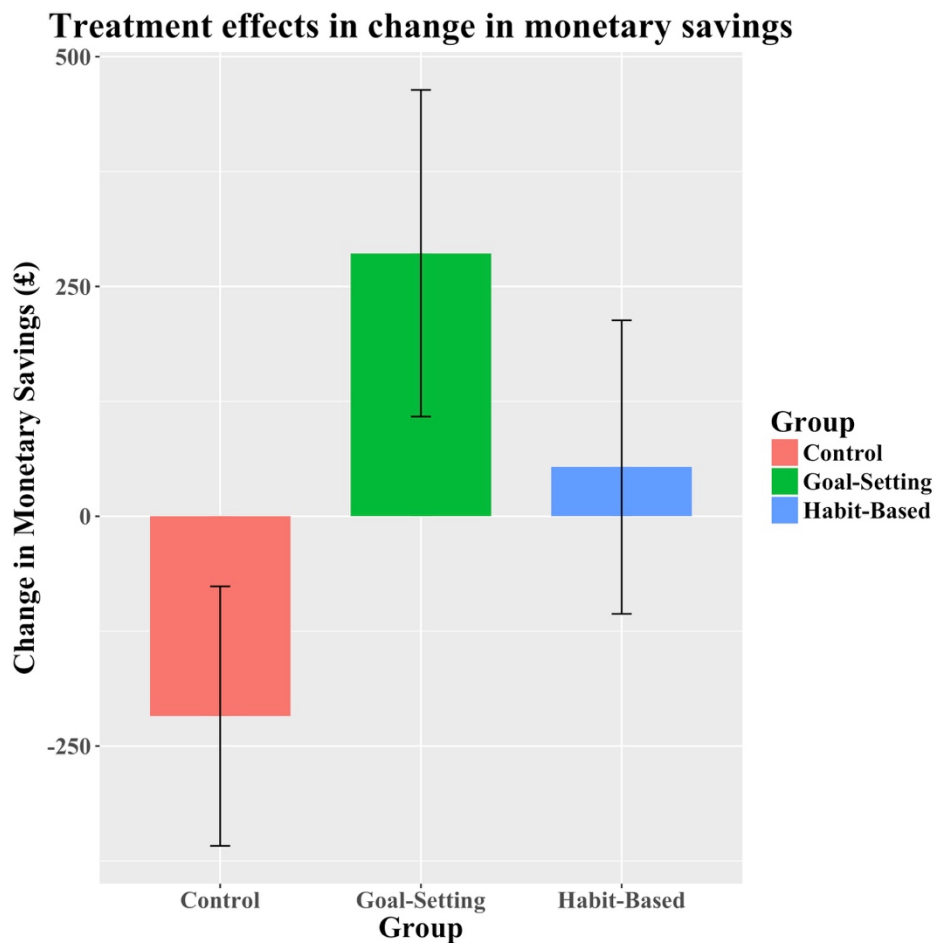
**s.e.m denotes standard error of the mean*

When evaluating treatment effects, estimated marginal means calculated using the average values for the control variables were used. Monetary consumption was shown to decrease for those in the treatment groups in comparison to the Control, however only the Goal-Setting intervention displayed significance over time compared to Control, as shown in Figure 17, which shows the reduction in consumption (i.e. the larger the bar, the greater the reduction in consumption). The Control group (M = -£156.06, SE = £208.80) exhibited a reduction in consumption over time, and this may be a due to a variety of reasons. Firstly, individuals who are generally more inclined to save, are more likely to volunteer for studies to increase monetary savings. As such, these individuals are already saving without further behaviour support. Secondly, it may be a result of demand characteristics, where individuals enrolled in a study to improve monetary savings then alter their behaviour to demonstrate improvements.

The Goal-Setting group and Habit-Based group both demonstrated a greater reduction in consumption than the Control group. The Goal-setting intervention exhibited

the greatest differences in consumption ($M = -£663.64$, $SE = £262.79$), and this was significantly greater than the difference for the Control group ($p = .004$). The Habit-based group also demonstrated a reduction in consumption ($M = -£557.32$, $SE = £236.12$), however such effects were not significantly greater than the Control group. This may be a result of a slightly underpowered study, considering the heavy attrition rates. This may also be as suggested earlier, the effects of substituting behaviours rather than substituting options.

Figure 18: Raw difference in savings, error bars represent s.e.m.

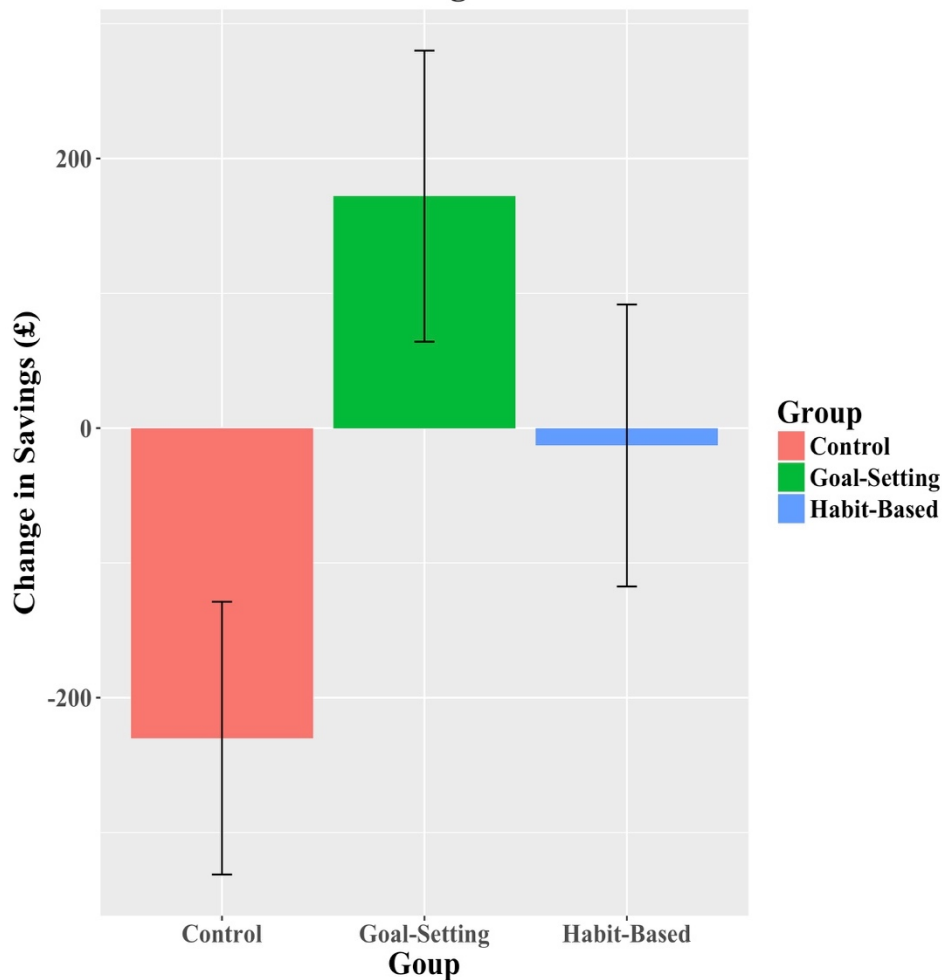


**s.e.m denotes standard error of the mean*

In raw differences in savings, the group means demonstrate an identical trend as seen above. The Control group identified an overall loss ($M = -£217.40$, $SE = £141.18$), suggesting that typical saving techniques employed by the average student are not efficient in aiding saving behaviour. An additional factor may also be variance in monthly income. The deficit seen in the Control group and positive effects observed in both

treatment groups are illustrated in Figure 18 above. The Goal-setting group demonstrated the greatest change in savings ($M = \text{£}286.10$, $SE = \text{£}177.70$), which was statistically significant. The Habit-based group also demonstrated a positive change ($M = \text{£}53.49$, $SE = \text{£}159.66$), however, this was insignificant. This could be due to the nature in which participants implemented the Habit-Based intervention, where many participants wanted to substitute behaviours entirely as opposed to swapping purchases bound within a given context.

**Figure 19: Raw difference in account balances, error bars represent s.e.m.
Treatment effects in change in account balances**



**s.e.m denotes standard error of the mean*

When examining account balances, the Control group again exhibited a negative change ($M = -\text{£}167.21$, $SE = \text{£}101.74$), which aligns with the results seen across the other variables. The Goal-setting group ($M = \text{£}93.05$, $SE = \text{£}120.36$) and Habit-based group

both showed improvements in account balances ($M = £44.48$, $SE = £107.71$), with both groups demonstrating significantly greater change in comparison to the Control group. These differences can be seen in Figure 19 above.

The trends in raw differences describe uniformity between groups. The Goal-Setting group performed the best across all domains, with the highest pre-post differences. The Habit-Based group performed better than the Control group, but not significantly across all three domains. Finally, the Control group performed the worst, with participants even showing a depreciation in their savings.

However, when examining the savings ratios, or the propensity to save, mixed effects are seen. Here, estimated marginal effects are calculated on the transformed dependent variable. This makes a direct interpretation of the coefficients difficult to make. As such, the main focus is on the significance and sign (i.e. direction) of the values. Treatment effects as a whole, demonstrated an increase in the propensity to save compared to the Control group. This difference was significant only within monthly savings for the Goal-Setting group. The savings ratios identify a loss in the propensity to save for the Control group ($M = -17.6\%$, $SE = 14.2\%$), and the Habit-Based group ($M = -15.9\%$, $SE = 15.2\%$). The Goal-Setting group, however, demonstrated a significant improvement in their saving ratios, increasing their propensity to save ($M = 17.8\%$, $SE = 16.1\%$). These differences are shown in Figure 20. At the raw level, this would describe an improvement of 4.44 percentage points for the Goal-setting group compared to the Control group. These results are somewhat consistent with the results in savings rates. However, the trend in savings ratios demonstrate how income accounts for a large proportion of the explained variance in change in spending and saving behaviour.

Figure 20; Difference in saving ratios of savings, error bars represent s.e.m.



**s.e.m denotes standard error of the mean*

The examination of the savings ratio expressed in account balances identifies null effects. All three groups exhibited reduction in savings ratios, suggesting the propensity to save expressed in their account balances reduced over time, i.e people in all three groups were saving less in proportion to their income. The Habit-Based group saw the highest levels of reduction (M = -70.2%, SE = 26.8%), followed closely by the Control group (M = 61.1%, SE = 25.9%); with the Goal-Setting intervention showing to moderate this reduction with the lowest depreciation scores (M = -25.0%, SE = 27.6%).

Both monetary savings and account balances were calculated through the same rolling window size of 30 days from enrolment. This effect may be due to the fact that the account balances vary for each individual already, in addition to the amount saved (calculated as the difference between income and consumption). These two scores added together produces the account balances; and this adds increased variance onto the already observed variance in raw differences in savings. This increased variance may have reduced the sensitivity to detect a group difference.

The sample size for the analysis of savings ratio in account balances dropped to 146 individuals. This reflected a drop of around twenty participants per group, and this reduction in sample size leads to a reduction in statistical power, which may explain the results. There is also an additional extraneous factor to consider - the commercial banks participants bank with, and whether certain individuals ascribe to specific companies. It is possible that the branding of a particular commercial bank coincides with a particular market audience, and this audience may be perhaps more or less financially stable. For example, international students may have opted more towards banks such as HSBC and Barclays in the UK. This self-selection process may cluster particular traits of financial behaviour to particular banks. For example, individuals who are more meticulous and check their account more regularly may align themselves with a perceptually similar branding. This is of particular interest, considering only certain banks provide customers with both their transaction histories and account balance data. These effects may be small in nature, but additively can accumulate and contribute to such group differences.

6.13 Intervention fidelity

6.13.1 Habit-Based group

When examining the results in the habit intervention, a pattern is identified in the substitution of one option for another, where participants incorrectly specify substitutions with one behaviour for another. This connotation is important in habit theory in psychology, and under computational assays, which both specify state specification (i.e. the context in which a behaviour is executed) as being integral to habit formation. The implementation intention made by participants, in this case, may not coincide with the context in which participants are making the substitution. 35.71% of participants (N = 35) had incorrectly specified their behavioural substitution; with four participants not putting a substitute, six participants choosing an option that is not applicable (e.g. Instead of ‘Wasting time at night’ in ‘the room’ I will buy ‘Learning to code in Python or exercising’). Of the remaining 30.95% (N = 26), all participants mentioned cooking at home or some variant instead of buying food out. For instance, instead of “Coffee” at “the morning” in “the coffee shop at Monash” I will “bring coffee from home”. Although this seems, at face value, an ideal substitution, the environmental triggers for buying coffee in the morning are separate and distinct from signals which code to bringing in

coffee from home in the morning. The intervention was designed purposively to swap choices within a set context of time and location, however, such an incorrectly specified substitution could have resulted in a lack of habitual uptake.

Consider the example of “cooking at home” as a substitute for “buying food out”;. This substitution would require the individual to prospectively remember to initially purchase the ingredients, prep and make the food ahead of time, in addition to bringing in the lunch. The only instance in which their card would be used when breaking this behaviour down is at the purchase stage, and by this point they would already be at the till.

Therefore the tool effects are dramatically reduced, as the credit-card sleeve would no longer provide effective prompts. Nor would it act as a feedback tool, as the act of tallying each substitution would require the individual to remember to take out their card sleeve and record each instance, when in fact, they would now not use their card when preparing food at home, bringing it into university or having it at lunchtime.

As such, the translation of intervention protocol to implementation is poor as this substitution of behaviour was not as the purpose of the intervention and as such, was not designed to enable such behaviour change.

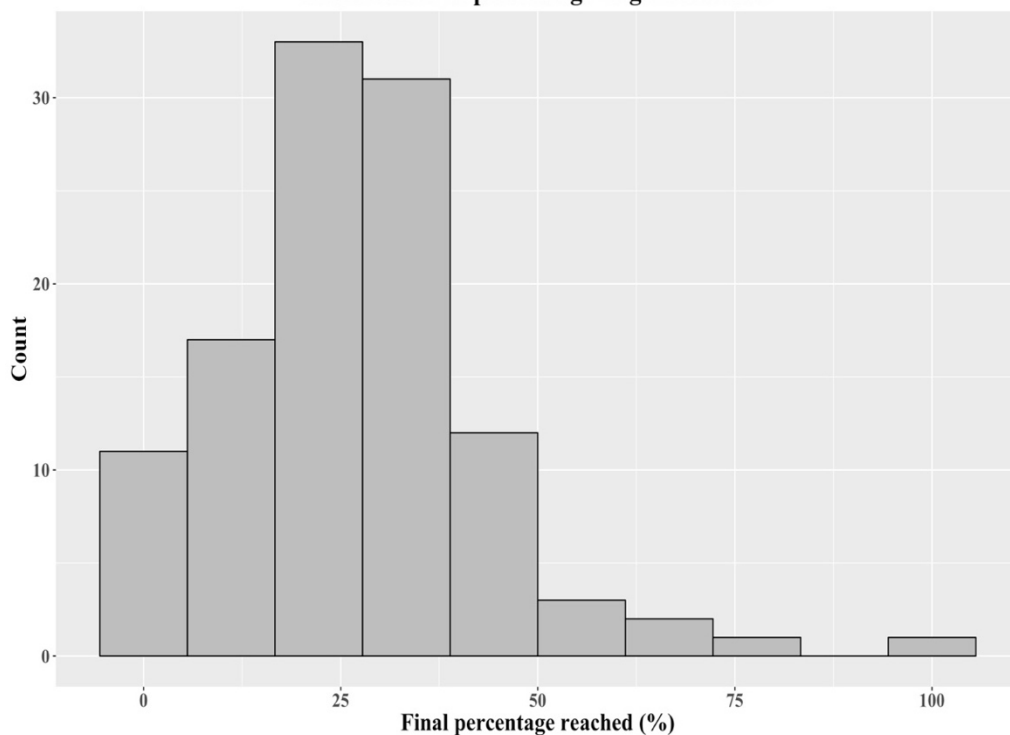
6.13.2 Goal-Setting group

Examining the data retrieved from the 111 total Goal-Setting participants on the web based expense tracker, the goal prices ranged from £40 to £11,666.82 ($M = £1351.19$, $SD = £2108.32$). Of the 111 participants only 105 participants entered any information regarding their goal. Six participants failed to name their goal, and another six participants failed to provide a price. The most common category of goal was a technological purchase ($n = 38$); whilst the most common goal was for a ‘holiday’ ($n = 19$) whilst ‘trip’ was close behind ($n = 18$). Four participants chose to set a goal as a gift for another person, “flight ticket for sister”, “vacation for mum” or as presents. These individuals would have received an additional boost in effort due to the social desirability and commitment for another person as opposed to themselves (Headey, Muffels, & Wagner, 2010).

When examining the overall distance towards each participant’s goal, many individuals showed problems in reaching their goal as exhibited by the distribution of final distance in

Figure 21 below. On average, participants only ascertained 25.05% of their savings goal (SD = 17.29%). Only one participant fully reached their goal, with the next highest attaining 82.5% of their goal. Six participants failed to reach their goals at all and a further seven participants attained less than 10% of their savings goal, potentially demonstrating poor implementation. It should be noted that the data may only demonstrate part of the picture, and there are two potential issues that could factor into this. Firstly, participants may have documented spending but not documented any form of savings towards their goal. As such, there could be missing data regarding overall progress made towards saving goals. Secondly, participants may have set too high of a savings target, as suggested from the large range in goal prices (range = £11,626.82; min = £40, max = £11,666.82; Mean = £1351.19, SD = £2108.32), which was unattainable in the three months of the intervention.

Figure 21; Distance reached by participants in Goal-Setting group
Distribution of percentage of goal attained



The average total amount saved was £437.20 (SD = 449.74), with a range of £3300.05; (min = £33.334; Max = £3333.38). These results would suggest that on average, participants did save, but they had aimed too high and as such poor progress was made towards their goals. This average saving of £437.20 as exhibited in the goal-setting

data, less than the measured raw change in savings (£503.50) but is in fact reasonably close in value. This would suggest perhaps that participants often, forgot to update these values.

Examination of saving-intentions was achieved through the contribution of ‘potential savings’ (difference in income and consumption) toward the savings goal. This was calculated as the

$$\textit{Intention to save} = \textit{Max} [\textit{save}] / \bar{I} - \bar{C}$$

Where, *save*, denotes the total saved that month. In this case, the maximal value is the furthest the participant could have reached, which is 100%. \bar{I} , is the average of that month’s income and \bar{C} is the average of that month’s consumption. Here, average values were taken as total consumption varied from month-to-month, making it difficult to calculate a single parameter to ascribe saving intentions. Eleven participants made either no intention-to-save, or demonstrated negative values (through over-consumption). A further 17 individuals over-pledged, contributing more than in potential savings possible, and these were excluded from the analysis. On average, participants put forward 36.76% of their possible savings (SD = 26.87%), with a range of 3.18% to 100%. Only 26 of the possible 83 remaining individuals showed an intention of higher than 50%. This suggests that the Goal-Setting group demonstrated significant differences despite only putting in limited effort.

This may highlight the high level of consumption typically displayed amongst university students, where minimal effort shows significant improvements. Secondly, further reinforcement mechanisms to bolster implementation of the Goal-Setting group could demonstrate even greater effects if implemented well to motivate users to log-on and track progress more frequently.

6.14 Intervention feedback

To understand how participants perceived the trial was of importance in understanding its effectiveness and acceptability. To this end, a feedback questionnaire was sent to all participants in the trial after submitting their transaction histories. Of the 224 participants that finished the study, only 49 participants completed the feedback questionnaire

(21.88%). Of the 49 participants who completed the questionnaires, only 37 were included in the intervention groups. The remaining twelve were of the Control group and did not respond to any questions about tools or intervention efficacy.

Of the 37 participants who were in the intervention, 27 stated they did not experience any unforeseen expenses, whilst ten individuals said they had. Examples of these included an £28 uber ride, meals and shopping of undisclosed amounts.

Participants were asked to rate how difficult they found the intervention on a 1-10 likert scale. This item was to understand the ease with which participants took to the intervention. Participants rated the difficulty of their interventions at an average of 4.67 (SD = 2.30). This would suggest that participants did take to the intervention well, however, there were some difficulties experienced, and this needs to be refined in the intervention process to make it more streamlined. For instance, future research could look to partner with financial apps to utilise information much more seamlessly, rather than asking participants to self-report spending. This process could help to automate reminders and identify perhaps more efficient behavioural interventional methods. The difficulties were expressed by only fourteen participants who identified technological issues, where the automated emails were always sent to their junk inbox. Most of the responses (50%, 6 responses) were towards the Habit-Based group's credit card sleeve. One participants identified how the credit-card sleeve was easy to lose, or even simply forget to use:

“I once forgot my wallet and paid with my phone, so temporarily lost the habit tool”

Anonymous participant on the habit tool

“Forgetting to use the habit tool, having unexpected expenses that I couldn't use the habit tool for.”

Anonymous participant on the habit tool

“I always lose the habit tool”

Anonymous participant on the habit tool

Another participant mentioned that the act of developing the substitution was difficult and time consuming.

“It keep messing up my daily schedule and took up more time to do the habit.”

Anonymous participant on behavioural substitution

The effort required in the intervention was sometimes more than participants were willing to engage in, as given by the participant below.

“Sometimes I just didn’t want to do the thing I was supposed to”

Anonymous participant on the intervention implementation

These quotes identify how the effortful implementation required by the Habit-Based intervention could have led to diminished effects observed in the intervention results. This finding was further reinforced from the instances of the tools being identified as difficult to use, where nine participants (25%) identified they had some uncomfortable instances with their behavioural tool. This could be addressed through a more automated procedure that helped participants through data collection in partnership with a bank or financial app. This could therefore allow for an algorithm to be utilised that sends prompts in response to cue-based triggers, such as their location and time.

When asked if they were embarrassed by the intervention, most participants said they were not (31 participants, 79.49%), however, five participants did identify that they were embarrassed to be part of the intervention. This may be a reflection of beliefs and perceptions about getting help or assistance in the form of support, for instance perceptions about therapy (Farrell, Deacon, Kemp, Dixon, & Sy, 2013).

When asked about how interesting the intervention was through a 1-10 likert scale, participants on average scored the intervention at 5.81 (SD = 2.53), this demonstrates some active involvement by participants from the intervention design, however there may be a need to gamify this sort of behavioural approach in future endeavours to make it more entertaining. Participants felt that the trial was secure and safe, with an average safety rating of 7.09 (SD = 2.56).

Participants felt on average they had learnt from the intervention on a 1-5 likert scale, an average rating of Mean = 2.31 (SD = .95), a positive finding suggesting that individuals were felt they had improved, this was reinforced from the positive effects

from the intervention which consistently described how the intervention made them second-guess their purchase decisions. As exhibited by the quotes below

“It gave me motivation so rather than buying clothes I'd think "well, this top is one driving lesson!" And wouldn't buy the top!”

Anonymous participant on the effects of the intervention

“Whenever I used my card, the paper cover for my card I was given reminded me to buy cheaper version not only of a product I put on it but to look for other cheaper things too.”

Anonymous participant on the use of the credit-card sleeve

Sometimes, the motivational effort required negatively impacted implementation.

“I would go for the alternative (cheaper) drinks most of the time and sometimes, I decide to not buy any altogether when I "must" choose the alternative.”

Anonymous participant on the Habit-Based intervention

Participants were more likely to suggest these learnt skills to others, where 61.11% of participants stated they would be happy to recommend these skills to others. Participants identified that the Habit-Based intervention did produce the desired effect, through positive affective responses from tallying their substitution.

“It was super easy to do and ticking the box from a swap felt good.”

Anonymous participant on the Habit-Based intervention

Another participant in the Habit-Based group described how the credit-card sleeve was able to remind and prompt them to substitute:

“The sleeve was a good way to keep reminding me about the habit”

Anonymous participant on the Habit-Based intervention

Participants who were allocated to the Goal-Setting intervention described how the use of the tool helped to reflect on and evaluate their spending. Participants stated that this level of detail can help to motivate them to reconsider their purchase decisions.

“I’ve been keeping monthly records of my expenses for two years, but I’ve never really specified on what my expenses were on, to the details that was presented in the website that I was required to update weekly. I think it really helped me to classify my expenditures into categories, rather than just recording where (the name of the shops) I spent my money.”

Anonymous participant on the Goal-Setting intervention

“Forced me to think about what/where I could cut down my expenses and save on”

Anonymous participant on the Goal-Setting intervention

Some individuals wanted a more comprehensive list of consumption categories, where one participant had used up their list of ‘others’ and were left with the inability to categorise some of their expenses. They also expressed that the term ‘Income’ as given on the tool was misleading, despite attempts to ensure that income was given as a umbrella term.

“1) More intuitive categories for the expenses record... I maxed out all of the "others" categories. 2) Clearer definitions. As my entire studies is funded by savings, and I am not drawing an income, I do not quite know how to define ‘savings’.”

Anonymous participant on the Goal-Setting tool

There was a more general idea of how the intervention helped participants to reflect on their savings. With participants talking about their reported perceived self-controlled went up with the intervention.

“I think that I in general try to save money on a daily basis but this intervention helped me to actually control it.”

Anonymous participant on the intervention outcomes

“It made me think about what I was buying which reduced impulse buys and made me more aware of my money situation!”

Anonymous participant on the intervention outcomes

“Forced me to think about what/where I could cut down my expenses and save on”

Anonymous participant on the intervention outcomes

When asked about their believed savings amounts, the average self-reported expected savings value provided from participants was £131.82 (SD = £207.47) for the intervention groups (combined Goal-Setting and Habit-Based group); whilst the Control group demonstrated an average believed savings of £87.82 (SD = £213.26). When asked about how happy they were with this outcome on a 1-5 likert scale, participants on average expressed an average of 3.63 (SD = 1.24), identifying a positive perception from participants. When comparing response ratings of intervention groups (Habit-Based and Goal-Setting collapsed into one) against Control group, this demonstrated a significant difference, $t(26.630) = -2.458, p = .021$; where the Control group identified a lower rating ($M = 3.11, SD = 1.49$) than the intervention groups ($M = 4.04, SD = .84$). This does show that the intervention groups do believe they saved more. However this may be an effect of desirability characteristics, where in asking individuals this question would exhibit a believed need to inflate their estimated savings.

6.15 Conclusion

These results suggest a positive perception of the intervention, which corroborated the results of the intervention. Participants noted how the intervention helps them to reconsider purchase decisions and to think critically. Participants felt the intervention was secure and interesting, and identified that the intervention did in fact help to give them more control and reflection on their purchase decisions.

Participants noted that the behavioural tools themselves had differential effects, the credit-card sleeve was shown to help prompt purchase substitutions, as its intended design function. However, some participants did state difficulties in using the tool where it was easy to forget to use, or difficulty in retrieving their card from the sleeve.

The Goal-Setting tool was shown to help engage reflective mechanisms, however some individuals felt that the categories provided were not sufficient. Future work here

could be directed towards user experience research on what the most efficient and practical requirements would be for a web-based tool.

Participants' feedback identified much effort was required to implement the interventions. This could represent the self-monitoring component of tracking the consumptions or substitution on the web-based expense tracker or credit-card sleeve respectively. This idea was corroborated by participants noting how the credit-card sleeve was easy to leave behind or even misplace. This behaviour characterised how difficult the Habit-Based intervention is, and how important the credit-card sleeve is to the intervention. This finding could also explain why, if participants chose to substitute behaviours rather than in-context purchases, there was a reduced effect. A more streamlined process which uses automated procedures to collect consumption data and feedback this to the participants would be ideal, to minimise the effort on behalf of participants and provide detailed feedback from finer grained data. This would be beneficial for both the Goal-Setting and Habit-Based interventions.

Overall the intervention was well received, on average participants did identify a positive belief from the results of the intervention and were happy with this outcome. There was some individuals who expressed difficulties in implementation, though this is expected, and future research, should aim to utilise more automated methods. This may be true of behaviour change, generally, when aimed at the individual level, to produce more cost-effective results by promoting the behaviour through decreased effort on behalf of participants.

Chapter 7 Individual differences in interventions

SUMMARY

- Endophenotyping represents the markers of intermediate measures between top-level behaviours and bottom-up biological contributions (Chamberland, Blackwell, Fineberg, Robbins & Sahakian, 2005).
- Individual differences were examined in the effectiveness of the intervention, the SAVINGS Trial. Individual differences were examined under the domain of goal-directedness, impulsivity and executive function. These markers were behaviourally analysed to compute parameters of variation within each construct. These were then used to predict intervention efficacy.
- The results demonstrated that goal-directedness (or model-based reliance of control) was predictive of intervention efficacy in reducing monetary consumption and improving savings. Lower impulsivity rates also predicted reduction in monetary consumption and improving savings. Executive function observed significant prediction only for propensity to save.
- These results highlight to potential value in endophenotyping before an intervention to identify and stratify the population into those who require further support and those who can maintain intervention fidelity. Then the intervention can focus on those who require further support through the best and most effective means.
- Interventions could employ the use of additional goal-directed training such as using implementation intentions, specifying outcome and action goals; or through the use of pharmacological intervention using pharmacological agents shown to increase goal-directed behaviour.

7.1 Introduction

Individuals can often differ in their ability to achieve their behavioural intentions within environments that offer tempting alternatives (Ridderinkhof et al., 2004). For example, individuals may intend to save money, but fail to do so when tempted by options to engage in consumption activities that conflict with these goal, such as spending on an expensive holiday. This intention-behaviour gap is large, that is to say there is a large discrepancy between an individuals' intentions to act and their actual behaviours. For instance, Webb and Sheeran (2005) found that intentions accounts for just 28% of the variance in behaviour. The gap between individuals' intentions to change their behaviour and actual behaviour change is even larger (cohen's $d = .36$; Webb & Sheeran, 2006). The difficulty individuals have in achieving their behavioural intentions have been explained by dual process theories (Daw et al., 2005; Dolan & Dayan, 2013; Evans & Stanovich, 2013; Osman, 2004; Wood & R nger, 2016). Specifically, the reflective cognitive systems seem to underlie the formulation and maintenance of behavioural intentions, whilst the automatic cognitive systems often compete with these processes (Evans, 2008; Kahneman, 2011; Rouault et al., 2018; Stanovich & Toplak, 2012). Some individuals are more likely to maintain their behavioural intentions and achieve their goals than others, possessing greater goal-directedness and cognitive control (Huys & Dayan, 2009; Otto et al., 2015; Ridderinkhof et al., 2004; Selart et al., 1997).

The fact that individuals differ in their ability to achieve their behavioural intentions is in part due to differences in cognitive control (Otto et al., 2015). Cognitive control has been conceptualized by different researchers to include, for example, behavioural automaticity, goal-directedness, impulsivity, and executive function (Barrett, Tugade, & Engle, 2004; Gardner, 2014; Gillan et al., 2015; Jonides et al., 1997; Lally & Gardner, 2013; Otto et al., 2015; Verbruggen & Logan, 2008). For example, research suggests that targeting individuals with low levels of goal-directedness, through personalised interventions, such as pharmacological or behavioural, can more significantly improve their wellbeing. (Kulendran et al., 2013, 2016; Nederkoorn et al., 2010). The first step in this process is identifying which measures can segregate the population and identify deficits in outcomes (Goldberg, 1993; Robbins et al., 2012). This technique is known as endophenotyping (Robbins et al., 2012).

The current study aims to identify the moderating effects of individual differences in cognitive control in a RCT (SAVINGS Trial, see Chapter 6) to enhance university

students' financial capabilities (see Section 0 for more information). Three measures of cognitive control are examined, including measures of goal-directedness, impulsivity, and executive function.

7.2 Goal-directedness

Goal directedness is conceptualized in the current study as in computational reinforcement learning theories (Daw, Gershman, Seymour, Dayan, & Dolan, 2011; Dayan & Abbott, 2001; Gillan, Otto, Phelps, & Daw, 2015; Vlaev & Dolan, 2015). Reinforcement learning theories describe choice behaviours as being guided by the value of each options' expected outcome (Daw et al., 2011b; Otto et al., 2015; Wan Lee, Shimojo, & O'Doherty, 2014). Under reinforcement learning habitual and goal-directed choices are predicted by different processes (Dolan & Dayan, 2013). Habitual behaviour is predicated by a model-free process, where individuals learn to repeat actions followed by rewards according to 'cached' values (Dolan & Dayan, 2013), calculated from past utility and so are disassociated with the future outcomes they predict. Goal-directed behaviour is denoted by a model-based process, where individuals' choices are calculated based upon their internal models (knowledge) about the structure of the environment and their motivations (Daw et al., 2011a).

Notably, people differ in the degree to which their behaviour can be predicted by model-free and model-based processes. These processes have not been explored with regard to financial capability behaviours, but have been explored with other behaviours, predominantly for behaviours connected to psychiatric diagnoses. For instance, some researchers posit that substance abuse and addiction behaviours may stem from diminished goal-directedness (Sebold et al., 2014b), which leads to an over-reliance on habitual/model-free system (Everitt & Robbins, 2005; Kahneman, 2011; Voon et al., 2014). This hypothesis was suggest by Gillan, Kosinski, Whelan, Phelps and Daw (2016), who examined the relationship of goal-directedness/reliance on model-based control across various psychiatric disorders. For example, people diagnosed with eating disorders are characterised as having high degree of psychological control (Vitousek & Manke, 1994), as expected, Gillan and colleagues identified that eating-disorder patients exhibit a greater propensity for model-based choices. The researchers also found that people diagnosed with social anxiety who are anecdotally characterised as having low self-control, as expected, exhibit a deficit in goal-directedness with a low propensity of

model-based choices. Gillan and colleagues suggest that levels of self-control map onto a linear degradation of model-based control, or put succinctly sub-optimal behaviours are characterised by deficits in goal-directedness (Gillan, Kosinski, et al., 2016). As such therefore the primary concern is the tendency towards model-based control, or deficits thereof, where those who demonstrate lower reliance on model-based control may exhibit poor intervention outcomes.

With regard to the current study, individuals whose behaviours are better described by the model-based process, may be naturally more goal-directed and so more easily benefit from the goal-setting intervention. In contrast, individuals whose behaviours are better described by a model-free process may identify as poorer intervention effects, due to the deficits in goal-directedness.

7.3 Impulsivity

Impulsivity is conceptualised in the current paper as the degree to which people engage in a given behaviour for immediate satisfaction or meaningful reflective thought. For example, compulsive buyers have been shown to possess higher levels of impulsivity as measured through trait impulsivity scales such as Zuckerman's sensation-seeking scale (Desarbo & Edwards, 1996; Lejoyeux, Arbaretaz, McLoughlin, & Ades, 2002), and the UPPS Impulsive Behaviour Scale (Billieux, Rochat, Rebetez and Van der Linden (2008).

Furthermore, research has also demonstrated that impulsive individuals are more likely to show hyper-consumption, in regards to food consumption (Nederkoorn, Guerrieri, Havermans, Roefs, & Jansen, 2009; Nederkoorn et al., 2010); as well as addiction disorders (Belin, Mar, Dalley, Robbins, & Everitt, 2008; Dick et al., 2010; A. J. Lawrence, Luty, Bogdan, Sahakian, & Clark, 2009), OCD and compulsivity disorders (Samuel R Chamberlain et al., 2007; Chamberlain, Fineberg, Blackwell, Robbins, & Sahakian, 2006; Penades et al., 2007), and even to level of household debt (Ottaviani & Vandone, 2011) These comorbidities across sub-optimal behaviours identify commonalities in neuropsychological underpinnings (Gillan, Kosinski, et al., 2016; Trevor W Robbins et al., 2012). These insights are further extended to lifestyle behaviours such as obesity (Claes et al., 2006; Kulendran et al., 2013; Chantal Nederkoorn et al., 2010), where higher levels of impulsivity can even diagnose differences between clinical levels of obesity from healthy individuals (Kulendran et al., 2016). Such findings suggest a common overlap in terms of impulsive behaviour where

greater levels of impulsivity increase the propensity to consume, conflicting against their own intentions and goals (Doñamayor, Strelchuk, Baek, Banca, & Voon, 2018; Voon, Reiter, Sebold, & Groman, 2017).

This study seeks to examine how impulsivity can indicate propensities of goal-directed deficits, in particular in poor intervention efficacy. Impulsivity is parameterised through the Stop Signal Task and the monetary choice questionnaire, which can derive measures of response inhibition and temporal discounting, respectively.

7.4 Executive function

Executive function is conceptualised in the current paper as a set of higher-order cognitive processes known to be involved in planning, initiation, sequencing and monitoring of complex goal-directed actions (Royall et al., 2002), where variation in efficacy of these higher-order processes can relate to the degree to which an individual can execute their intended actions.

Executive function has been shown to moderate the intention-behaviour gap; for instance, Hall, Fong, Epp and Elias (2008) found that executive function explained a significant proportion of variance in diet and exercise behaviour beyond intentions. Those with the strongest levels of executive function was shown to exhibit stronger intentions and yield the best translation of intentions to action. Executive function and interactive effects accounted for 59% of the variance in physical activity, and 61% of dietary behaviour which is almost twice that of intentions alone (Sheeran, 2002).

These results were further supported by Allan, Johnston and Campbell (2011) who found that individuals with poor cognitive flexibility (as measured through task switching, verbal fluency task and a tower task) were more likely to exhibit higher rates of intention-behaviour gap with respect to eating fewer portions of fruit and vegetables as intended. Put succinctly those with lower cognitive control, i.e. the ability to plan, process information and monitor behaviour, ate less fruit and vegetables and more snacks than intended.

For instance, in one study examining executive function and savings behaviour, as measured through the ELSA (English Longitudinal Study of Aging), a British household panel survey. The researchers found that higher executive function predicted greater savings (Banks & Oldfield, 2007b). This finding is further supported by Cole and Shastry (2009), who examined cognitive ability through the Armed Services Vocational

Aptitude Battery (ASVAB). The researchers identified greater executive function was predictive of higher financial capability, through the knowledge and use of specialised financial instruments.

In a different study (Agarwal & Mazumder, 2010), researchers examined cognitive ability (again measured with the ASVAB) with household financial behaviour. The researchers find that cognitive ability protects from financial mistakes in credit-card behaviour, in addition to reducing error in property valuation for accurate loan and credit applications, resulting in lower annual percentage rates. The researchers highlight how greater executive function protects from sub-optimal financial decisions.

As such, executive function is an important facet in the intention-behaviour gap. Executive function seems to help prioritize and maintain higher order processes, which can have profound consequences behaviourally and in regards to the outcome of those behaviours. For instance, executive function has been shown to be diminished for addicts (Albein-Urios, Martinez-González, Lozano, Clark, & Verdejo-García, 2012; Verdejo-García et al., 2006; Woicik et al., 2009). Considering the above evidence, executive function seems to play an important role in maintaining goal-directed actions.

7.5 Aim

The current study examines the moderating effects of individual differences in cognitive control in a RCT (SAVINGS Trial, see Chapter 6) to improve household financial behaviours, i.e., decrease consumption and increase savings. The study uses three individual difference domains related to participants' cognitive control described above, and assesses the moderating effects of each individual difference measure on the intervention outcomes.

7.6 Method

In the current study, 397 participants were recruited through a multi-site RCT, with 210 participants recruited at the University of Warwick (UK), and 187 recruited from Monash University (Australia). All participants self-confirmed having normal or corrected-to-normal vision, and not being colour blind. At the beginning of the meeting, participants agreed to provide the research team with anonymized bank statements from their main account to the researcher at the end of the 84 day period.

On the first day of the RCT, participants met with a researcher in at the Behavioural Science Lab at Warwick Business School or at the Monash Business Behavioural Lab at Monash University. At this meeting, participants completed the behavioural tasks in a fixed order, to assess their goal-directedness, impulsivity and finally executive function. All tasks were completed on a 22" LCD screens with 60Hz refresh rate. To index goal directedness, participants completed sequential decision task. To index impulsivity, participants completed a stop signal task and a monetary choice questionnaire. To index executive function, participants completed an N-Back task. Participants completed these tasks using methods described in 1.1.1.1 Appendix E.

After completing these tasks, participants were randomly allocated into three groups in a 1:1:1 fashion, including a Control group, a Goal-Setting group, and a Habit-Based group. Participants in the Control group did not experience any intervention. Participants in the Goal-Setting group experienced the goal-setting intervention, and participants in the Habit-Based group experienced the habit-based intervention. The interventions were already described in Chapter 5 and the reader may refer to that chapter for greater details.

As a brief reminder, the Goal-setting intervention participants were asked to set a financial goal to save enough money to purchase a desirable item. To assist them, participants received a behavioural tool (a web-based expense tracker) to help self-monitor their progress to achieving that goal. In the Habit-setting intervention participants substituted a more expensive, impulsive purchase with a cheaper alternative, and were given a behavioural tool (a credit-card sleeve) to help self-monitor their progress to achieving that habitual change.

At the end of the first meeting, all participants were reminded that they agreed to return their bank statements at the end of the 84 day period. Participants at Warwick Business School were paid a fixed amount of £5 with an additional bonus contingent on their decision-making performance (up to an additional £12), while participants at Monash University were provided with course credit units (one for participation in the trial, and an additional for submitting their transaction histories).

7.6.1 Data Analysis

Below, the analysis plans for each behavioural task are described, then the outcome variables are specified, i.e., participants consumption and saving. Subsequently, the

model specification is detailed to assess the interventions' effects and the moderating effects of the individual differences is described.

7.6.1.1 Sequential decision-making task

For the sequential decision-making task, a trial-by-trial analysis was conducted for each participant using a computational analysis to estimate the model parameters (Daw et al., 2011a; Gillan et al., 2015; Voon et al., 2014). This analysis produces seven parameters in total (for more information see 1.1.1.1 Appendix E): however, this study is only interested in the perseverance (the degree to which a choice is repeated bounded between $-1 \leq p_s \leq 1$, a value of 1 indicates complete perseverance, whilst -1 denotes shifting behaviour) and weighting parameters (the weighting of reliance on model-based or model-free control, bounded between $0 \leq w \leq 1$, where $w = 1$ indicates model-based control and 0 denotes model-free), as they have underlying psychological component related to goal-directedness.

An additional analysis was conducted on choice behaviour across participants to validate the choice behaviour of the present sample against the data obtained from past instances in which the task has been used (Daw, Gershman, Seymour, Dayan, & Dolan, 2011b; Gillan et al., 2015; Otto, Skatova, Seth Madlon-Kay, & Daw, 2015; Voon et al., 2014). This analysis uses a logistic regression to examine the probability of repeating a past top-level state choice given the previous trial's outcome (reward and transition). The logistic regression uses qualitative ideas of model-free and model-based behaviour where purely model-free individuals would be solely fixated on repeated choices which were rewarded, whilst purely model-based individuals would be predicted by the interaction of a reward and common transition.

7.6.1.2 Stop signal task

For the Stop-Signal Task, Stop Signal Reaction Times (SSRT) were calculated for each participant using the integration method (see Logan, Schachar, & Tannock, 1997). The integration method was used because it is more robust to skewed data and strategic slowing of reaction times (Logan et al., 2014; A. Osman et al., 1986; Verbruggen & Logan, 2008). Generally, SSRTs are an indication of response inhibition where higher values denote higher levels of impulsivity.

7.6.1.3 Monetary choice Task

For the Monetary Choice Task, a discounting parameter k was recorded as an index of the rate at which the individual discounts rewards as a function of time, as represented in the formula:

$$V(D) = \frac{A}{(1 + kD)}$$

In the above formula, $V(D)$ indicates the perceived value of a monetary reward, A indicates the actual monetary value of that reward, D indicates a delay's duration, and k is a free discounting parameter (Kable & Glimcher, 2007). A greater k value is indicative of greater impulsivity, displaying a preference for immediate over delayed rewards.

7.6.1.4 N-Back task

For the N-back task, signal detection theory was utilised to compare the distributions of hit rates against false alarms. Signal detection theory compares z-scores for Hit rates (i.e. yes | correct response) against z-scores for False alarm rates (i.e. yes | incorrect response) to calculate a single value referred to as d-prime (d'). The d' coefficient is often referred to as a sensitivity index corrected for response biases. A greater d' is indicative more executive function. Participants whose Hit rates or False alarm rates equate to the upper or lower bounds were removed from the analysis because their d' is incalculable. This is because the d' is calculated as the difference between Hit rates and False alarm rates. In cases where participants Hit rates or False alarm rates hit the bound, the d' value becomes incalculable as the difference of these rates becomes 1 or 0, computing a d' of infinity or negative infinity, as such, these individuals were removed from the analysis.

7.6.1.5 Consumption

Consumption was given as monthly expenditure from the account; the outcome was taken as the difference in monthly expenditure of month one from month three. For more details please see Chapter 6.

7.6.1.6 Saving

Savings were measured as the difference in income and consumption; this score was then used as monthly savings. Difference scores were calculated for monthly expenditure of month one from month three. For more details please see Chapter 6.

7.6.1.7 Account balances

As money may be stagnated in participant's bank accounts, the account balance was analysed. The change in account balances was taken as the difference of monthly expenditure of month one from month three. For more details please see Chapter 6.

7.6.1.8 Interventions' effects and the effects of individual differences

To assess the interventions' effects along with the moderating effects of the individual difference measures the below linear fixed-effects mode was considered:

$$\text{Outcome}_i = \beta_{0,i} + \beta_1.C_i + \beta_2.I_i + \beta_3.T_i + \beta_4I:T_i$$

In this model, Outcome_i indicates the outcome variable (Consumption, Savings, Account Balance), C_i is a vector of control variables (age, sex, site, statement length, change in the number of transactions and income), I_i is a vector of the individual difference parameters (Goal directedness, Implulsivity or Executive function), and T_i is a vector signifies the participants' allocation (Group).

The data was run through the model using the lme4 package (Bates et al., 2018) in the R programming language (R Core Team, 2018). Parameters were tested for normality using Shapiro–Wilks test, with square root transformation, and an alpha value of for $p < .05$ to assess statical significance. Levene's test was used to test for equality of variance across intervention groups. To account for heterogeneity, White's estimates of robust standard errors (White, 1980) were calculated using the 'HC1' command in the vcovHC function under the sandwich package (Zeileis & Lumley, 2017).

Due to the effects of transformation the coefficients do not yield a straightforward unit-for-unit interpretation, as such, the sign and significance of the effects are the more important characteristics.

7.7 Hypotheses

The hypotheses are listed below, with a specific hypothesis for each individual difference: goal directedness, impulsivity and executive function. As a reminder, there are three outcomes: consumption, savings and account balances. Below the effects are only discussed as significant, though note that we mean significant decreases in consumption and increases in savings.

[i] Goal Directedness – weighting parameter, w , will predict interventional efficacy. At the consumption level, lower w -parameter values will predict greater change in monetary consumption, as such, a negative coefficient is observed. whilst for savings (both in monetary terms and in account balances), greater w -parameter values would predict an increase in savings, as such, a positive coefficient is observed.

[ii] Goal Directedness - perseverance parameter, ps , will predict interventional efficacy. At the consumption level, lower ps -parameter values will predict greater change in monetary consumption, as such, a negative coefficient is observed. whilst for savings (both in monetary terms and in account balances), greater ps -parameter values would predict an increase in savings, as such, a positive coefficient is observed.

[iv] Impulsivity - response inhibition parameter, SSRT, will predict interventional efficacy. At the consumption level, greater SSRT scores will predict greater change in monetary consumption, as such, a positive coefficient is observed. whilst for savings (both in monetary terms and in account balances), lower SSRT scores would predict an increase in savings, as such, a negative coefficient is observed.

[v] Impulsivity - discounting scores, k parameters, will predict interventional efficacy. At the consumption level, higher k -value scores will predict greater change in monetary consumption, as such, a positive coefficient is observed. for savings (both in monetary terms and in account balances), lower k -value scores would predict an increase in savings.

[iii] Executive function, - executive function, d' parameter, will predict interventional efficacy. lower d' values will predict greater change in monetary consumption, as such,

a negative coefficient is observed. Whilst for change in savings, positive d' values will predict greater change in monetary savings and account balances, as such, a positive coefficient is observed.

7.8 Results

Of the 397 participants enrolled into the trial, 224 returned their bank statements after 84 days. Of these 224 participants, seven submitted transaction histories with no account balance data, with a further 2 participants were removed from analysis due to missing data as a result of technical errors, from participants skipping tasks or not providing adequate data (such as not responding to any trials). Thus, the final sample contained 195 participants, of which 67.18% Female ($M = 20.989$ years, $SD = 2.694$ years). Of these 195 participants, 58 participants (29.74%) were allocated to the Goal-Setting group (38 Female, Mean age = 21.638 years, $SD = 3.562$ years); 64 (32.83%) to the Habit-Based group (42 Female, Mean age = 20.781 years, $SD = 2.207$ years) and 73 participants (37.44%) to the Control group (48 Female, Mean age = 20.657 years, $SD = 2.181$ years).

The following results first examine participants' performance on the three behavioural tasks. Then the results for each hypothesis are reported.

7.8.1 SAVINGS Trial

For discussion of the outcome measures of the SAVINGS Trial see Chapter 6.

7.8.2 Stop Signal Task

Participants completed 128 trials each, with an average accuracy of 65.693% across both stimuli categories. Participants demonstrated non-significant differences in accuracy between stimuli categories (Square or Circle), $t(13119) = 1.932$, $p = 0.053$; or in response time, $t(13119) = 0.653$, $p = .514$. Participants demonstrated an average RT of 535.916ms ($SD = 302.909$ ms), with an average reaction time of 473.356ms ($SD = 343.214$ ms) on No Signal Trials. SSRT scores ranged from -256.25ms to 1051.94ms, with an average SSRT score of 627.75 ± 246.5 m. The negative SSRT scores indicate a faster Stop signal than Go Signal.

7.8.3 N-Back Task

Participants completed 144 trials each, with an average accuracy rate of 74.051% and an average reaction time score of 627.087ms (SD = 311.259ms). Participants failed to respond on 10.437% of trials. Calculated d' scores ranged from -0.19 to 2.87, with a mean of 1.58 (SD = 0.55). Negative d' scores identify a propensity to respond to noise or false alarms over correct identification.

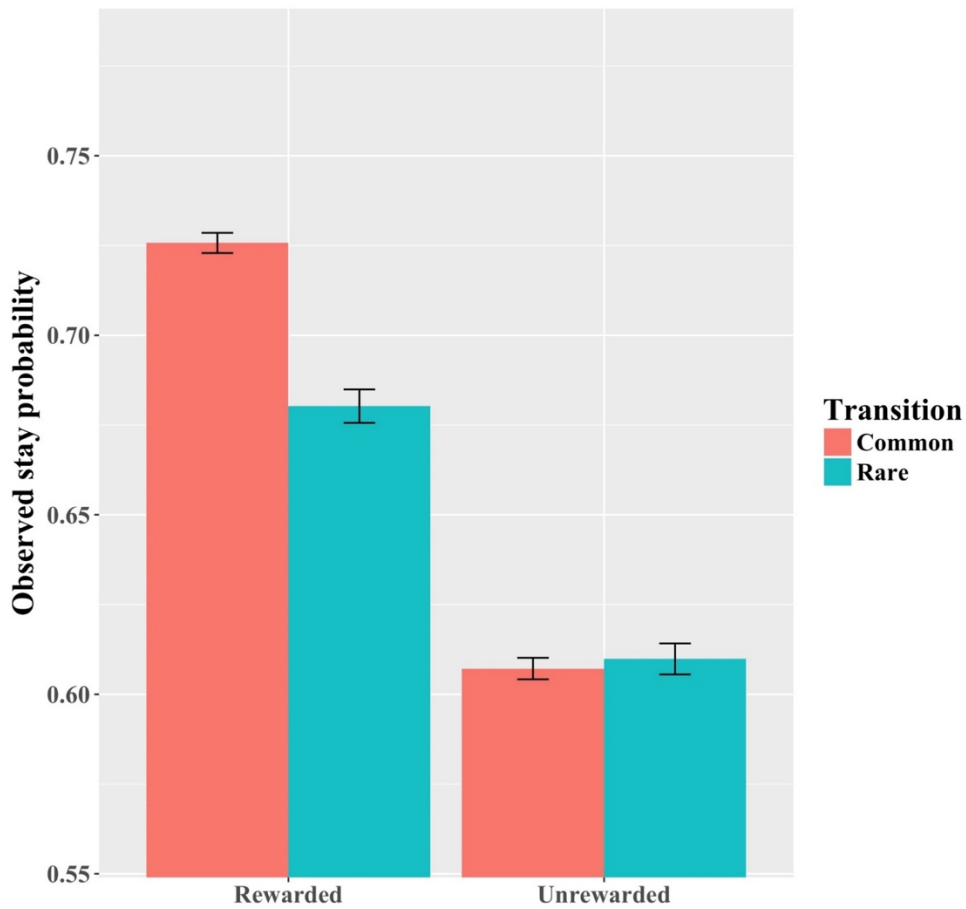
7.8.4 Markov Decision Task

In the sequential decision-making task, participants made sequential choices in a series of two-alternate forced choice task. Participants made one choice at the first-state, which led to a probabilistic transition to one of two second-state options, finally the choice at the second-state led probabilistically to either a reward or null outcome. Thus there is a two-way design of transition probability and reward outcome that could drive choice behaviour within the remit of this task. Participants failed to complete only a small fraction of trials, .976% of all trials (± 0.265 SEM), participants received on average a reward on 46.992% of trials (± 0.448 SEM).

To ensure that participants engaged with the task correctly, choice behaviour can be analysed qualitatively, which then be compared against other studies to validate that choice behaviour is indicative and expected. Such practice ensures face-validity to the computational parameters.

This is achieved by examining how second-state rewards impact subsequent first-state choices to discern model-free and model-based choices. For instance, if a first-state choice led to a second-state reward in a rare transition, a purely model-free individual would repeat the first-state choice regardless of transition, which is a characteristic of habits within reinforcement learning (Daw et al., 2005). A pure model-based individual would construct a mental-map of the environment taking into account probabilistic transitions between states and their rewards, as such they would shift away from their previous first-state choice, as the other option would lead to a higher chance of that second-state option. Figure 22 below depicts the observed frequencies of staying with a first-state choice as a function of the previous trial's reward and transition (averaged across the sample).

Figure 22; Observed stay probabilities of repeating first-state choice



As such, through the use of a logistic regression one can validate qualitative choice behaviour to corroborate similar findings as identified by previous research (Daw et al., 2011b; Otto et al., 2015; Skatova et al., 2013). Here, the choice to repeat or shift first-state choices can be predicted by reward only for model-free individuals, and reward and the interaction of reward and transition for model-based individuals. This was conducted through a mixed effects logistic regression ran using the lme4 package (Bates et al., 2018) on R (R Core Team, 2018). The model specification was ran as similar to Skatova et al. (2013):

$$stay \sim trans*rew + (1+trans*rew | subjID)$$

Where stay codes for whether participants repeated a first-state choice, calculated as the absolute difference of $t+1 - t$ of first-state choices, producing values of 0 or 1, where 0 is a repeated choice. Trans is the transition probability which represents the high (common transition, 70%) probability and low (rare transition, 30%) probability, this is coded as

1,-1 respectively. The reward component, rew, codes for whether the previous trial's second-state choice was rewarded or not, coded as 1,-1 respectively. This model included the interaction term as well as a random effect of the task parameters.

All three main effects were highly significant, the coefficients reported are at the population level, as noted in Table 16. The intercept demonstrated the greatest effect in prediction of staying behaviour (i.e denoting baseline tendency of 79.5%), whilst reward demonstrated a 27% likelihood in staying for the next trial, compared to a 7.5% chance by a common transition. The interaction effect was also significant, with an 8.1% increase in staying if rewarded and common transitions both occurred in the previous trial. The main effect of reward ascribes model-free behaviour, whilst the interaction term denotes model-based control. The values obtained are consistent with previous studies (Otto et al., 2015; Skatova et al., 2013), as such, the choice pattern is also identical to those by other researchers, with the parameter values aligning closely with theirs. As such the exploratory analysis revealed consistent findings across studies of qualitative choice behaviour of model-based and model-free reliance of control, these validations identify that the task does indeed isolate model-free and model-based behaviour as explored by other researchers and the sample obtained here behaved consistent with other samples.

Table 16; Population level coefficients of stay vs. switch behaviour

Main effects	Coefficient	Standard Error
Reward	0.271***	-0.016
Transition	0.075***	-0.011
Intercept (perseveration)	0.795***	-0.046
Interaction effects		
Reward:Transition	0.081***	-0.013
N	374	
Loglik	-43728.9	
AIC	87485.7	

*, **, ***, significance at the 10% 5% and 1% level respectively

7.8.5 Individual differences effects in trial outcomes

To examine the effects of individual differences on the interventions' effectiveness across the three outcomes (consumption, then savings and account balances). The model results are reviewed below separately. Firstly the raw differences were analysed across the three domains whilst controlling for income; followed by the savings ratio.

7.8.5.1 Saving Rates - Monetary Consumption

Individual difference parameters did predict changes in interventional outcomes, but not all parameters demonstrated significance.

[i] Goal Directedness - Weighting parameter, w:

The weighting parameter demonstrated significant effects in change in monetary consumption, the main effect of w demonstrated positive significant effect ($\beta = 203.81$, p (two-tailed) = .04). The interaction term of w with the Goal-Setting group exhibited a significant negative association, identifying that reduction in consumption was more likely to be associated with model-based reliance of control ($\beta = -4342.50$, p (one-tailed) = .004). The interaction of w with the Habit-Based group allocation also exhibited a significant negative coefficient, further identifying the role of model-based control in goal-directed outcomes ($\beta = -4543.60$, p (one-tailed) = .009)

[ii] Goal Directedness - Perseverance parameter, ps:

The perseverance parameter did demonstrate significance at the 10% level, for the main effect predictor ($\beta = -1760.70$, p (one-tailed) = .08). However the interaction term for ps and the Goal-Setting group allocation demonstrated a negative albeit insignificant effect ($\beta = -487.61$, p (one-tailed) = .41); as did the interaction of ps with the Habit-Based group ($\beta = -1535.90$, p (one-tailed) = .35). These effects are consistent with the hypothesis but lack significance across the three levels, which may be the result of large variability in the data and an inadequate statistical power to detect such differences.

[iv] Impulsivity - SSRT:

Response inhibition identified a negative effect on change in monetary consumption, ($\beta = -148.14$, p (two-tailed) = .047). The interaction of SSRT and Goal-Setting allocation

identified a positive but insignificant effect on change in monetary consumption ($\beta = 91.20$, p (one-tailed) = .16). A similar finding is identified in the interaction of SSRT and Habit-Based group allocation, which reached significance ($\beta = 174.650$, p (one-tailed) = .037).

[v] Impulsivity - k-parameter:

The temporal discounting parameter did not demonstrate significance at the main level or interaction levels. At the main level, there is a positive, insignificant effect ($\beta = 156.51$, p (one-tailed) = .14). The interaction effect of k and Goal-Setting allocation identified a negative insignificant effect ($\beta = -174.920$, p (two-tailed) = .42). The interaction of k and Habit-Based group allocation yielded a significant negative effect at the 10% level ($\beta = -412.81$, p (two-tailed) = .082).

[iii] Executive function parameter, d' :

There was no effect of the executive function parameter as given by the d' parameter values in the prediction of change in monetary consumption ($\beta = -18.42$, p (two-tailed) = .97). The interaction effect of d' and Goal-Setting group allocation was positive in concordance with the hypothesis but was, however, insignificant ($\beta = 46.07$, p (one-tailed) = .47). The same pattern was identified for the interaction of d' and Habit-Based group allocation ($\beta = 203.81$, p (one-tailed) = .37).

7.8.5.2 Saving Rates – Savings

Individual difference parameters did predict changes in interventional outcomes but not all parameters demonstrated significance.

[i] Goal Directedness - Weighting parameter, w:

The weighting parameter was not a significant predictor of change in monetary savings ($\beta = -267.43$, p (two-tailed) = .80). The interaction effect demonstrated a positive albeit insignificant effect with Goal-Setting group allocation ($\beta = 1279.30$, p (one-tailed) = .17), and Habit-Based group allocation ($\beta = 1172.60$, p (one-tailed) = .17). Such findings suggest an association of model-based control and goal-directed outcomes, however this

relationship was not shown to be significant, which may be a result of lack of statistical power.

[ii] Goal Directedness - Perseverance parameter, ps:

The perseverance parameter was positive, indicative of more goal-directed behaviour, however the coefficient value was not significant ($\beta = 473.90$, p (one-tailed) = .34). The interaction effect of ps and group allocation demonstrated an insignificant, negative effect with Goal-Setting group ($\beta = -329.55$, p (one-tailed) = .83), and Habit-Based group ($\beta = -643.22$, p (one-tailed) = .39). Such findings suggest an association between behavioural perseverance and goal-directed outcomes, however, this relationship was not shown to be significant, which may be a result of lack of statistical power. Given the sample size drop to 195, this would leave approximately 60 participants per cell of the intervention to make statistical inferences. In addition, the large variance exhibited in the small financial datasets regarding monetary consumption and spending could reduce the sensitivity of the analysis to detect a difference given one exists.

[iv] Impulsivity - SSRT:

SSRT scores demonstrated a significant albeit positive relationship with monetary savings ($\beta = 122.340$, p (one-tailed) = .089). However there is a negative relationship for treatment effects, which is significant at the 10% level for the Goal-Setting group ($\beta = -106.66$, p (one-tailed) = .098); but not for the Habit-Based group ($\beta = -60.69$, p (one-tailed) = .22).

[v] Impulsivity - k-parameter:

The main effect of the discounting parameters demonstrated a negative predictor of monetary savings as consistent with the hypothesis, however the coefficient did not reach significance ($\beta = -29.84$, p (one-tailed) = .42). The interaction with the Goal-Setting group and the k-parameter did identify a negative relationship ($\beta = -112.99$, p (one-tailed) = .29), although the result was insignificant. The interaction with the Habit-Based group and the k-parameter was insignificant ($\beta = 29.60$, p (one-tailed) = .43).

[iii] Executive function - parameter, d':

The d' parameter was not indicative of increase in monetary savings, as the main effect term ($\beta = -54.62$, p (one-tailed) = .89); or in the interaction effect with the Goal-Setting group ($\beta = -168.07$, p (one-tailed) = .75) or the Habit-Based group ($\beta = 5.78$, p (one-tailed) = .99).

7.8.5.3 Saving Rates – Account Balances

Individual differences were not wholly observed under account balances domain of monetary savings, with only one parameter establishing significance.

[i] Goal Directedness - Weighting parameter, w :

The weighting parameter displayed an insignificant main effect ($\beta = 59.91$, p (one-tailed) = .47). The interaction of w with Goal-Setting group allocation was insignificant ($\beta = -189.33$, p (two-tailed) = .87), as well as the interaction of w and Habit-Based group allocation ($\beta = -24.90$, p (two-tailed) = .98).

[ii] Goal Directedness - Perseverance parameter, ps :

The perseverance parameter displayed insignificance at the main effect level ($\beta = -144.49$, p (two-tailed) = .85) and at the interaction levels for Goal-Setting group ($\beta = -208.39$, p (two-tailed) = .83), as well as for the Habit-Based group allocation ($\beta = 383.67$, p (one-tailed) = .41).

[iv] Impulsivity - SSRT:

SSRT did not yield a significant coefficient at the main effect level ($\beta = 35.54$, p (two-tailed) = .49); or at the interaction level despite both identifying a negative coefficient in Goal-Setting group ($\beta = -36.29$, p (one-tailed) = .29) or the Habit-Based group ($\beta = -37.06$, p (one-tailed) = .27).

[v] Impulsivity -, k -parameter:

The main effect of k -parameter did exhibit a negative coefficient, in line with the hypothesis, however the size of the coefficient was not significant, ($\beta = -28.42$, p (one-tailed) = .43). The interaction effects revealed insignificant effects for both Goal-Setting

group ($\beta = 11.94$, p (two-tailed) = .87); and the Habit-Based group ($\beta = -34.60$, p (one-tailed) = .44).

[iii] Executive function - parameter, d' :

The main effect of d' identified an insignificant predictor ($\beta = -315.82$, p (two-tailed) = .27). The interaction effect with the parameter and Goal-Setting allocation yielded a significant positive effect (at the 10% level), consistent with the hypothesis ($\beta = 621.64$, p (one-tailed) = .06). The interaction effect of d' and Habit-Based group allocation yielded a positive coefficient which did not reach significance ($\beta = 281.68$, p (one-tailed) = .22).

7.8.6 Propensity to save

The propensity to save was calculated as the proportion of income that was not consumed, with difference scores calculated for pre-post differences. This analysis was conducted only on two of the three domains; savings and account balances. The reason for this choice is due to the mathematical calculation of the outcome variable where consumption and savings produce reverse effects, where,

$$\frac{Savings}{income} = \frac{income - consumption}{income} = 1 - \frac{consumption}{income}$$

As specified in Section 6.11.2 the construction of the variable yielded extreme values, outside the expected lower and upper bounds of 0 and 1, as such a cube root transformation is used to transform the data to reduce variance and construct robust estimators. Cube root transformations have been used in literature for income transformations (Cox, 2011; Mirowsky & Hu, 1996), where research has demonstrated that the cube root transformation offers one of the best transformation of monetary data, particularly income (Schwartz, 1985).

7.8.6.1 Monetary Savings

[i] Weighting parameter, w :

The weighting parameter did not display significance ($\beta = -.25$, p (two-tailed) = .78); whilst the interaction for w and Goal-Setting group allocation yielded a significant positive coefficient ($\beta = 2.38$, p (one-tailed) = .02), identifying that reliance of model-based control was more indicative of increased propensity to save. The interaction of w and Habit-Based group allocation however did not demonstrate a similar outcome ($\beta = .16$, p (one-tailed) = .45).

[ii] Perseverance parameter, ps :

The perseverance parameter did not yield significant coefficients at either the main effect level ($\beta = 1.27$, p (one-tailed) = .15), or the interaction effects with either Goal-Setting allocation ($\beta = -2.63$, p (two-tailed) = .15), or Habit-Based group ($\beta = -1.41$, p (two-tailed) = .49).

[iii] Executive function parameter, d' :

Executive function as expressed through the d' parameter did not identify a significant main effect, ($\beta = 0.03$, p (one-tailed) = .47); the interaction term with Goal-Setting group allocation did yield a significant interaction effect albeit negative ($\beta = -1.22$, p (two-tailed) = .03). The interaction of d' and Habit-Based group allocation yielded an insignificant coefficient ($\beta = -.05$, p (two-tailed) = .93).

[iv] Impulsivity (a), SSRT:

SSRT did not yield significance at the main effect level ($\beta = .09$, p (two-tailed) = .11), or for the interaction with either Goal-Setting ($\beta = -.04$, p (one-tailed) = .30), or for Habit-Based group allocation ($\beta = -.09$, p (one-tailed) = .13).

[v] Impulsivity (b), k -parameter:

The discount parameter did not identify significance at the main effect level, ($\beta = .02$, p (two-tailed) = .94). The interaction with the Goal-Setting group did yield a negative albeit insignificant coefficient ($\beta = -.05$, p (one-tailed) = .44). The interaction with the Habit-Based group yielded a negative significant coefficient ($\beta = -.53$, p (one-tailed) = .06),

identifying that lower discount rates were significantly predictive of higher propensity to save.

7.8.6.2 Account Balances

[i] Weighting parameter, w :

The weighting parameter did yield a negative coefficient significant at the 10% significance level for the main effect ($\beta = -2.69$, p (one-tailed) = .09), with an insignificant interaction effect with either Goal-Setting ($\beta = -.45$, p (two-tailed) = .85), or for Habit-Based group allocation ($\beta = 1.90$, p (one-tailed) = .17).

[ii] Perseverance parameter, ps :

The perseverance parameter did not yield significance at the main effect level ($\beta = .34$, p (one-tailed) = .43), or for the interaction with either Goal-Setting ($\beta = -1.31$, p (one-tailed) = .63), or for Habit-Based group allocation ($\beta = .22$, p (one-tailed) = .47).

[iii] Executive function parameter, d' :

The executive function parameter identified a significant negative coefficient in predicting propensity to save ($\beta = -1.29$, p (two-tailed) = .06). The interaction within the Goal-Setting group demonstrated a significant positive effect consistent with the hypothesis ($\beta = 2.53$, p (one-tailed) = .01), this finding was also identified for the interaction with the Habit-Based group allocation ($\beta = 1.81$, p (one-tailed) = .03).

[iv] Impulsivity (a), SSRT:

SSRT did not yield significance at the main effect level ($\beta = -.004$, p (one-tailed) = .484), or for the interaction with either Goal-Setting ($\beta = .004$, p (two-tailed) = .814), or for Habit-Based group allocation ($\beta = .015$, p (one-tailed) = .127).

[v] Impulsivity (b), k -parameter:

Discounting rates did not yield significance at the main effect level ($\beta = .13$, p (two-tailed) = .74), or for the interaction with either Goal-Setting ($\beta = -.34$, p (one-tailed) = .28), or for Habit-Based group allocation ($\beta = .71$, p (two-tailed) = .29).

7.9 Discussion

Individual differences did demonstrate significant effects of psychological domains in intervention efficacy. Regarding goal-directedness, the weighting parameter devised from the Q-net model, demonstrated that significant reliance on model-based control moderated the impact on change in monetary consumption. This effect, however, was not found in either monetary savings or account balances. Monetary savings did yield a positive coefficient for the interaction effect for Goal-Setting and the Habit-Based group allocation, there was no effect in w , as either a main effect or interaction for predicting change in account balances. In regards to the propensity to save, the weighting parameter did identify model-based control in only the interaction with Goal-Setting group allocation for calculated monetary savings, but not for account balances. The weighting parameter did yield a negative significant coefficient for account balances with regards to saving propensity, however this was only at the 10% level. This may suggest that reliance on model-free control can increase savings in account balances, where account balance savings are the effect of a default bias in behaviour in which an individual makes no active decision to transfer funds towards any other account as the savings are stagnated. As such, the savings accumulate in the accounts, identified in the account balances. Negative coefficients were observed in the interaction of both treatment allocations with w -parameter in difference scores of monetary savings in account balances, which may corroborate this finding.

Regarding goal directedness, the analyses of perseverance demonstrated results consistent in the direction of the hypothesis for the interaction effects in both monetary consumption and savings, however the coefficients failed to reach significance. This identifies higher rates of perseverance were predictive of reduced consumption and increased savings respectively in both interventions. It is likely that the attrition rates reduced the statistical power within each cell of the intervention to make statistical inferences, especially considering the variance exhibited in the dataset regarding monetary consumption and spending; compounded with small financial datasets may have dramatically reduced the statistical power of the study. Again in account balances, perseverance displayed no effects consistent with the direction of the hypothesis, however this could be due to default bias as well, where individuals are making no active decision to move money out of their accounts, to retain and accumulate the funds as opposed to depositing these amounts into a separate savings account.

Impulsivity demonstrated diminished results, across the three domains with both outcome variable specification, SSRT was shown to negatively predict change in monetary consumption, which would suggest that lower levels of impulsivity can aid in reduction of goal-directed outcomes. SSRT demonstrated a positive prediction in change of monetary savings, though these results are significant only at the 10% level of note and are likely a result of spurious association as opposed to any significance in effects. The interaction of SSRT with Habit-Based group allocation displayed significant positive effects for change in monetary consumption. The same result was in monetary savings for the interaction of SSRT and Goal-Setting group allocation; identifying better response inhibition were predictive of reduced consumption and improved savings respectively. This relationship does concur with the hypothesis.

The effects of discounting rates was shown to only demonstrate significance for the interaction effect of k-parameter with Habit-Based group allocation. The interaction identified a negative relationship for change monetary consumption as well as for change in savings ratio at the monetary savings levels. This would suggest that lower discounting rates (i.e. lower rates of impulsivity) were predictive of increased savings, consistent with the hypothesis. At the main effect level for monetary consumption, higher discounting rates were predictive of reduced monetary consumption, which would be contradicting to the hypothesis. One explanation of this finding may be due to the 10% significance level (where the beta value's significance is at, $p = 0.082$), this significance may not be attributed to the intervention and may be a chance finding.

Executive function did not significantly predict change as a main effect in monetary consumption, savings or account balances, however the interaction of d' and treatment allocation did corroborate with Hypothesis iii, but failed to reach significance in monetary consumption and for the Habit-Based group in the domain of account balances. This would suggest that a higher executive function, in this case parameterised by the d' value, is associated with an increase in goal-directed behaviour, however the effect is not consistent across domains which may be attributed to insufficient statistical power from small financial dataset and from a limited sample population from high attrition rates

7.10 Conclusion

These results highlight the extent to which individual differences can moderate the efficacy of an intervention. These findings align with the role that individual difference plays in other domains such as in health, where higher impulsivity levels are associated with obesity (Kulendran et al., 2016), and relapse rates (Kulendran et al., 2017); in addition to goal-directedness and its predictive ability in outcomes (Andrew Prestwich, Paschal Sheeran, 1900; Deserno et al., 2015; Sheeran, 2005). Furthermore these findings also corroborate with research in compulsive shopping behaviour where the underlying behavioural constructs of diminished goal-directedness and heightened impulsivity predict higher rates of monetary consumption (Billieux et al., 2008; Black et al., 2000; Derbyshire et al., 2014). These results do demonstrate generalisable trends that do cross other domains of research and therefore highlight the validity to the findings.

The results demonstrate that parameters denoting goal-directed phenotypes are predictive of interventional efficacy, goal-directed individuals are more likely to demonstrate better performances in interventions. This holds across interventions that seek to utilise automatic motivation through habit-based protocols and for reflective motivation based interventions through goal-setting. The goal-directedness was exhibited across measures and across domains of outcome variable specification, corroborating such an observation.

These results further extend towards Gillan's hypothesis regarding sub-optimal behaviour is a result of deficits in goal-directedness (Gillan, Kosinski, et al., 2016), such findings identify commonalities across sub-optimal behaviour and interventional outcomes. Poor interventional outcomes can be regarded as sub-optimal behaviour, where the individual has a set goal, specified behaviourally, for instance in the Habit-Based intervention, the behavioural goal is to, "save money by reducing expenditure through substituting purchase decisions of option X, for a cheaper alternative, option Y, at every opportunity in context, C". Where individuals are unable to execute such behavioural actions bounded under the parameters of X, Y and C, whatever this may be for that individual, they are sub-optimal and executing diminished goal-directedness.

These results allow for researchers to isolate and stratify the population, into those who may demonstrate the greatest change in the outcome of the intervention, whilst also identifying those who require further additional support. This technique may help to isolate those in-need and increase both intervention efficacy by focusing resources on

those whose needs are greater. This however does pose a fundamental question of whether these deficits in goal-directedness are inherent in the individual or whether they represent fluctuational changes in cognitive processing?

This is an integral question at the heart of the diagnosis of sub-optimal behaviour, where the deficits are the result of fluctuational changes in processing, where an individual has learnt to update their parameters based upon sampling of a specific information set. If this is true, then additional support can be constructed to help update these parameters back to normal range. This can be delivered as part of the intervention itself through additional support and training.

However the alternative is that the deficits in goal-directedness are the result of specific neurological pathways. If true this does raise questions over to what extent can behavioural training and support aid to the reduction of these deficits? Indeed, in such case neuropharmacological interventions may be a more likely and effective means to improve goal-directedness (Wunderlich et al., 2012), as opposed to utilising behavioural training which may be costly in both terms of time and resources. Future work is required to further probe into the fundamental question, which has implications in the clinical realm, for psychiatric disorders. As well as for targeted interventions for endophenotyping and the policies that interventionists should be taking in future.

Chapter 8 Discussion

The discussion section first reviews the studies main findings, followed by its relation to previous studies, strengths and limitations; finally discussing the implications for future interventions to improve people's financial capabilities.

8.1 Main Findings

The current thesis first explored reasons why financial education alone can be insufficient to improve people's financial capability. This is plausibly because financial education only increases one component of people's financial capability, i.e, their knowledge (also called Capability in the COM-B model). To more reliably improve people's financial capability, interventionists should consider additional behavioural factors, i.e., motivation and opportunity, to more comprehensively diagnosis why people lack sufficient financial capability before intervening to improve it (see Chapter 2).

The current thesis then described secondary analyses of formative research into identifying the causal mechanisms behind sub-optimal financial capability. Although there is previous research that used behavioural science (De Meza et al., 2008) or that sought to identify the key barriers (Peñaloza & Barnhart, 2011), this formative research was the first to utilised behavioural change frameworks to understand and diagnose the enablers and facilitators behind financial capability. This formative research identified that while sub-optimal financial capability can be caused by issues related to people's psychological capability, issues related to people's motivations were also profound across three components of people's financial capability: Keeping track of money, Making Ends Meet and Planning Ahead. Regarding keeping track, barriers included psychological capability, where numeracy and financial literacy were important factors in sub-optimal checking and understanding. However, another major factor was Pavlovian instrumental transfer, where individuals would opt not to check to avoid seeing confirmation of impulsive expenses, unforeseen expenses and negative or even low account balances. Barriers to making-ends-meet included people repeatedly purchasing products and services to would improve their social rank amongst their peers, which was reinforced through pleasurable affective responses. Barriers to planning ahead, included people's beliefs about risk, their ability to make plans, their ability to set goals, and their ability to reflect and evaluate their current financial position relative to a plausible, future

financial position. The issues identified in the aforementioned formative research were then used to inform the interventions that sought to bolster facilitators of financial capability whilst counteracting the barriers described above. The interventions developed were then assessed through a feasibility study using the APEASE framework (Michie et al., 2014). To the author's knowledge, this is the first feasibility trial to use the APEASE framework to assess an intervention for financial behaviour. The APEASE framework analysis helped to overcome issues with the implementation of the intervention tools, and the efficacy of those interventions (e.g. data collection). The feasibility study's assessment illustrated that participants were familiar with the Goal-Setting intervention and showed a higher affinity towards this intervention than any of the others. In contrast, participants avoided the Habit-Based intervention as they believed it would highlight their current financial situation as their responsibility rather than situational. Participants also exhibited some hostility to a Checking intervention, which was focused on informing participants of their spending rather than motivating them to decrease consumption or save more. This information was then used to revise the interventions and implement a fully-powered, multi-site randomised-controlled trial.

The randomised controlled trial was conducted with 397 student participants attending the University of Warwick and Monash University. The trial randomly allocated participants to one of three groups in a 1:1:1 fashion, including the Habit-Based intervention, the Goal-Setting intervention and the Control group. The trial sustained heavy attrition due to a number of factors, such as the type and level of payment, the effort required to engage in behaviour change, and even the participants' prior experience with the experimenters. The trial identified significant differences between the participants in the intervention and control groups. Specifically participants in the Goal-Setting group had lower monetary consumption, higher savings and higher account balances. Participants in the Habit-Based group only exhibited a higher account balances than participants in the Control group; other differences trended in the correct direction but were not significant.

The last set of analyses in the current thesis examined how individual differences can moderate the effects of these intervention. These analyses isolated how goal-directedness was important in desired outcomes. The study identified that model-based control moderates the reduction in monetary consumption. In addition the response inhibition parameter was shown to moderate consumption and savings. These results

suggest that parameters of goal-directedness can predict intervention's efficacy, and identify individuals who are more likely to engage in behaviour change.

8.2 Relation to previous studies

Previous policies to improve people's financial capability and household finances have typically utilised education or examined the role of psychological capability. The literature has shown that education does play a role in financial behaviours (Bayer et al., 2009; Bruhn et al., 2014; Gale & Levine, 2011; Gutter et al., 2010; Walstad et al., 2010). However, it also shows that education barely accounts for any variance in financial behaviours (Choi et al., 2011, 2002; Fernandes et al., 2014; Gartner & Todd, 2005; Mandell, 2008; Servon & Kaestner, 2008). This conflict suggests that there is more to this story than a simple narrative of the deficiencies in knowledge.

As such, researchers and policy-makers should be moving towards a behavioural science focus to understand and improve people's financial capabilities and household finances. The first study that utilised a behavioural science framework in examining factors that could underlie sub-optimal financial capability was conducted in 2008 (De Meza et al., 2008), and since then, more work has followed (Atkinson et al., 2007; Dolan, Elliott, et al., 2012; Elliott et al., 2010; Vlaev & Elliott, 2017).

This formative study conceptualises how deficits in people's psychological capability and motivational systems can lead to sub-optimal financial capability, which are two components of the COM-B model (Michie et al., 2014). This finding builds upon the research into implementation sciences and behaviour change where behaviours are often the result of more than one behavioural factor.

There is very little known about the psychological determinants of financial capability (for more information see Chapter 1). Evidence suggests that psychological constructs can play a major role in sub-optimal financial behaviours. The current randomised controlled trial's results agree with some previous findings. For instance, the Habit Tool resembles a behavioural contract. Previously one research team used a field experiment to test the use of a commitment savings financial product in the Philippines (Ashraf et al., 2006). The researchers designed a savings account akin to a locked piggy bank. Participants who used the savings account for 12 months saved 81% more than participants in a control group. The trial demonstrated how interventions designed based

on an understanding psychological motivation and processes can produce dramatic behaviour change.

Goal-directedness is another psychological construct utilized recognized as important for behaviour change and utilized in the current randomised controlled trial. For instance, Karlan, McConnell, Mullainathan, and Zinman's (2010) research suggests text-message reminders can be used to promote goal-directedness. In their study, participants who received text messages demonstrated a 3% increase in likelihood of reaching savings goal and a 6% increase in total amount saved. The benefits of goal-directedness have also been found in research on adolescents. For instance, Rodriguez and Saavedra (2016) showed participants who received monthly reminders had a greater propensity to save than participants who did not receive those reminders.

These results identify how increasing goal-directedness is important to maintaining intentions and outcome goals. In the current randomised controlled trial, feedback was integrated into the Goal-Setting intervention. The current data suggests that through promoting goal-directedness helped participants save an additional £503.50, i.e., a 4.4% increase in propensity to save.

8.3 Strengths and Limitations

One limitation of the formative research was the sole use of qualitative methods. It would be extremely helpful to be able to quantify and model the causes of sub-optimal financial capability, using the qualitative results to form computational models to compare and identify the best fitting models. For example, this could be achieved through consumer or banking data. This quantitative process would help to prioritise behavioural mechanisms in the design of the intervention. This however, is extremely time consuming, and would require collaboration or partnership with a banking institution or regulatory body with a research amenable infrastructure.

However, simply using formative research of any kind to develop an intervention is a strength. Conducting such formative research allows the diagnosis of the barriers and facilitators of financial capability. This diagnosis of the behavioural then affords a more efficient procedure to design and assess interventions (Atkins & Michie, 2015; Michie, Van Stralen, et al., 2011). Through this procedure, the most prominent barriers through qualitative and quantitative methods were identified. The process uses a design perspective (Niedderer et al., 2016), which takes a bottom-up approach, by using the

building blocks of such behavioural processes to understand and design the intervention. The design perspective takes more time and resources but can be highly effective when used in conjunction with the MRC approach (Campbell et al., 2000), as it affords an evidence base within the project to draw more targeted behavioural insights (Atkins & Michie, 2015).

Although examining individual differences in the SAVINGS Trial did find strong associations between goal-directedness and improvements in financial behaviour, confounding variables may explain the effects. One potential confounding variable is intelligence. For instance, researchers have found that people's mathematical ability predicts the likelihood of defaulting on their mortgage (Gerardi et al., 2013), and national average IQ predicts national economic growth (Meisenberg, 2012). Another potential confound is affective processes, as these can mitigate and trigger sub-optimal behaviour in goal-directedness. For example, some research has demonstrated that social rejection can increase spending (Baumeister & Vohs, 2003).

Another limitation concerns the implementation of the current SAVINGS Trial. In the SAVINGS Trial, participants in the Habit-Based group exhibited a propensity to substitute entire behaviours rather than contextual bounded choices. For instance, many participants wanted to swap buying lunch on campus to bringing lunch from home. Although these substitutions are reasonable and may produce tangible results, the credit card sleeves are not designed for this particular purpose, and these swaps may not have been properly supported.

In addition, one of the limitations of the SAVINGS Trial is the sample population, i.e., university students. University students were selected largely because they are convenient to recruit. However, whether the results found in the SAVINGS Trial will generalise to a broader population is an open question. Indeed, students have been shown to differentiate from unemployed young adults (Jackson, 1999), based upon levels of resilience compared to unemployed populations. There is research, however, that does suggest these differences at the population level do indeed vary in the same way between the student and general populations (Hanel & Vione, 2016).

In addition, a study commissioned by Money Advice Service found that students do demonstrate sub-optimal levels of financial capability (Money Advice Service, 2018). Specifically, the Money Advice Service Study found that 20% of students find themselves frequently overdrawn, and 40% have gone past their overdraft limit or into

an unplanned overdraft. The study further found that while 77% of students had at least a saving account, many no savings at all (31%). However, future work should look to see the trial implemented in an adult population setting. This would require much more thought and consideration into the exact strategy of implementation and whether future research may be needed to delve deeper into savings behaviour and how consumers utilise banks. A field experiment of adult-population, whether employed or un-employed would be of great use to examine further intricacies of consumption and savings behaviour and to potentially provide low-cost interventions.

Another strength of the current SAVINGS Trial was effects found in the Goal-Setting group. Participants in the Goal-Setting group were able to save £503.50 on average whilst only putting 36.76% of potential savings towards their goal. This finding suggests that deficits in goal-directedness be addressed through behavioural interventions.

8.4 Implications

The financial markets are beginning to take stock of the findings and impact that behavioural science has to offer especially in regards to behaviour change (Elliott et al., 2010). Recently, there is a growing use of the body of behavioural science literature being utilised in policy research and design in the current climate (Dolan, Elliott, et al., 2012). Financial behaviour has seen a growing interest in the last few years, with the Financial Conduct Authority (FCA) setting up their own behavioural economics and data science unit. In this time the FCA has used behavioural science and behavioural economics as a theoretical tool to inform policy and research. For instance, in one randomised controlled trial, the FCA suggest that limited attention and a present bias could explain why consumers often leave savings stagnated in their savings accounts after the interest rate ends. Consumers leaving money in these accounts are losing out on interest due to the inability to actively switch. The FCA randomised a series of letters to consumers with some not receiving any letter, as a control group. The results demonstrated an 8% increase in switching behaviour.

Future work could see the FCA and other institutions doing more to provide a behavioural diagnosis of the problem behaviour. For the above example, how well does the present bias and a limited attention explain the current lack of switching? Expressed as a formative model this could be used to provide a diagnosis of the inability to switch,

which could be compared to alternative models. Through this approach then the utilisation of a randomised controlled trial would be cost-effective. As such, the financial sector should make full use of not only behavioural science literature but also of implementation science, such as the MRC guidelines (Campbell et al., 2000; Craig et al., 2008). Although the MRC guidelines are an iterative time-consuming process, however, even a simple policy guide framework would be extensively useful, as conducted as part of the current study, in reducing unnecessary waste of time and resources through sub-optimal policies. This could be perhaps be a sequential three-part process: in which a conceptual review is initiated, then to a behavioural diagnosis using qualitative or quantitative methods, and finally to implement some experimental work to design and test interventions. This may be through lab-based or natural experiments or even as randomised-controlled trials. For instance designing a lab-based mechanistic paradigm could be used to provide a cost-effective demonstration of potential interventions and their corresponding effects. The most effective intervention could therefore be implemented. The cost of a lab-based experiment would only be a fraction of the randomised-controlled trial and could even be implemented online, saving time and resources. Take the FCA research into consumer switching behaviour, here the researchers made no attempt of behavioural diagnosis and therefore the link between the interventions ran and the behaviour is made through top-down, goal-orientated assumptions. However, these assumptions may be valid, but not explain the behaviour as would an alternative model or hypothesis. This falls into the ISLAGIATT problem, where policy-makers often run interventions or policies test their assumptions rather than testing interventions to combat the most powerful explanation of the problem (Atkins & Michie, 2015; Michie et al., 2014).

This methodology offers an investigative, procedural format to maximize efficiency in reaching the optimal policy. Policy-makers and regulatory bodies such as the FCA should look to utilising a behavioural diagnosis, then towards experimentation. This could be done through quantitative modelling and then analysing natural experiments. For instance, using regression discontinuity designs where randomised controlled trials are not practical or even lab-based experiments. For example, stripping behaviour down to potential mechanisms, such as looking at individuals willingness to repay based upon an exemplar credit-card statement (Stewart, 2009) in which an experimental group were shown minimum payment required. The research matched the

real-world behaviours for those who saw the minimum payment information, where this minimum payment amount predicted partial payments; furthermore the distribution of partial payments matched the real-world distribution. This behavioural paradigm allows policy-makers and researchers to make a behavioural diagnosis, and target interventions or policies based upon such outcomes. For instance, in the credit-card repayment example, removing the minimum payment information raised mean payments by 70% demonstrating a staggering effect size ($d = .51$) from a simple intervention which is highly-cost effective. This also reduces the chances of faulty assumptions or anecdotal evidence. This may produce an effect, but implementing a behavioural diagnosis and identifying the causal mechanisms allows policy-makers and researchers to implement more cost-effective based upon accurate and detailed evidence of causal factors.

In investigating individual differences in intervention efficacy this was able to identify how deficits in goal-directedness, as through constructs such as impulsivity, can often hinder savings behaviour. This approach could be of use within the personal finance and banking sector, where research can be used to segregate the populations more efficiently through psychological insights of behaviour. This could be done, for example, to reduce consumption in impulsive individuals by designing specific products to counteract such impulsivity. Furthermore regulatory institutions may seek to optimise policy by taking these constructs into account, in how to reduce delinquency rates of defaulting on credit-cards or loans. By segregating the population, this also offers an additional component by identifying the goal-directed fraction of the population, who would provide desirable outcomes.

8.5 Conclusion

This thesis used the MRC framework (Campbell et al., 2000; Craig et al., 2008) to diagnose and identify sub-optimal financial capability behaviours. These behavioural mechanisms were used to design interventions (under a bottom-up, design perspective) (Niedderer et al., 2016). These interventions were piloted and then tested in a fully-powered randomised controlled trial, which identified significant intervention effects for the Goal-Setting intervention, whilst diminished effects for the Habit-Based intervention. Furthermore, investigations of moderating effects of individual differences, identified deficits in goal-direction predicted poorer intervention efficacy.

These results demonstrate how the MRC approach in conjunction with a design process can optimise the design and implementation of interventions or policy. This process can increase efficiency in policy design by highlighting causal factors to target and intervene (Atkins & Michie, 2015). This is the first time that such a process has been utilised in the financial sector, and demonstrates success in improving savings behaviour amongst a university population. Intervention efficacy was predicted by the degree to which an individual was goal-directed, producing greater savings the more goal-directed they were.

The formative research identified how behavioural motivation was a major component of financial capability, across all three areas of Keeping track, Making ends meet and Planning ahead. This finding is of paramount importance in development of household financial policy, for policies regarding financial education and financial literacy. These insights correspond to psychological theories of motivation of impulsive and compulsive behaviours (Black, 2007b). These insights, in addition to the results of the RCT and endophenotyping study, demonstrated a consistent finding that goal-directedness translates into better intervention outcomes. These results support the ideas from computational neuroscience and psychiatry which demonstrates how goal-directedness is a causal factor of sub-optimal behaviour (Gillan, Kosinski, et al., 2016; Huys et al., 2015; Montague, Dolan, Friston, & Dayan, 2012; Rouault et al., 2018), which this thesis demonstrated was responsible for sub-optimal savings. In these studies, I demonstrate how goal-directedness can offer a buffer in the maintenance of financial goals in the example of savings behaviour through an intervention. These insights map to fundamental behavioural constructs that are causally related to sub-optimal financial behaviours, and stem further across contexts (Rouault et al., 2018).

Chapter 9 References

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Appendix A Visit One: discussion matrix

A.1 Background

The Money Advice Service is a free, independent service which exists to help everyone manage their money better by giving clear, unbiased money advice to help people make informed choices. We have been commissioned to carry out longitudinal, ethnographic research in order to refine the definition of ‘financial capability’. The Money Advice Service already uses the FSA’s skills-based definition of financial capability around the following three domains:

- Making ends meet
- Keeping track of money
- Planning ahead

While helpful, this definition doesn’t go far enough. As it’s a skills based definition, it doesn’t take account of how attitudes, emotions, motivations and opportunities affect financial capability. This research will help MAS understand how context, environment, culture, seasonal changes and aspirations influence and change peoples’ financial capability. It will also feed into the new index of financial capability for the UK (produced by the follow-up quant stage).

A.2 Aims and Objectives:

The aim of the research is to understand the role that money plays in peoples’ lives in order to create a new definition of financial capability. Specific areas to explore are:

- Life on a day-to-day, week-to-week basis and the role money plays. As part of this, we will also look at seasonality and how decisions and actions change over the course of a week, month or year.
- How people cope with planned and unplanned events that require a money input. How people feel about these events as they occur and afterwards and the role that money plays in them.
- The extent to which money is thought about (e.g. what reviewing and planning takes place), and when, including triggers. In line with this we will explore people’s awareness of the Money Advice Service and their interaction with it.
- The interaction that takes place between family members regarding money e.g. how and where is money discussed and what outcomes this leads to.
- People’s aspirations in life and the role money plays in these aspirations. As part of this, we will look at what the future means to people – is it next week or 30 years hence?

- How money affects people's emotions, and the key determinants of this. As part of this we will also explore links to wellbeing, health and stress and examine how culture and context influences this.
- How people relate to the current indicators of financial capability and what other key determinants could be included and measured.

NB. Please note that a discussion matrix is different to a discussion guide in that the discussion takes place in a much more organic fashion. The questions/ areas of focus are embedded into the participant's everyday life and are therefore led by the participant's behaviour. Many of our observations are led by what they are discussing ("Can you show me...").

A.3 Introduction

- Inform participants about the purpose of the research – that we are here to talk with them about their lives, about the part money plays in it.
- Stress there are no right or wrong answers - we're just really interested in understanding
- what life is like for them.
- Also stress that we'll fit around them; if they have things they need to be getting on with then they should do this – we'll work round them.
- Remind them that (where applicable) we'd like to talk to other members of the household too.
- State that this is the first of four visits and is really just a session where we will get to know the participant. In between the visits we'll be calling them once a month to see how they're getting on.

FOR THOSE COMPLETING DIARIES: Explain that we would like them to complete this either every fortnight or every month depending on what makes most sense for them and that we'll collect these from them the next time we visit.

Dates for following visits: Visit 2 – September – October (incentive £100) Visit 3 – December – January (incentive (£125) Visit 4 – March – April (Incentive £150)

A.4 Understanding the participant and their life

A.4.1 Questions

- How long have you lived here? Who lives here with you? Ask about family, social networks, relationship with partner, children
- What about the area you live in, what's it like? What's good about it? What's bad about it? Why did you choose to live in this area?
- What facilities are there in the area? Which of these do you use regularly? How convenient are they for you?
- How do you like to spend your time? Where do you like going? What else you do with your time...where do you go out? What do you do to enjoy yourself?
- Who else do you spend time with that's important to you?
 - Can you explain what relationship you have with this person?
 - Probe: family member/friend/colleague etc.
- How often do you see them?
 - What kind of things do you do together?
 - Where do you spend your time?
 - Why is this?
- What about other people in the household – what do they do with their time?
 - Ask similar questions as above according to answer.
- Do you rent your home, pay a mortgage or some other arrangement?
 - What are the advantages of this?
 - And the disadvantages?
 - How did you come to this arrangement?
- Ask about employment –
 - what they do, skills levels, how long they have done this for?
 - Do you enjoy it?
- If not in employment ask what they do instead – caring responsibilities (for children or other family members?)
- Is this what you always wanted to do? Ask as appropriate....
 - How long have you wanted to do this for?
 - How did you get about making this happen?
 - What got in the way of you doing what you wanted to do

- Do you think you'll always do what you do now? Why do you say this?
 - What do you think you'll do instead?
 - What would need to happen for you to be able to do this?

A.4.2 Observations

- Tour of the house – room to room, show me what you do in here
- THROUGHOUT: Observe interactions between couples / children / friends
- / others in household or visitors
- If others are home, speak to them about this too

A.5 General Finances

A.5.1 Questions

- Do you feel like you are where you should be at this stage in your life when it comes to finances?
 - Why / why not?
 - Where should you be at this stage?
 - Why do you think this?
 - Where do these messages come from?
 - Do you know many people at your stage in life who have this? Who? How have they achieved this?
- Where do you think your attitudes / behaviours around finances stem from?
 - Did you learn them from anywhere / anyone?
- What do you enjoy spending money on? What do you dislike spending money on?
- Are there particular brands that you are loyal too? PROBE: Clothing, food, technology etc
 - Why / why not?
 - How would you feel if you couldn't buy the brand/s that you like?
 - Are there any brands you would not buy? Why?
- What would you describe as your financial priorities?

A.5.2 Observation

- Look for interactions between members of a household – e.g. are children

learning from their parents? Look for examples of this

- Look for brands around the house, does it seem as though material things are valued

A.6 Thinking to the future

A.6.1 Questions

- Can you tell me about the last time you experienced a significant change in your life? By this we mean something like moving house, getting married, starting or leaving work etc? Tailor suggestions depending on participant and their life stage.
- Tell me about what happened? Moderator to probe sensitively here – may be about to experience difficult changes. If more applicable, talk in terms of ‘events’ rather than changes.
 - What was this change about – what kind of things did you experience?
 - Was this positive/negative?
 - When did the change happen? How long did the whole process take?
 - How prepared for this change were you? What kind of preparations did you make? How did these preparations help you?
 - If they didn’t make any preparations – how much of a surprise was this change? How did it affect you? How were you able to cope given you had not made any preparations for it?
 - How did you feel throughout this process? And how did it change you?
 - If you had to go through this again, what might you do differently?
- What kind of changes do you expect you will experience in the next year or so? For each ask:
 - What their aspirations are, and the part money plays in these?
 - What do you think will happen?
 - Why do you say this?
 - How do you feel about this change? Probe for whether it is a positive or negative event.
 - When do you think this change will occur?

- How are you preparing for it – what kind of things are you doing?
- How will this help?
- Are saving anything for it, or making financial preparations for it?
- If applicable – why are you not preparing for it?
- How do you think your life will be different after this change has happened? Why do you say this? How do you feel about this?
- What other changes would you like to happen over the next year or so?
 - Why do you say this?
 - What difference do you think this would make? To you? To other people in your household? To other people you know?
 - What would have to happen for you to be able to realise this? How likely do you think this?
- Overall, how confident do you feel when you think about the future?
 - Why do you say this?
 - What would make you feel more confident?
- Tell me about your expectations in life
 - What are your peers doing at the moment?
 - Where did you think you would be in life?
 - Where would you like to be in life?
 - What do your parents think?

A.6.2 Observations

- Observe how people react when talking about these changes
- See how others in the household feel about the changes – are they agreeing or contradicting
- Ask to see any documentation about how they are pulling together for this
- Look at where and how do they store this
 - Where possible – ask them to show us what these changes might look like, what difference they might make etc.

A.7 Financial management

A.7.1 Questions

- Tell me about your financial situation

- How do you feel about this? Why?
 - How would you describe the state of your finances?
 - How does this compare to this time last year?
 - And to five years ago?
 - What has changed in the intervening time?
 - COMPARE EVERYTHING ABOVE TO OTHER HOUSEHOLD MEMBERS
- How well informed do you feel about financial matters more broadly?
 - What do you think the pressing issues facing people today are? And which are most relevant to you and your household?
 - Do you plan in advance for your outgoings? E.g. if you are going on holiday do you save up before booking or would you pay on a credit card and then pay it off?
 - Do you pay for things on credit? Why/ why not?
 - How often do you do this?
 - What kinds of things do you use your credit card for? Why?
 - How do you manage this debt? Do you make your payments each month? How much of it do you pay? All of it? The minimum payment?
 - Have you ever withdrawn money from a cashpoint with your credit card? Why/ why not? What was it for if so?
 - Do you have a bank overdraft?
 - How often do you use it?
 - Have you ever exceeded your overdraft limit? If yes – how often does that happen? In what circumstances? What happens as a result?
 - Do you ever borrow money from friends or family to pay for things?
 - Who?
 - What kind of support do they provide?
 - How do you feel about doing this? Has it affected your relationship with them? How?
 - Is there anyone outside of the household who you provide any kind of financial support for?
 - Who?

- What kind of support do you provide?
- How do you feel about doing this?
- Does this have any impact on the way you view your finances?
How?
- How do you manage your money?
 - Who in the household takes responsibility for making sure things get paid?
 - How did this arrangement come about?
 - How happy are you with this arrangement? Why do you say this?
 - How well does this arrangement work? What bits about it work less well?
- Are there times of the year when you find it easier or more difficult to manage your money? Tell me about this.
- If applicable ask – do you and your partner have separate income streams?
 - What items of spending are you responsible for?
 - And what is your partner responsible for?
 - Do you need to ask permission for certain purchases? Which ones would you run past your partner first? And which would you just buy for yourself?
 - Why do you say this? How do you feel about this?
- How far do you plan ahead when it comes to money?
 - Probe to see whether they live day to day or whether they plan ahead for things.
 - Are you saving or planning financially for any particular event now? If so – could you tell me about what you're doing, why and how you feel about this?
 - Do you have regular form of savings that you put aside?
 - If yes – how much do you save? What do you save for? Where do you save your money? How do you feel about this?
 - If something happened tomorrow – say your boiler broke – and you needed to get it fixed immediately, how easy would it be for you to find the funds to do this if it cost £1000?
 - Where would you get the money from?

- Would you be able to raise the money yourself, or would you need to borrow some? Who would you borrow it off?
- What about if it cost £2000? Or £3000? What would happen then? PROBE to try and find the tipping point?
- Thinking about all your outgoings...
 - Which of your outgoings would you class as a priority i.e. something you would try and cover no matter what? Why?
 - Are there any items you don't think are essential?
- Would you consider taking out a loan if something like this happened?
 - What kind?
 - Would you consider using a payday loan? Why? Why not? Have you ever done this in the past?
- Have you ever used a pawn broker or a cash
- converter service when you've needed money?
 - If yes – can you tell me about that? What circumstances were you in? What did you sell? Would you do this again?
 - If no – would you consider doing this? Why/ why not?
- And what if received some money you weren't expecting – say you won £1,000? What do you think you would do with this?
 - Would you spend it? What would you spend it on? Why?
 - Would you save any of it or pay off any debt with it? Why/ why not?
- What will you use the £75 incentive which I'll give you today for? Why?
- If you were to hear the phrase 'struggling financially'
- what do you think this would mean?
 - What kind of behaviours do you think someone would exhibit?
 - How would they feel?
 - What kind of money would they have coming in?
 - What kind of demands would they have on their income?
 - Have you ever felt that you have struggled financially? When? What happened?
- Repeat above questions with regard to the phrases: 'financially just getting by'; 'financially comfortable'
- Is there a difference between being financially comfortable and being well off?

- What is it?
- Why do you say this?
- Do you think you could be described as being well off?
- What do you think it would take for you to be getting by/financially comfortable/well off?
 - What would need to change?
 - Would you just need extra money coming in, or would other changes need to happen?
 - How likely is it these changes will happen?

A.7.2 Observations

- Observe how people react when talking about these changes
- Ask participants to show us bills, receipts, things they have purchased etc.
- Try to see the things they spent the money on
- Ask to see examples of advertisements / messages
- If they search for information, ask them to show us where they search – check the sources they use.
- Ask to see documentation / card etc and
- Observe any interaction between them and others in the house – any contradictions on who is responsible.
- Ask them to show us any budgeting systems they have in place, any filing systems, how these are organised etc.
- Ask to see purchases they make and purchases their partner / others in the household have control over.

A.8 Conclusion

- Thinking about all the things we have discussed today what do you think the key message you would like me to take back is?
 - Why do you say this?
- And is there anything else that we haven't discussed that you think is important mention?
 - Why do you say this?
- Thank them for their time, find out when works for a catch up call and inform them about visit 2.

Appendix B Visit two: discussion matrix

B.1 Introduction

This visit aims to build on the discussions from visit one to develop a greater understanding of all the internal and external factors and influences which determine the participant's financial behaviour including. We'll be using the findings from this visit to develop interventions which we will test with some participants in visit three.

Inform participants about the purpose of the research – that we are here to talk with them about their lives, about the part money plays in it.

Stress there are no right or wrong answers - we're just really interested in understanding what life is like for them.

Also stress that we'll fit around them; if they have things they need to be getting on with then they should do this – we'll work round them.

Remind them that (where applicable) we'd like to talk to other members of the household too.

State that this is the second of four visits and is really just a session where we want to build on previous knowledge from wave 1. In between the visits we'll be calling them once a month to see how they're getting on.

FOR THOSE COMPLETING DIARIES: Review diary since last visit

B.2 Catch up from last visit

B.2.1 Questions

- What's happened since my last visit?
 - Has anything changed?
 - Has this had an effect on your finances?
- Have you made any major purchases since my last visit?
- Did our conversations last time make you think at all?
 - Has anything if your behaviour changed since the last visit?
 - If yes, why do you think this?
- For those completing diaries - review this with them and discuss anything that stands out such as increases or decreases in incomings or outgoings (especially food, clothing, toiletries, daily spending) or significant changes in scale

questions.

- How have you found completing the diary each month?
- How easy or difficult has it been to complete it? Was this what you expected – has it been easier/harder than you thought?
- Is this the only record of incomings and outgoings that you use at the moment?
- Have you been keeping track of spending to fill in the diary? Why/ why not? Is it harder to keep track of some items of spending than others? Which ones? Why is this?
- How do you know how much you've spent on
- things like food?
- Are you surprised by how much you're spending on certain things or not? What things are you spending more on than you thought? And what things are you spending less on than you thought?
- Have you changed any of your spending habits since you started completing the diary? If yes in what way?
- If no – do you think this diary might change your spending habits in the future? why do you say this?
- If yes – in what way?

B.2.2 Observations

Look around the house to see if there are any new purchases since the last visit

B.3 How is money talked about? (keeping track)

B.3.1 Questions

- Is money talked about in this house?
 - When?
 - In what sense? Is it all about the immediate everyday expenses or thinking of money in terms of the future?
- Who is in control of the finances in this household?
 - How does this work? How are these decisions made? Are you consulted?

- Are they influencers on others in the home (kids, partners, spouses, others)? Are they recognised as influencers? Is this in a positive or negative sense?
- How do they discuss the decisions they make with you? Do you always understand why these decisions have been made? What happens if you disagree with the decision that has been made?
- Is money ever the source of disagreements in this house?
 - If yes, ask for an example?
 - Are the disagreements trivial or more serious?
 - What are the consequences of such disagreements?
- Has money been the cause of stress for you / your family?
 - Do you have any examples of this?
 - How has this affected you/other people?
- Have you ever fallen out with someone over money before?
 - If yes, ask for an example
 - What caused the argument?
 - Was it about something you had done or someone else's behaviour?
 - Is this a common occurrence or an exception?
- Do you think people you know are generally comfortable or uncomfortable talking about money?
 - Talking specifically about the finances in their household?
 - Talking generally about money
 - Talking about investments and / or financial products
 - Why do you think this is? Probe fully around this.
 - What types of people do you think are more likely to talk about money? And who might be less likely? Why?
- Do you discuss your earnings with other people?
 - Why / why not?
 - If yes, who?
 - How much detail do you go into?
 - Is there anyone you wouldn't discuss this with?
 - Do your friends / family discuss their earnings with you?

B.3.2 Observations

- Are they open when speaking about money or does it feel like an intrusion on their privacy?
- Listen out for any disagreements around money.
- Try to ascertain whether they think behaviours around discussing money are based on need, knowledge or attitude/ culture.

B.4 Financial allocation / organisation (keeping track, making ends meet, living within means)

B.4.1 Questions

- Do you have (or I noticed last time you have) a specific system in place for organising your money?
 - Can you show it to me in more detail?
 - How long have you had a system?
 - Why did you start organising your money in this way?
- Have you ever broken your system since I last saw you? If yes, how & why?
- Does having / not having a system impact your finances?
 - In what respect?
 - How would you be impacted if you didn't have a system?
- If you had more or less money than you currently do, would you still use a system?
 - Why / why not?
 - Would it be different to the one you use right now? Why do you say this?
 - What difference would this make?
- Do you take any other specific steps to monitor your finances?
 - What are these?
 - What does cash flow mean to you?
 - Do you ever have 'cash flow' problems?

- For non-diary participants, use the template – for diary participants, review the latest entry.
- Tell me about the money you have coming into the household at present.
 - Thinking about the last month, how much did you have coming in?
 - Where did this money come from? Probe for wages, benefits, savings, credit, loans, gifts etc.
- And how have you spent your money over the last month?
 - Thinking about the last month, how much did you spend, roughly? Was this more or less than your incomings?
 - Where did your money go? What kind of things did you spend it on? How much did these things cost?
 - Was this a pretty typical month for you? If no how and why did it differ to usual?
 - Did you have to spend money on things you wouldn't normally? Or vice versa? Why was this?
- Has the recession had an impact on your finances?
 - In what respect? (Cost of living, rising prices etc)
 - Could you give an example of what has changed for you since the recession?
 - Is this something you discuss? Who with? When do you discuss it? What happens as a result?
- Has the recession had an impact on the people around you?
 - What kind of an effect?
 - Is this something you discuss? When do you discuss it? What happens as a result?
- Have you had a pay rise in the past few years?
 - Has this made a difference to you? What has the extra money been used for?
 - Do you know if this has been in line with inflation?
- Can you give me your understanding of inflation? How does it affect people like you?
- Do you feel as though your income has decreased since the recession in 2009?

- Have your earnings fallen?
- Has your spending power decreased?
- Do you have examples of this?
- Do you think this has been the case for other people?

B.4.2 Observations

- Ask to see what these financial systems are.
- Bring up this topic while they are with friends and observe the interaction – does it seem as if this is a subject they have discussed before?

B.5 Making money work for you (planning ahead)

B.5.1 Questions

- Do you have plans for the next few years?
 - If yes:
 - What are they?
 - When would you like to achieve them?
 - How are you going to achieve them?
 - Do you think they are realistic to achieve?
 - If no:
 - Is there anything stopping you making plans?
- Do you have the money to pursue these plans?
 - Do you need money? How much?
 - Do you think you will get the money? How?
- Would you use a loan of some sort to help you achieve these plans?
 - Would you use a credit card? Why / why not?
 - Would you use an overdraft? Why / why not?
 - Would you use a bank loan? Why / why not?
 - Would you use a loan of some other kind? What kind of loan would it be? Why / why not?
 - Would you go to family or friends? Why / why not?
 - Is there a difference between the above ways of borrowing money?

- Which is best? Why?
 - And which is worst? Why?
- If you wanted to get a credit card or a loan, how would you go about choosing one?
 - Would you look for information before hand or not? What would you be interested in finding out?
 - Where would you look for this information? Who do you trust to give advice about these sorts of things?
 - Which is more important to you, getting the money you need quickly and easily or getting the best deal possible?
- Would you say you think long term or short term when it comes to money?
 - Do you plan your money for the next day, week, month or think longer term (next year, 5 years, 10 years?)
 - Why do you think of money within this time frame? (PROBE: is it because of the amount you have?)
- If you know they already have a goal they're working towards:
- What progress have you made with your goal since I saw you last?
 - Have you been able to stick to your plan or not?
 - How easy or difficult has it been?
 - Do you think your plan to achieve your goal is achievable or is it ambitious?
 - Have you had to change your plan at all maybe by changing the end date or the amount you save?
- Do you set yourself goals around money (saving for specific things, paying off debts etc)
 - Why / why not?
- If yes:
 - Do you normally set short term or long term goals or both? Why? Can you give me some examples?
 - Do you tend to set an exact date for meeting a goal or are you more flexible about it?
 - Do you usually succeed in meeting these goals? Why? Why not?
- Do you 'shop around' or look for the best bargains?

- If yes, how?
- Online, in-store etc?
- Do you do this for all purchases or only some?
- What do you shop around for; insurance, household bills, food shopping anything else?
- How long have you done this for?
- How do you feel when you get a good deal?
- How do you know the deal you are getting is good?
- Do you leave bills to the last minute or do you like to pay things in advance?
 - Why is this?
 - What difference does this make to you?
- Is it more important for you to have things now and get into debt, or to save for things and get them later?
 - Why?
 - How much control or choice do you feel you have over this?
 - What difference does it make?
- Do you consider yourself to have a safety net when it comes to money?
 - Savings for a rainy day?
 - Parents, grandparents, other relatives?
- If you won some money– say £1,000 - what do you think you would do with this?
 - Would you spend it? What would you spend it on? Why?
 - Would you save any of it?
- What if this money was a tax rebate, would you use it the same way? Why/ why not?
- Is there a difference between winning money and receiving a refund you weren't expecting?
- If I offered you £x (one weeks' income) which I would give you in 3 day's time or £x (two weeks' income) which I would give you in 3 month's time which would you take?
 - Why? Do you think that's the most attractive offer?
 - What would you use the money for?
 - If you chose the other option do you think you would spend the money

on the same thing or something different? Why?

- Would your answer be different if the second amount was three weeks' income? Why do you say this?

B.5.2 Observations

- How do people look when talking about their future plans – how important do they seem for them?
- What feeling do you get from people when they talk about borrowing money / potentially getting into debt?

B.6 Being networked / creativity (making ends meet, living within means, planning ahead)

B.6.1 Questions

- Do you think the people around you have an influence on how you deal with your finances?
 - Who?
 - In what sense?
- Do you speak to people you know about your finances?
 - Who?
 - Why this person?
 - What do you speak about?
 - Do you ask their advice?
 - Do you trust their opinions?
 - How much detail do these people give you?
- Do you go to specific people in your network for advice about finances or anything related to the money in your household?
 - Why / why not?
 - What do you ask for advice about?
 - Is the advice you get helpful?
 - Is there anything you wouldn't ask about?
 - Why?
 - Can you give an example of some advice you followed with regard to

finances?

- Do you have any ways of supplementing your income?
 - Can you tell me more about this?
 - How long have you been doing this for?
 - What difference does this make to you
 - What would it mean to your life if you didn't have this extra income?
 - Is there any risk attached to this?
- Have you or would you go outside of your own network to seek advice on your finances?
 - Why / why not?
 - Where would you go? Why would you go here?
 - How do you know about them?
 - Would you trust them?
- Do you go to your bank and discuss your finances?
 - Why / why not?
 - Would you trust what your bank told you?
 - Are there some things you would be more likely to ask your bank advice on than others? If yes, what & why?
- Do you feel confident when speaking to bank staff?
 - Which products are easiest to get to grips with? And which are hardest?
 - Do you understand the terms they use?
 - Do you know the difference between debit / credit?
 - Do you know what APR means?
 - How does APR work? Try to ascertain their extent of understanding here – i.e. that the quicker you pay it off the cheaper it is to borrow.
 - Is there a difference between APR and Interest rate?
 - Would you feel confident asking them to explain something if you didn't understand?

B.6.2 Observations

Try to see people interacting with family, friends, neighbours and observe whether you think they are influenced / influencers

B.7 Moments of transition (planning ahead)

B.7.1 Questions

- How would you describe your financial position today?
 - Has it changed in the past few months? Why?
 - Has it changed in the past year? Why?
 - Has it changed in the past 5 years? Why?
- Would you say you have got better or worse when it comes to managing your finances?
 - Why do you think this is?
- What do you think is the reason you have your current approach to your finances?
 - Has anything happened to make you approach them this way? What?
 - Have you been particularly influenced by anyone?
- When (if at all) have you engaged in a 'plan'?
 - What did you change?
 - What convinced you to do things in that way?
 - Did you make yourself any goals or commitments?
 - How long-term are those plans?
- Do you think anything could happen that would make you change your approach to finances?
 - What would that be?
- Would you like to change your behaviour around finances?
 - Why / why not?
 - In what respect?
- What are your plans for Christmas?
 - Are you already preparing?
 - Have you been saving for it?
 - Do you have a budget in mind?
 - How much money do you think you will spend?
 - How are you feeling about it?

B.8 Conclusion

- Do you think anything will have changed for you by our next visit?
 - What? Why?
- Do you think anything will have changed with regards to your finance by our next visit?
 - What? Why?
- Thinking about all the things we have discussed today what do you think the key message you would like me to take back is?
 - Why do you say this?
- And is there anything else that we haven't discussed that you think is important mention?
 - Why do you say this?
- Thank them for their time, find out when works for a catch up call and inform them about visit 2.

Appendix C Visit Measures

How much money has come into the household in the last fortnight/month from the following sources? Please try and indicate the amount YOU receive, so if you are listing money from employment, then write what you get after tax and National Insurance deductions.

Employment (Please indicate amount as far as possible)

Family member _____ £ _____

Family member _____ £ _____

Family member _____ £ _____

Benefit (Please indicate type of benefit and amount -As far as possible)

Family member _____ £ _____

Family member _____ £ _____

Family member _____ £ _____

Family member _____ £ _____

Other sources (Please indicate type and amount As far as possible)

Type of source _____ £ _____

Type of source _____ £ _____

How much money has been put towards the following things in the last month/fortnight?

Shopping £ _____

Food and drink £ _____

Alcohol £ _____

Cleaning products £ _____

Toiletries/beauty £ _____

Tobacco £ _____

Daily expenditure £ _____

Housing, fuel and power

Mortgage/rent £ _____

Water £ _____

Gas Electricity £ _____

Council tax £ _____

Home goods and services

E.g. furniture repairs £ _____

Getting Around

Vehicle upkeep £ _____

Fuel £ _____

Public transport £ _____

Debt

E.g. Credit cards £ _____

Savings

E.g. Pensions £ _____

Other things

Item £ _____

Item £ _____

Health

Item £ _____

E.g. prescriptions

Clothing

Item £ _____

Item £ _____

Communication

Landline £ _____

Internet £ _____

Mobile phone £ _____

Recreation and culture

Sports/gym £ _____

Going out £ _____

TV packages £ _____

TV Licence £ _____

Children (including adult children)

Childcare £ _____

Pocket Money £ _____

Other (Specify) £ _____

Pets

Petfood £ _____

Vets bill £ _____

Insurance

Buildings £ _____

Contents £ _____

Car £ _____

Mobile £ _____

Pet £ _____

Life/Health £ _____

3. Have you paid for anything in the last fortnight/month using money which didn't come from either employment or benefits?

Please indicate what you spent your money on and the amount as far as possible.

Savings

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Loan

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Credit cards

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Something else (e.g. gift from family)

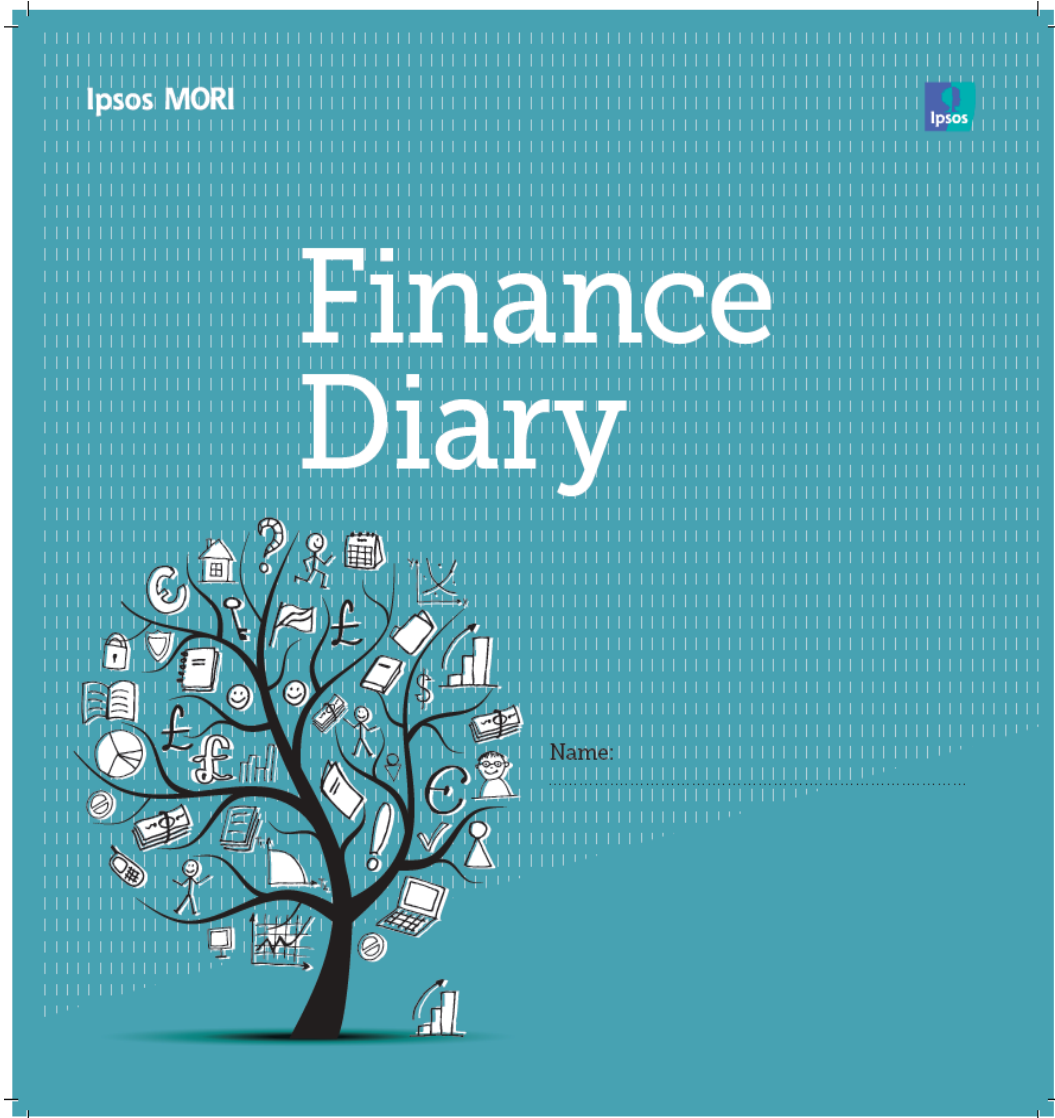
Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Item _____ £ _____

Appendix D Financial Diary



How to complete this diary...

When completing this diary it is important that you record your entries regularly and honestly. Try not to let completing this diary influence your behaviour. If you have any problems completing the diary, then just get in touch.

Researcher contact details:

Name:

Phone:

Email:

When to complete this diary:

We'd like you to complete this diary either every fortnight or every month, depending on whatever most closely matches your incomings.

Please indicate how often you intend to complete this diary:

Fortnightly Monthly

Using the calendars overleaf, please indicate the days on which you will make your diary entries.

Calendar 2012

January

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

February

S	M	T	W	T	F	S
		1	2	3	4	
5	6	7	8	9	10	11
12	13	14	15	16	17	19
19	20	21	22	23	24	25
26	27	28	29			

March

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

April

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

May

S	M	T	W	T	F	S
	1	2	3	4	5	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

June

S	M	T	W	T	F	S
				1	2	
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

July

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

August

S	M	T	W	T	F	S	
				1	2	3	4
5	6	7	8	9	10	11	
12	13	14	15	16	17	18	
19	20	21	22	23	24	25	
26	27	28	29	30	31		

September

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

October

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

November

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

December

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

Calendar 2013

January

S	M	T	W	T	F	S
	1	2	3	4	5	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

February

S	M	T	W	T	F	S
						1 2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28		

March

S	M	T	W	T	F	S
						1 2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
						31

April

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

May

S	M	T	W	T	F	S
	1	2	3	4		
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

June

S	M	T	W	T	F	S
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
						30

July

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

August

S	M	T	W	T	F	S
						1 2 3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

September

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

October

S	M	T	W	T	F	S
	1	2	3	4	5	
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

November

S	M	T	W	T	F	S
						1 2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

December

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

Date:

1. How satisfied are you with the financial situation of your household?

Ring or put a tick next to the relevant number.

completely → 10
satisfied
8
7
6
5
4
3
2
1
completely
dissatisfied → 0

Why? *Please provide a brief written response.*
.....
.....
.....
.....
.....
.....
.....
.....
.....

2. How worried have you been about money in the last fortnight/month?

Ring or put a tick next to the relevant number.

very → 10
worried
8
7
6
5
4
3
2
1
not at all
worried → 0

Why? *Please provide a brief written response.*
.....
.....
.....
.....
.....
.....
.....
.....
.....

Finance Diary

3. How much money has come into the household in the last fortnight/month from the following sources? *Please try and indicate the amount YOU receive, so if you are listing money from employment, then write what you get after tax and National Insurance deductions.*

Employment

(Please indicate amount as far as possible)

FAMILY MEMBER: £

FAMILY MEMBER: £

FAMILY MEMBER: £

Benefit

(Please indicate type of benefit and amount as far as possible)

TYPE OF BENEFIT: £

TYPE OF BENEFIT: £

TYPE OF BENEFIT: £

TYPE OF BENEFIT: £

TYPE OF BENEFIT: £

Other sources

(Please indicate type and amount as far as possible)

TYPE OF SOURCE: £

TYPE OF SOURCE: £

Finance Diary

4. How much money has been put towards the following things in the last month/fortnight:

Shopping:

FOOD & DRINK: £

ALCOHOL: £

CLEANING PRODUCTS: £

TOILETRIES/BEAUTY: £

TOBACCO: £

DAILY EXPENDITURE: £
(e.g. lunch)

Housing, fuel & power:

MORTGAGE/RENT: £

WATER: £

GAS: £

ELECTRICITY: £

COUNCIL TAX: £

Home goods & services:

(e.g. furniture repairs) £

Pets:

PET FOOD: £

VETS BILL: £

Health:

£
(e.g. prescriptions)

Clothing:

£

Communication:

LANDLINE: £

INTERNET: £

MOBILE PHONE: £

Recreation & culture:

SPORTS/GYM: £

GOING OUT: £

TV PACKAGES: £

TV LICENCE: £

Getting around:

VEHICLE UPKEEP: £

FUEL: £

PUBLIC TRANSPORT: £

Finance Diary

Children:

CHILDCARE: £

POCKET MONEY £

OTHER £

(please specify)

Savings: (e.g. pension)

ITEM:..... £

ITEM:..... £

ITEM:..... £

Insurance:

BUILDINGS £

CONTENTS: £

CAR: £

MOBILE: £

PET: £

LIFE/HEALTH: £

Other things:

ITEM:..... £

ITEM:..... £

ITEM:..... £

ITEM:..... £

Debt: (e.g. credit cards)

ITEM:..... £

ITEM:..... £

ITEM:..... £

Finance Diary

5. Have you paid for anything in the last fortnight/month using money which didn't come from either employment or benefits? *Please indicate what you spent your money on and the amount as far as possible.*

Savings:

ITEM: £
ITEM: £
ITEM: £

Credit card:

ITEM: £
ITEM: £
ITEM: £

Loan:

ITEM: £
ITEM: £
ITEM: £

Something else:

ITEM: £
ITEM: £
ITEM: £

6. Were there any unusual circumstances that had an effect on the household finances? *For example, this could be things like visitors staying, someone in the household having a birthday, having to pay a bill or needing to get the boiler fixed. Please explain the circumstance or unexpected event and how you paid for it.*

.....
.....
.....
.....
.....

Finance Diary

7. Overall, how satisfied are you with your life nowadays? Ring or put a tick next to the relevant number.

Why? Please provide a brief written response.

.....

.....

.....

.....

.....

- completely satisfied → 10
- 9
- 8
- 7
- 6
- 5
- 4
- 3
- 2
- 1
- completely dissatisfied → 0

8. How happy are you...?

- a ... with your health? (how healthy and well you feel)
- b ... with the prospect of the future? (life chances/opportunities)
- c ... with your friends?
- d ... with the home you live in?
- e ... with the things you have? (money / possessions)
- f ... with school/work/what you do day to day?
- g ... with the way you use your time?
- h ... with the amount of choice you have in life?
- i ... with your appearance? (the way that you look)
- j ... about how safe you feel? (personal safety, safety in the local area)

	Not very happy										Very happy											
	0	1	2	3	4	5	6	7	8	9	10	0	1	2	3	4	5	6	7	8	9	10
a ...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
b ...	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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Appendix E Individual Differences

This chapter discusses in more depth the most appropriate methods to investigate the research questions. A detailed overview of the measures used in this study are provided below, including the implementation and analysis.

E.1 Sample Populations

E.1.1.1 United Kingdom

The United Kingdom sample consisted of 208 students attending the University of Warwick in the United Kingdom, recruited via the University's recruitment program. Ethics were granted through the University of Warwick Humanities and Social Sciences Research Ethics Committee [02/15-16]. Measurements of participants' individual differences were taken at the Warwick Business School during a two-hour session. Up to 50 participants could be tested simultaneously during each session. After the participants completed the individual difference measures, they were then randomly allocated into one of the three groups for the 12-week intervention in a 1:1:1 allocation ratio, to one of three groups: Control, Habit-based intervention or Goal-Setting intervention.

E.1.1.2 Australia

The Australian sample consisted of 189 students attending the Monash University in Melbourne, Australia recruited via the University's recruitment program. Ethics were granted through the University of Warwick Humanities and Social Sciences Research Ethics Committee [02/15-16] and the Monash University's Ethics Committee. Measurements of participants' individual differences were taken at the Monash Business School during a two-hour session. Up to eight participants could be tested simultaneously during each session. After the participants completed the individual difference measures, they were then randomly allocated into one of the three groups for the 12-week intervention in a 1:1:1 allocation ratio, to one of three groups: Control, Habit-based intervention or Goal-Setting intervention.

E.2 Measures

The current study aims to measure participants' behavioural control, i.e. their ability to make sub-optimal financial decisions to reduce monetary consumption, increase financial

savings and increase account balances. This study looks to measure individual differences across two implementation methods; scales and behavioural tasks. In each context, trade-offs were made between data-richness and ease of collection. For example, eye-tracking or fMRI data would yield extremely rich data but would have taken long to collect. I provide an in-depth overview of the measures used and the justifications for the chosen measure.

E.2.1 Impulsivity

Impulsivity is a tendency to act without considering consequences (Steinberg, 2004). For example, an impulsive individual is more likely to choose unhealthy food over healthy food, even when expressing to lose weight. Impulsivity is likely related to goal-directed actions where impulsive actions can interfere with goal-directed formulations, for instance, consider an agent intending to lose weight, they are out for dinner at a restaurant and have the option of a burger or salad. If the agent is impulsive, they will often make rash choice with reward seeking behaviour for the burger as opposed to the salad, despite the salad being the optimal choice given the goal. Impulsivity is also related to habit formation where neurological structures and pathways that are responsible to impulsivity also function for habit formation (O'Hare et al., 2016; Yin & Knowlton, 2006). For instance, O'Hare and colleagues identified differences in the cell activity that denote GO-signals (a signal to initiate an action) from the basal ganglia, those with greater GO signals were found to be able to break and form habits faster (O'Hare et al., 2016).

As impulsivity is related to goal-directed actions and is linked to habit formation the current study aimed to measure this ability in each participant the Stop Signal task (Logan, Schachar & Tannock, 1997) was found to be the most reliable behavioural measure of impulsivity. The Stop Signal task is a task designed to measure short to intermediate control within the construct of response inhibition, that is, the ability to stop an action. The Stop Signal Task is described in more detail below (see Section E.3.1.1), in this version of the task, the task uses a Go/No-Go structure, in which an individual must make a Go response by identifying a shape shown on the display by responding with a given key response. In 25% of randomly selected trials however there are No-Go signals, in this task in the form of an auditory beep, the beep signals participants to not respond on that given trial.

As the Stop Signal Tasks only deals with a closer temporal domain in regards to short and intermediate future, the current study also includes a temporal discounting task

to understand longer-term impulsivity, i.e., the Monetary Choice Questionnaire (Kirby et al., 1999). The Monetary Choice Questionnaire asks participants to choose between a smaller-sooner monetary amount or a larger-later monetary amount, e.g., £20 today or £55 in 7 days. The temporal discounting task had been shown to reliably recruit the ventro-medial prefrontal cortex and the dorsal-lateral prefrontal cortex (Bickel et al., 2007; Hare, Hakimi, & Rangel, 2014; van den Bos, Rodriguez, Schweitzer, & McClure, 2014), with the connectivity of the striatum to the limbic systems such as the bilateral-amygdala has been reliably shown to correlate with impulsive behaviours (van den Bos et al., 2014).

E.2.2 Executive function

Executive function is a term that encapsulates higher order processes, here the interest is primarily in the capacity of the system to process information, update the current space, and to compute the outcome of behaviour to align with the agent's goal. For example, consider an individual needing to complete an assignment, the individual has a list of actions required, executive function requires this individual to retain this list of actions, process the importance of such actions and prioritise the important options. Executive function is related to goal-directed behaviours because these functions are a necessary underlying component of goal-directed behaviour, where goal-directed actions are instigated and maintained by executive functions that help to inhibit prepotent responses, resolve interference, co-ordinate behaviour and compute complex mapping (Friedman & Miyake, 2004; Logie, Cocchini, Della Sala, & Baddeley, 2004; Salthouse, Atkinson, & Berish, 2003). Executive function may also be related to habit formation because poor deficits in executive function can lead to habitual behaviour and even addictions (Everitt & Robbins, 2005; Kalivas, 2008); deficits in executive function, as demonstrated in N-Back task performance was predictive of performance in a response inhibition task (Stroop task) where those with poorer working memory and executive function displayed higher errors in the response inhibition task (Kane & Engle, 2003). As such where executive function can be diminished this can give rise to repeat past habitual choices despite these contradicting our own goals.

As executive function is related to goal-directed actions and is linked to habit formation the current study aimed to measure this ability in each participant To measure executive function the N-back task was selected. The N-Back task is described below in more detail (see Section E.3.2). In the N-Back task, participants are shown a

sequential series of letters, displayed one after another on the screen. Participants are tasked to making a Yes/No response to identify whether the letter on the screen matches a previously shown letter n -positions back in the list. For instance in a $n = 1$ task, individuals must compare the letter displayed on the screen and compare with the previously shown letter, when these letters are equivalent, i.e. when a letter repeats itself, participants respond “yes”, otherwise participants respond with the “no” key.

The N-back task is the most commonly utilised method to measure executive function, arguably due to its robust and consistent neuroactivations by varying memory load demands (Cohen et al., 1997; Jonides et al., 1997; Kane & Engle, 2002). The N-back task has been associated with a distributed network of the parietal, frontal and striatal sites which is reliably activated in executive functions (Olesen, Westerberg, & Klingberg, 2004; Owen, McMillan, Laird, & Bullmore, 2005; Tsuchida & Fellows, 2009). The face-validity of the N-back task demonstrates strong convergent validity with Working Memory related processes such as Working Memory capacity (Schmiedek, Hildebrandt, Lövdén, Wilhelm, & Lindenberger, 2009; Shamosh et al., 2008; Shelton, Elliott, Hill, Calamia, & Gouvier, 2009), various executive functions (Ciesielski, Lesnik, Savoy, Grant, & Ahlfors, 2006). Although research demonstrates weak correlations with Working Memory processes (Friedman et al., 2006; Jaeggi, Buschkuhl, Perrig, & Meier, 2010; Kane, Conway, Miura, & Colflesh, 2007). The overall literature suggests that the N-back task is a proxy of Working Memory and executive function, with the behavioural level showing weak to moderate concurrent validity (Conway et al., 2005; K. M. Miller, Price, Okun, Montijo, & Bowers, 2009), whilst the neuroactivation established by the N-back task demonstrates reliable activation of goal-directed regions (Kearney-Ramos et al., 2014). As such the N-back task was selected as a behavioural measure for a proxy of executive function.

E.2.3 Goal-Directed Behaviour

While the previous measures captures elements of goal directed behaviours, the current study also measured goal-directed behaviours more directly. Specifically goal directed behaviours are representations of contingencies between states, actions and desired outcomes (Zwosta, Ruge, & Wolfensteller, 2015). Goal-directed behaviour is also dependent upon an agent’s motivation and desires, what the agent is motivated to fulfil, whether an innate drive, need or want primarily optimizes the search parameters of which actions are the optimal choices. Therefore goal-directed actions also require these

representations to be acquired to predict the outcomes of such given choices, or to construct predicted outcomes based upon a constructed model of the world.

For instance, consider choosing between a bottle of water or a diamond. In most cases, the agent would opt for the diamond due to its considerable high monetary value. Suppose this agent is now dehydrated, does the diamond still seem as valuable? The motivation of the agent is driven by a basic desire to survive based upon water, the bottle of water in this context has a higher utility than the diamond. This is important as the actions selected here are constrained by one's motivational drives, the goals are not fixed but instead flexible, based upon are ever changing and fluctuating motivations (Zwosta et al., 2015).

Goal-directed behaviours are distinct from habitual behaviours because habitual behaviours are representations of action values within a given context, these are fixed, bounded within contextual parameters. This distinction is important as goal-directedness is flexible but is targeted on a given outcome, and can be considered as a top-down processing of behaviour to fit behaviour to a given orientation; whilst habit-based behaviour is more of bottom-up process, which bottom-up activation of contextual identifiers trigger set behavioural patterns rigid to the contextual parameters.

Roughly, dual-process theories relate to this idea as goal-directed behaviours are denote in system 1 (a more reflective system); while habitual behaviours are denoted in system 2 (a more automatic set of systems) (Balleine & O'Doherty, 2010; Daw et al., 2005; R. J. Dolan & Dayan, 2013; Evans & Stanovich, 2013; Kahneman, 2011). A popular computational refinement of dual-process theory refers to the goal-system as being model-based, and a habitual-system as being model-free ((R. J. Dolan & Dayan, 2013). As the current study seeks to measure the model-based and model-free concepts, each are described more thoroughly below.

Model-based refers to the computational assays in the requisition of modelling the environment to provide action values. These action values are based upon an agent's motivation, current and future states, possible action spaces, and the outcome of those actions as vectors of rewards and probabilities of subsequent states. This complex set of processes therefore require larger computational resources (Daw et al., 2011a; Glimcher et al., 2014), where an agent seeks to derive the best policy, that is set of actions in each given state that will lead to the targeted outcome. Model-based algorithms essentially refer to learning states and transitions, i.e. how the world maps and the pathways along

states leading to a given motivational outcome. Through the use of this mapping, the agent can then compute potential routes to the desired outcome when confronted with barriers.

Model-free on the other hand, refers to a relatively much simpler computational process, albeit still a simple model (K. Miller et al., 2016), that refers to a simplistic way of predicting future outcomes based upon the action utility of past choices. In other-words the model-free system uses cached values, these are values that have been learnt through repetitive training and are devoid of the outcomes that they predict (as based on past utility). The model-free system looks to essentially predict rewards, it takes into account past states and actions, the actions chosen at each given state and whether those actions led to a reward. This reward is then back-propogated through the sequence to denote smaller action values through the chain (Daw et al., 2011a; R. J. Dolan & Dayan, 2013; Guitart-Masip, Duzel, Dolan, & Dayan, 2014; Vlaev & Dolan, 2015).

Model-based and model-free calculations predict different patterns of behaviour. Purely model-based calculations lead to agents taking into account rewards and transitions, whilst the model-free calculations lead to agents being interested in purely maximising rewards given past choices.

The present experiment aims to measure participants model-free and model-based behavioural tendencies using a markov-decision task first implemented by Daw, Gershman, Seymour, Dayan and Dolan (2011b). This task itself is comprised of 201 trials, each of which contain two states each of which is a two-alternate forced choice (2AFC). In the first state the participants is shown two coloured boxes, these are differentiated with some form of stilmuli (in this task version by Tibetan characters). Participants must choose one of the two options, in doing so they are then shown one of two sets of boxes at the second-state, one set is more likely (common transition), the other is less likely (a rare transition). Participants must then make another 2AFC decision, selecting one of the two boxes again, the outcome of this choice is demonstrated as either a monetary reward or a null outcome. The reward probabilities are independent of the choices made and fluctuate over time based on a random-walk. As such the optimal strategy is to sample the choices in one of the second-state options, if the sets of boxers yields poor outcomes, making note of the colour of the boxes and the reward likelihood. If the outcomes are poor then the optimal strategy is to change the first-state choice.

The task structure differentiates model-free behaviour from model-based due to the computational algorithms and their respected outcomes, model-free behaviour utilises only a vector of past rewards to predict future choice behaviour; whilst model-based utilises both transition probabilities and reward outcomes.

The Markov-decision task has been cited over 600 times, and has been implemented numerous within a research environment (Daw et al., 2011a; Otto et al., 2015; Skatova et al., 2013; Wunderlich et al., 2012) and has diagnostic validity in clinical environments (Everitt & Robbins, 2005; Gillan, Kosinski, et al., 2016; Kahneman, 2011; Rouault et al., 2018; Voon et al., 2014).

E.3 Behavioural task parameters and analysis

As many of our measurements required parameter and analysis decision that affect our results, these measures are discussed in greater length below.

E.3.1 Impulsivity

E.3.1.1 Stop Signal Task.

The STOP-IT task (Verbruggen, Logan & Stevens, 2008) was used, a windows executable version of the Stop Signal Task constructed by Logan and colleagues (1996), was used to measure response inhibition. Response inhibition is characterised as the inhibition of a pre-potent response, where an action can be seen as a horse race model (Logan & Cowan, 1984) of two signals that compete against each other; a Go start signal that initiates an action, and a No-Go signal that stops a given action. If the Go signal finishes before the No-Go signal, then the agent initiates and completes the action. If the No-Go signal is completed before the Go process, then any such action initiated by the Go signal becomes inhibited. The horse race model has been demonstrated to describe empirical data (Logan, 1994).

The experimental design of the stop start paradigm features a go/no-go response to stimuli displayed on a monitor. In the case of the STOP-IT task (Verbruggen, Logan & Stevens, 2008), participants would initially be shown a fixation cross for 250ms, followed by either a square or circle, to which participants responded by pressing either the 'z' and 'm' keys respectively, the stimuli were white shapes presented on a black background. On 25% of randomly selected trials, a stop signal was presented in the form of an audible beep after a preset delay of 250ms referred to as the Stop Signal Delay

(SSD). this is adjusted dynamically by 50ms after each response, with an additional 50ms to the SSD for each incorrect response, or a reduction of 50ms for each successful response. Participants were given 12 practice trials as the inclusion of other behavioural measures increased time pressures, such that fewer trials could be afforded. Participants completed 128 trials, split equally across two blocks. The outcome variable of interest was the Stop Signal Reaction Time (SSRT), a computationally calculated variable that characterised the time required for an agent to cancel or inhibit a go response following an audible stop stimulus. Responses of greater than 1250ms were regarded as incorrect responses as given as the default parameter of the STOP-IT task.

E.3.1.2 Analysis

For the Stop-Signal Task, a Stop Signal Reaction Time (*SSRT*) was calculated for each participant, as given by the Horse Race Model (Logan et al., 1997). The horse-race model (Logan & Cowan, 1984), puts forward the notion of two parallel behavioural signals a Go and Stop signal that compete in a parallel fashion. Neurological evidence further supports the horse-race model with activation in dorsal lateral prefrontal cortex and the ventral medial prefrontal cortex (Chambers et al., 2007) whilst the anterior cingulate cortex and the inferior frontal gyrus is shown to be associated with the Stop signal (A. R. Aron & Poldrack, 2006; Adam R. Aron et al., 2003), demonstrating high validity with the horse race model of impulsivity. The *SSRT* parameter is a single value that describes impulsivity as the time required to cancel a Go response, with larger values denoting higher rates of impulsivity (given that longer is required to stop a prepotent action). *SSRT* scores have been validated as a measure of response inhibition (Adam R. Aron et al., 2003; Claes et al., 2006; Kulendran et al., 2013, 2016; Chantal Nederkoorn et al., 2010; Schachar, Tannock, Marriott, & Logan, 1995). Here the integration method is used, as this is more robust to skew and strategic slowing of reaction times (i.e. block differences) than the common mean method (Logan et al., 1997, 2014; Osman et al., 1986; Verbruggen & Logan, 2008). The common mean method involves subtracting the stop-signal delay from the mean reaction time on Go trials, however this requires the assumption that participants inhibit 50% and those outside of this assumption will no longer be applicable under this method. Therefore the integration method is a more favourable option.

The integration method assumes that *SSRT* is a constant, such that any Go commands that finish before the stop-signal delay + *SSRT* will be executed, or if the Go

signal fails to finish are inhibited. The integration method uses the Go-RT distribution, stop-signal delay and the probability of responding given a signal. This involves taking the integral of the Go-RT distribution and shifting from left to right until the integral equates to the probability of responding given a signal. At that point: $t = t_D + SSRT$, where t is reaction time and t_D is the stop-signal delay, such that SSRT can be calculated by subtracting the stop-signal delay. In practice, this is implemented by rank-ordering *Go-RT's*, and then taking the N th reaction time, where $N = N_{Go-RT's} \times P(\text{respond}|\text{signal})$, and subtracting the stop-signal delay from this reaction time (see Logan, 1994).

E.3.1.3 Temporal discounting task parameters

One main outcome displayed in the ethnographic analysis under the COM-B framework isolated a lack of planning, or forethought for the future. Where people displayed a tendency for immediate gratification. Here the 27-item Monetary Choice Questionnaire (MCQ) (Kirby et al., 1999) is utilised to measure temporal discounting, the MCQ has been validated across numerous trials (Amlung & MacKillop, 2011; Büchel et al., 2017; Huddy et al., 2017; Kirby, 2009; Kirby & Finch, 2010; Ohmura, Takahashi & Kitamura, 2005; Schimdt, Holroyd, Debener & Hewig, 2017; Takahashi, Sakaguchi & Hasegawa, 2008; Takahashi et al., 2011) and has been demonstrated to hold a construct validity ($\alpha = 0.97$) (Myerson, Baumann & Green, 2014). Participants were issued the questionnaire through Qualtrics, private software-based research company. The MCQ approach identified preferences through a Revealed Preferences method estimating intertemporal discounting parameters through choices. Participants were presented with a sooner and shorter monetary reward on one side (for example £20 today) or a larger and later monetary reward on the other side (for example £55 in 7 days). Participants completed all 27 items taking roughly two minutes. Participants were informed there was no time limit to the questionnaire, nor was there any correct answer. Choices were made for hypothetical options.

E.3.1.4 Analysis

Through the choices, a discounting parameter k was recorded as an index of the rate of the individual discounts rewards as a function of time, which is given by the formula:

$$V(D) = \frac{A}{(1 + kD)}$$

V indicates the current value of the delayed monetary reward A , at delay D , where the free floating parameter k is the discount parameter (Kable & Glimcher, 2007). A greater k value is indicative of greater impulsivity, displaying a preference for immediate over delayed rewards. The automated analysis file developed by Kaplan, Lemley, Reed and Jarmolowicz (2014) was used to calculate the discounting parameter.

E.3.2 Executive function

E.3.2.1 N-Back Task

The N-back task was used as an indicative measure of executive function. The N-back task used in this thesis uses visual stimuli. The design of the N-back task features an identification process of a yes or no response to a sequence of 12 letter stimuli displayed on the screen one after another. Participants were initially shown a fixation cross for 300ms, followed by the sequence of letters. Participants were required to respond to the stimuli identifying a correct trial, where the on-screen stimuli matched with what was presented 'n' positions back by pressing the 'm' key, or a rejection where the on-screen stimuli did not match the 'n' positions back. Participants completed 144 letters across 12 blocks of 12 letters, with three different 'n' value parameters encapsulating three blocks of $n=1$, $n=2$ and $n=3$. Where for example in $n=2$, participants would identify a match between the on-screen stimuli and what was shown 2 trials before, should the stimuli match, the participant should respond by pressing the 'm' key; otherwise by identifying a rejection by pressing the 'z' key. Thus the larger the 'n' value parameter, the greater the cognitive load placed on the individual as they must consistently update their memory space by expelling older stimuli and encoding novel stimuli in the series, comparing the stimuli on-screen with their memory store. A larger 'n' value would then require a larger memory space, for instance $n=2$ would require a constant memory bank of the last two letters, whilst $n=3$ would then require the last three letters displayed.

The number of trials within each block for the different 'n' parameter values were kept constant at twelve trials per block, meaning for $n=2$ there were only ten potential trials and $n=3$ blocks would utilise only nine potential trials. The reasoning to maintain the total number of trials was due to time constraints as participants were completing a battery of tests and further trials may have drained participants' concentration and

capacity to continue.

The letters used within this task:

‘q’, ‘w’, ‘r’, ‘k’, ‘f’

The trials were all presented in lower-case, in the centre of the screen in Arial font size 30. These letters were selected as they lack any form of phonetic similarity that could invalidate encoding due to acoustic similarity (Camos, Mora, & Barrouillet, 2013; Salamé & Baddeley, 1986; Smith & Jarrold, 2014) or visual similarity (Carrasco-Ortiz, Midgley, Grainger & Holcomb, 2017; Logie, Del Sala, Wynn & Baddeley, 2000; Logie, Saito, Morita, Varma & Norris, 2016). Stimuli were white font colour presented on a black background. Participants were trained on a n=1 block of 12 letters, for which they must score at least 80% correct identification (note: a false rejection or Miss would be characterised as incorrect), to continue onwards to the study trials.

E.3.2.2 Analysis

For the N-back task, to identify executive function, signal detection theory is utilised to compare the distributions of accuracy vs inaccuracy. Signal detection theory compares Hit rates (i.e. yes|correct response) against false alarm rates (i.e. yes|incorrect response) (REF). These are compared through inverse normal distribution to calculate and compare probabilities as a single value referred to as d' (dee-prime), which is characterised as:

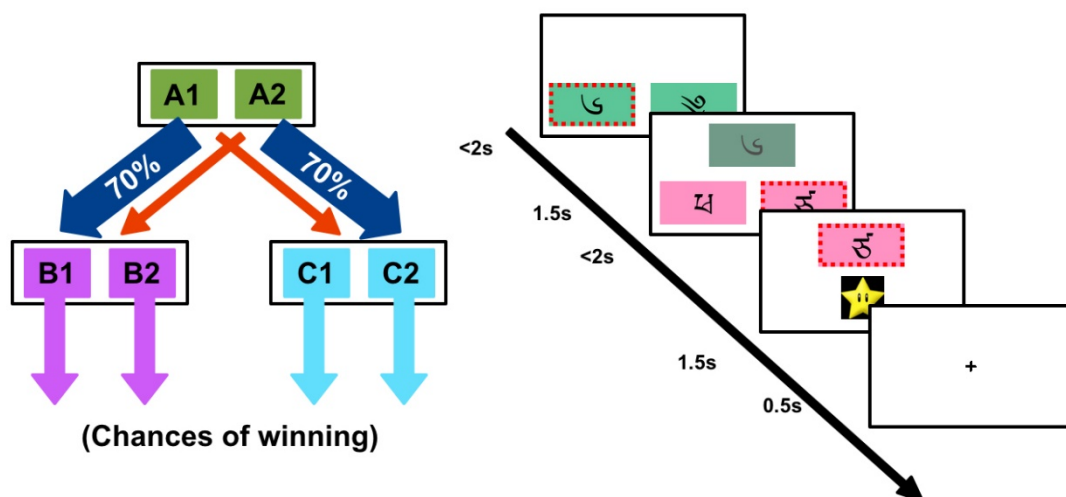
$$d' = z(\text{Hit rates}) - z(\text{False Alarm rates})$$

The d' is often referred to as a sensitivity index corrected for response biases. However if Hit rates or False alarm rates equate to the upper or lower bounds, the statistic is incalculable. As such any participants with such scores would be removed from analysis. The d' coefficients were calculated across all N-back sizes for 1-, 2- and 3-back trials to average out block effects.

E.3.3 Goal-Directed Behaviour

E.3.3.1 Markov-Decision Task Parameters

A Markov-decision task (Daw, et al., 2011) was employed to characterise reliance of control on automatic and reflective systems. The task itself is comprised 201 trials, each which contain three states; the first-stage state s_A , and two second-stage states s_B and s_C ; at each stage participants have an action which is characterised as a_A for the first state, or a_B at the second states. The first and second stage states are comprised of a stimulus pair that the participant must select under a 2 Alternate Forced Choice paradigm. There is then a probabilistic transition to one of two possible second-state stimulus pair options. One via a common transitional probability ($p_{\text{common}} = 0.70$), the other via a rare transitional probability ($p_{\text{rare}} = 0.30$). At the second state, the choice is followed by a reward or zero outcome, which is given by a slowly moving Gaussian random walk.



Appendix Figure 1; Markov Decision Task (A- Task Structure; B - Task Sequence)

The task lasts 15-20 minutes, where participants made choices by identifying their chosen box through either the 'z' or the 'm' key to identify the left or right boxes respectively for both the first and second step in each trial. Participants completed 30 practice trials to familiarise themselves with the complex nature of the task and the slowly changing reward. Participants completed 201 trials, using three differing sets of stimuli and box colour. The transition between the first and second stage of each trial was 1500ms, with the chosen stimulus of the first stage being left on screen for the second stage choices;

and the second stage choice remaining on screen in the feedback stage. Participants were displayed the stimuli on a black background with white text in font Arial, font size 28. Participants had 2000ms to select an option, with inter-stimulus and inter-trial intervals set at 500ms and 300ms respectively, with the monetary reward present for 500ms. The task was ran on MATLAB 2015b, here this version of the task retains the parameters of the version as used by Voon et al. (2015).

E.3.3.2 Analysis

Weighted Model

The automatic or habitual system is denoted through temporal difference learning, ascribed here as the SARSA (State Action Reward State Action) algorithm. The SARSA (λ) temporal difference (TD) algorithm was used to model the habitual system of control. The SARSA model of temporal difference learning uses the predicted long-term cache stored value. This is denoted as $Q_{TD}(s, a)$, which is the Q-value or utility ascribed to the state-action pairings of all actions and subsequent states within the markov-chain sequence. The algorithm uses the prediction error (δ), the calculated difference between the expected and observed reward. The choice for each stage of the trial $a_{i,t}$, where the action at the first-stage state ($s_{1,t}$) leads probabilistically to the second state ($s_{2,t}$) via the choice ($a_{1,t}$). The second state ($s_{2,t}$) is the proceeded by an action ($a_{2,t}$), and subsequently a reward $r_{2,t}$ (=1 or 0). Here a prediction error is used to update and learn how actions effect outcomes within each stage i ($= 1, 2$) for trail t . The update occurs at the end second-stage state and at the terminal reward. The update uses previous outcome based on the state-action pairings under a linear sequence of events, to back-propogate the reward signal to previous state-action pairings in the markov-chain. As given by:

$$Q_{TD}(s_{i,t}, a_{i,t}) = Q_{TD}(s_{i,t}, a_{i,t}) + \alpha_i \delta_{i,t}$$

Where,

$$\delta_{i,t} = r_{i,t} + Q_{TD}(s_{i+1,t}, a_{i+1,t}) - Q_{TD}(s_{i,t}, a_{i,t})$$

The algorithms initially update the Q-value of the first state through the resulting outcome value of the second state $Q_{TD}(s_{i,t}, a_{i,t})$ ($r_{1,t} = 0$ at this state); where the second state is then updated through the reward signal $r_{2,t}$, here the current trial transitions then to an terminal end state $Q_{TD}(s_{3,t}, a_{3,t}) = 0$. The learning parameter, α , is included for both the learning rate for s_1 to s_2 and for s_2 to s_3 (α_1, α_2).

In addition to the prediction error of s_1 to s_2 and for s_2 to s_3 ; the algorithm also back-propagates the prediction error of s_2 to s_1 through an eligibility trace decay or discounting parameter λ (constrained as $0 < \lambda < 1$, where $\lambda = 0$ indicates a highly impulsive agent and $\lambda = 1$ denotes a fully patient individual). This update is added to the earlier one:

$$Q_{TD}(s_{i,t}, a_{i,t}) = Q_{TD}(s_{i,t}, a_{i,t}) + \alpha_i \lambda \delta_{2,t}$$

The reflective or goal-setting system of control is denoted through a Model-based algorithm, which provides a more sophisticated, computationally taxing system which on a behavioural level is seen as more reflective, ‘mindful’. The model-based system creates a decision tree of possible prospective states and actions, based upon a learned internal model of the environment. Model-based works from the current state (seen as the initial starting point of the decision tree) and then searches for the policy (best set of actions given states leading to the highest utility) by navigating either forward from the initial state to the terminal points or backwards from the terminal point to the initial state. The model-based algorithm takes into account the probabilities of transitioning between states, then calculates the maximal Q-value of the action spaces within that subsequent, prospective state. Under model-based control, the problem of the learning immediate rewards becomes identical to TD learning as given above. This is because the Q-value of that state-action pairing becomes an estimate of the immediate, subsequent reward, with no further states to anticipate. As such the two approaches become identical at the immediately rewarded state, $Q_{MB} = Q_{TD}$. Therefore the algorithm for the model-based control can be expressed as:

$$Q_{MB}(s_A, a_j) = P(s_B | s_A, a_j) \max Q_{TD}(s_B, a_j) + P(s_C | s_A, a_j) \max Q_{TD}(s_C, a_j)$$

A net action value, of the combined model-based and model-free utilities for the first-stage action was calculated by weighting the Q-values of the respective models:

$$Q_{NET}(s_A, a_j) = wQ_{MB}(s_A, a_j) + (1 - w)Q_{TD}(s_A, a_j)$$

Where, w is the weighting parameter that characterises a complete reliance on model-based (goal-directed strategies) control where $w = 1$; or reliance on model-free (habitual strategies) control where $w = 0$.

The probability of a given choice was computed using the softmax equation in Q_{NET} :

$$P(a_{i,t} = a | s_{i,t}) \propto \exp(\beta_i [Q_{NET}(s_{i,t}, a_j) + p * rep(a_j)])$$

Where, β_i denotes the inverse temperature parameter or the degree of randomness in choices at each stage (β_1, β_2), with a lower value identifying greater choice randomness. The parameter p denotes perseveration ($p > 0$) or switching ($p < 0$) in the first-stage choices. The $rep(a_j)$ is a binary indicator variable as 1 for the first-stage action where $a = a_{i,t-1}$, and 0 otherwise.

The computational model is one of three models which was fitted to each individual trial-by-trial choices with the weighted net model, which produces seven parameters: The β softmax parameters for the first and second states, the learning rates for the first and second states, the weighting parameter, the perseverance parameter and the discounting parameter.

Logistic Regression Model

A simplistic logistic model was ran that predicted reliance on model-based or model-free control by investigating the effect of staying or switching first stage choices. Model-free and model-based control exhibit distinct patterns of behaviour that can be identified through about how second stage rewards impact subsequent first-stage choices. For instance, if a first-stage choice led to a second stage reward via a rare transition, a purely model-free individual would repeat the first stage choice, as it resulted in a reward. This behavioural pattern to repeat choices when rewarded is a characteristic of habits within the dual-system RL framework (Daw et al., 2005). A pure model-based individual would construct a map of the environment taking into account probabilistic transitions between

states and their rewards, as such they would shift away from the first stage choice, as the other first stage choice would lead to a higher chance of that second-stage option. Here rewards and transition were coded with effect coding (-1, 1); with a reward denoted as 1, null outcome as -1; common transition as 1, and rare as -1. The linear regression model to explain participant's shift or stay behaviour can be determined by four coefficients, (1) the reward term, which would identify model-free individuals; (2) whether transition was rare or common; (3) interaction term of transition and reward, which would identify model-based learning; (4) the constant which denotes baseline tendency to shift or stay if unrewarded. The key aspects of each trial was whether the second-stage choice was rewarded and whether this occurred in a rare or common transition to the second-stage, given the first stage choice made. Thus stay vs switching behaviour was characterised by whether participants' repeated first-stage choice behaviour on the current trial (n) compared to the next trial ($n + 1$). Mixed-effects models were ran in the R statistical environment (R Core Team, 2018) using the lme4 linear mixed effects package (Bates, Maechler, Bolker & Walker, 2015).

E.4 References

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