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A systematic review of the relationship between emotion and susceptibility to misinformation

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Abstract

Inaccurate memory reports can have serious consequences within forensic and clinical settings, where emotion and misinformation are two common sources of memory distortion. Many studies have investigated how these factors are related; does emotion protect memory or leave it more vulnerable to the distorting effects of misinformation? The findings remain diffused. Thus, the present review aimed to clarify the relationship between emotion and susceptibility to misinformation. 39 eligible studies were reviewed. Results varied according to the type and dimension of emotion measured. Level of arousal may be unrelated to susceptibility to misinformation when retrieval occurs without delay; studies including delayed retrieval were limited. Stimuli valence may be associated with increased susceptibility to peripheral misinformation but unrelated to other misinformation. The following results were reported by limited studies: short-term distress and moderate levels of stress may decrease susceptibility, while anger and greater cortisol response to stress may increase susceptibility to misinformation. Source memory may also be unaffected by emotion. The results have important potential implications for forensic and clinical practice, for example by highlighting the value of enquiring witnesses' source memory. Methodological recommendations for future studies are made.

Keywords: emotion; misinformation; suggestibility; suggestion-induced false memories

A systematic review of the relationship between emotion and susceptibility to misinformation

The accuracy of memory reports is desirable in most aspects of our life, but critical in forensic and clinical contexts. In these contexts, inaccurate memory reports can lead to serious consequences, such as miscarriages of justice (Howe & Knott, 2015) or unnecessary clinical distress caused by inaccurate memories (Lieberie & Linden, 2008; McNally et al., 2004). As such, any factors that can distort memory are important to understand and guard against. Two such factors, which are the focus of this systematic review, are emotion (Kensinger et al., 2009) and misinformation (Loftus, 1992; Loftus, 2005). In forensic and clinical settings individuals have often experienced emotionally taxing or distressing events, which are likely encoded and later recalled under similarly high levels of emotional intensity. Thus, while emotion may be ever-present in our daily lives, its influence is likely amplified, with significant consequence, in these contexts. Moreover, multiple sources of misinformation exist here, including family, media, co-witnesses, investigators, and therapists (see Howe & Knott, 2015; Loftus, 2005), risking the formation of suggestion-induced false memories (Otgaar et al., 2017). When combining these factors important questions arise: How does emotion influence the likelihood of suggestion-induced false memories? Does emotion protect the original memory or leave it more vulnerable to distortion? The present systematic review aimed to clarify the relationship between emotion and suggestion-induced false memories.

Before considering how emotion is associated with false memories, it is helpful to understand how emotion can affect the stages of memory processing. Positive moods can encourage a more relational style of processing, where incoming information is related to what is already known (e.g., stereotypes, schema), while negative moods

inhibit this style of processing, drawing more attention to minute details and item-specific information (Clore & Huntsinger, 2007; Holland & Kensinger, 2010). Emotionality can also influence what kind of information is encoded into memory, by drawing more attention to the arousing details of an emotional scenario and diverting attention away from non-emotional details (attentional narrowing; Kensinger et al., 2006). Similarly, retrieval is affected by emotion. Memories that are congruent to the mood at retrieval are easier to retrieve (mood-congruent memory; Holland & Kensinger, 2010), while the source of emotional memories can be recalled more easily than non-emotional memories (source monitoring advantage; Kensinger & Schacter, 2006). Additionally, because of their value to survival, *negative* emotional memories may be remembered and updated with greater ease (Porter et al., 2014). However, these updates may not always include accurate information. In other words, while the emotional content of memories can enhance their memorability, it can also leave them more vulnerable to further distortion (paradoxical negative emotion hypothesis; Van damme et al., 2017). These theories lead us to an important juncture: emotion can affect not only what we remember but also what we misremember, creating false memories.

There are two types of false memories. Spontaneous false memories are those created without any external pressure, while suggestion-induced false memories are created by external suggestion or misinformation (see Otgaar et al., 2017). Research on emotion and false memory has predominantly focused on the former, showing that negative valence engenders, while negative mood protects against, spontaneous false memories (Bookbinder & Brainerd, 2016). In contrast, how emotion affects suggestion-induced false memories is unclear, and to date, no review has examined the relationship between emotion and suggestion-induced false memory. Importantly, previous reviews of false memory highlight high degrees of heterogeneity in methods and outcome

measures (Brewin & Andrews, 2017; Muschalla & Schönborn, 2021). The literature on emotion and misinformation is similarly heterogeneous. Misinformation studies have explored a variety of subsets of emotion, such as arousal (Echterhoff & Wolf, 2012) and types of emotional states (e.g., anger; Greenstein & Franklin, 2020). Studies have also employed varying paradigms, such as the classic misinformation paradigm (e.g., English & Nielsen, 2010), Gudjonsson Suggestibility Scale (Roos & Gow, 2007), and implantation paradigms (Ecker et al., 2011). While this variability captures multiple aspects of emotion through different paradigms, it has also left the research area diffused. A clearer understanding of how emotion is related to suggestibility is required.

The overall aim of this systematic review was to investigate the relationship between emotion and suggestion-induced false memories. We focused on transient emotional states (e.g., anger, distress) and dimensions (e.g., valence, arousal), rather than long-standing individual trait characteristics (e.g., trait anxiety), as we were interested in emotions that are elicited in the moment, such as experiencing stress after witnessing a traumatic event or anxiety while being cross-examined.

Method

The review was registered with PROSPERO (CRD42021251921) and PRISMA reporting guidelines were followed.

Search Strategy

A search was conducted using OVID Medline, PsycINFO, Scopus, Web of Science, and Informit in May-June 2021. A second search was conducted on OVID Medline and Scopus with expanded search terms in July 2022. The search strategy included combinations of terms related to misinformation (suggestibility, suggestion-induced

false memories, susceptibility to misinformation, susceptibility to false memories) and emotion (e.g., emotion, arousal, subjective emotion, cortisol) (see Supplementary Material A). As the present review is the first on this topic, there were no limits on the date of publication. All types of original studies, including dissertations and theses, were included in the search. Reference lists of seminal papers (e.g., Brainerd et al., 2008; Laney & Loftus, 2008; Loftus, 2005; Loftus, 1992; Kensinger et al., 2007) were manually checked for additional relevant articles.

Eligibility Criteria

To be included in the current review, studies had to meet the following three inclusion criteria. 1) Studies had to include experimenter manipulation of participants' memory by implanting misinformation or suggesting misinformation about a recently encoded event. Studies requiring participants to imagine events or delivering hypnotic suggestions without misinformation were not included; 2) Studies had to include a measure of participants' subjective internal emotional state. Internal emotional states were defined as transient feelings, emotions, physiological arousal, stress, or states at the time the event was encoded, stored, or recalled. Thus, studies investigating only traits or long-term mood were not included in the review. Acceptable measures included self-report or use of materials that have been validated to reliably produce an internal emotional state. Where studies reported results according to the valence of the material being memorised, they were only included if the valence measure was successfully validated, such as through pilot ratings or manipulation checks. This was to ensure that the valence of the material was interpreted in the intended manner by the participants, as there can be individual variability in reactions to similarly valenced material (Kuppens et al., 2013); 3) Studies were required to report the relationship between participants' emotions and a measure of misinformation endorsed. Exclusion criteria were: 1) studies

conducted using a paediatric population (i.e., those under the age of 18 years old); 2) studies not presented in English; 3) articles that were a review or meta-analysis; and 4) studies that did not meet the above inclusion criteria.

Selection Process

All articles were screened using Covidence systematic review software. Authors PS and LJ screened all titles, abstracts, and full-text articles. KW was available to discuss any queries or disagreements. However, there were no disagreements during the selection process.

Quality Assessment

Quality assessment was performed by authors PS and LJ. Quality was assessed using a combination of questions from the Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies (National Heart, Lung, and Blood Institute, 2013), Ross et al. (2011), and Downes et al. (2016) (see Supplementary Material B). Interrater agreement was 98% across the included studies. It is worth noting that if blind evaluation was not specifically stated in the studies included in the review, it was assumed that it did not take place and was rated as high risk. Non-validated measures of emotions, such as single-item visual-analogue scales, were rated as high risk. Quality assessment results are available on Open Science Framework: https://osf.io/7s4bc/?view_only=a4231761f145414983f00656638bb1ab.

Data Extraction

Data were extracted using a spreadsheet with the following columns: title, year, author, country, participants, design, measure of emotion, measure of misinformation, results, and comments. Author PS extracted all data and author LJ randomly selected 25% of

the studies and extracted data from these studies to ensure consistency. There was complete agreement. Data extraction results are available on Open Science Framework: https://osf.io/7s4bc/?view_only=a4231761f145414983f00656638bb1ab.

Results

Search Results

The initial search resulted in 650 articles. After duplicates were removed, there were 552 titles and abstracts to screen. As depicted in Figure 1, 430 studies were deemed irrelevant at the title and abstract screening stage and 122 articles were screened at the full-text stage of screening. During full-text screening, 83 studies were deemed ineligible (no valid measure of transient emotion $k = 43$; no misinformation paradigm $k = 16$; wrong study design[1] $k = 13$, absence of English version $k = 4$, wrong outcomes[2] $k = 6$, and non-adult sample $k=1$). In total, 39 studies were included in the systematic review.

Study Characteristics

We found that emotion was assessed using a range of approaches. Therefore, we have presented the findings according to how emotion was measured. We also report on studies assessing suggestibility on central and peripheral details. Thus, the results are structured as follows: arousal (including stress and state anxiety), stimuli valence, affect (including affective valence, anger, distress), emotional elaboration, and central and

[1] Studies were excluded as having 'wrong study design' if they reviewed existing studies and did not report independent results (i.e., met exclusion criteria #3)
[2] Studies were excluded as having 'wrong outcomes' if they did not report the relationship between participants' emotions and measure of misinformation endorsed (i.e., did not meet inclusion criteria #3).

peripheral findings.[3] A brief description of these aspects of emotion, along with other key terms used throughout this review, is displayed in Table 1.

Table 2 summarises the key characteristics of the reviewed studies, split by experimental studies that induced emotion before encoding, experimental studies that induced emotion after encoding, and correlational studies. As displayed in Table 2, misinformation was delivered in a variety of ways. Twenty-four studies used a classic misinformation paradigm and provided misinformation via a narrative or questionnaire. Three studies provided misinformation by asking participants to elaborate on false details. Five studies used the Gudjonsson Suggestibility Scale (GSS), with three of these studies using GSS-2. Three studies used an implantation paradigm. Two studies used a social conformity paradigm and delivered misinformation via confederates. One study used a forced confabulation paradigm, and one study used a source identification paradigm with misinformation. A brief description of these paradigms is also displayed in Table 1.

Arousal and Suggestibility

Arousal was commonly included as a measure of emotion (k = 8). Measures of arousal included the International Affective Picture System (IAPS) normed image ratings[4] (Porter et al., 2014; Van Damme & Smets, 2014), pilot ratings of arousal (Porter et al., 2008; Roos & Gow, 2007), subjective ratings of arousal (English & Nielsen, 2010; Kluemper & Dalenberg, 2014; Porter et al., 2014), the arousal subscale of the Brief

[3]Where studies included material with varying arousal and valence and have reported results separately (k=5), the results are discussed under their respective subheadings. Studies that included both but did not report arousal results (k=1), controlled for arousal (k=1), or had material with comparable arousal (k=3), results are discussed under the 'stimuli valence' subheadings.

[4]The IAPS images are a standardised set of images, with mean arousal and valence ratings for each image (see Lang et al., 2005, 2008). Average arousal and valence ratings for the images used can be found in the respective reviewed studies.

Mood Inspection Scale (Van Damme & Seynaeve, 2013; Van Damme & Smets, 2014), and UWIST Mood Scale Adjective Checklist (Tiwari, 2011).

Amongst these studies, the most common finding was no significant effect of arousal on suggestion-induced false memory ($k = 5$). Specifically, there was no evidence that arousal was associated with suggestibility (Kluemper & Dalenberg, 2014; Porter et al., 2014; Roos & Gow, 2007), confidence in false memories (Van Damme & Seynaeve, 2013), or frequency of recall of false positive or negative events (Porter et al., 2008).

Some studies found a relationship between arousal and misinformation. English and Nielson (2010) found a protective effect of arousal on misinformation endorsement; arousal induced after encoding and receiving misinformation was associated with lower endorsement of misinformation than the absence of arousal. On the other hand, Van Damme and Smets (2014) found arousal to be associated with greater endorsement of some misinformation. Specifically, peripheral misleading details were accepted more for pictures of average arousal than of low arousal and central details were best remembered for images with high arousal.

Finally, Tiwari (2011) compared four dimensions of subjective arousal (without a neutral control group) and found that arousal did influence susceptibility to the misinformation effect. Misled participants ranking high on tense arousal (arousal ranging from tension/nervousness to relaxation/calmness) and anger/frustration showed greater impairment in memory retention, compared to those ranking high on energetic arousal (arousal ranging from vigour/energy to tiredness/fatigue) and hedonic tone (arousal related to overall pleasantness of mood).

Stress

Five studies included measures of stress, with stress being measured using salivary samples to measure cortisol (Echterhoff & Wolf, 2012; Hoscheidt et al., 2014; Monds et al., 2016; Schmidt et al., 2021; Zoladz et al., 2017). Studies induced stress using the Tier Social Stress Test (Echterhoff & Wolf, 2012; Hoscheidt et al., 2014; Schmidt et al., 2013), cold-pressor test (Zoladz et al., 2017), or a traumatic film (Monds et al., 2016).

Three studies found a protective effect of stress on misinformation. Schmidt et al. (2013) found that participants whose stress was experimentally induced a day after encoding and before receiving misinformation showed a lower misinformation rate than the non-stressed control group. Hoscheidt et al. (2014) found a protective effect of stress when combined with state anxiety. Stressed and anxious participants were more resistant to misinformation than stressed participants who reported low state anxiety. Memory performance of non-stressed participants was not affected by state anxiety. Zoladz et al. (2017) found that non-responders (i.e., stressed participants who did not show a cortisol increase) did not report a misinformation effect, compared to responders (stressed participants who showed a cortisol increase) and non-stressed participants (i.e., those whose stress was not experimentally induced).

In contrast to the above, Echterhoff and Wolf (2012) was the only study to observe no effect of stress on misinformation endorsement. Monds et al. (2016) was the only study to find stress was associated with increased suggestibility, as responders recalled more misinformation than non-responders. This difference was found at the free recall test immediately after misinformation but not at the one-week delay test.

State Anxiety

Seven studies measured state anxiety, with measures including the State-Trait Anxiety Inventory (Hoscheidt et al., 2014; Gudjonsson, 1988; Ridley & Clifford, 2006;

Wolfradt & Meyer, 1998), Spielberger State-Anxiety Scale (Santtila et al., 1999), and self-rating scales (Ridley & Clifford, 2004; Weeks, 2015).

Three studies found a protective effect of state anxiety against misinformation. As discussed above, Hoscheidt et al. (2014) found that high state anxiety was protective against misinformation when combined with stress. Ridley and Clifford (2004) found that participants who underwent an anxiety mood induction (either at encoding of misinformation, retrieval, or both) were significantly less susceptible to misinformation than those who did not undergo an anxiety mood induction. Ridley and Clifford (2006) also found state anxiety to be a negative predictor of source memory errors following misinformation.

Four studies found state anxiety to be associated with increased susceptibility to misinformation. Weeks (2015) found that when misinformation was said to be from a political party that participants did not align with, anxious individuals showed stronger false beliefs than non-anxious participants. When misinformation was corrected by experimenters, there were no differences between conditions. Using the GSS, Gudjonsson (1988), Wolfradt and Meyer (1998), and Santtila et al. (1999) found state anxiety to be associated with increased suggestibility.

Stimuli Valence and Suggestibility

Fifteen studies assessed the impact of the valence of the encoded material on suggestibility. Studies used IAPS images (Brown & Schaefer, 2010; Doss et al., 2020; Peace & Constantin, 2015; Porter et al., 2003, 2010, 2014), Nencki Picture Affective System (Doss et al., 2020), other validated photos (Kensinger et al., 2016), slideshow of photos depicting a scenario (Hess et al., 2012), films (Forgas et al., 2005; Monds et al., 2013, 2016, 2017; Schmidt et al., 2013; Van Schie & Leer, 2019; Zhang et al., 2021),

and subjective ratings of valence (Porter et al., 2014). All measures of valence were validated through ratings or manipulation checks.

Nine studies found no effect of stimuli valence on susceptibility to misinformation (Peace & Constantin, 2016; Porter et al., 2003, 2010, 2014; Van Schie & Leer, 2019; Monds et al., 2013, 2016; Forgas et al., 2005). Monds et al. (2017) found no relationship on the free recall test but found a relationship on the recognition test (discussed below).

Two studies found negative valence to be associated with less susceptibility to misinformation. Doss et al. (2020) found that negative pictures showed greater resistance to perceptual misinformation compared to positive and neutral pictures, and showed greater resistance to conceptual misinformation compared to neutral but not positive pictures. Schmidt et al. (2013) found negative clips were associated with less misinformation endorsement than neutral clips (positive clips were not included).

Two studies also found that emotional valence was associated with reduced misinformation, without showing differences between positive and negative material. Brown and Schaefer (2010) found that only neutral pictures, but not negative or positive, were susceptible to the misinformation effect. Kensinger et al. (2016), using a social conformity paradigm, found that negative and positive images showed fewer false memories than neutral images.

In contrast to the above, three studies found negatively valenced material to be associated with greater misinformation. As mentioned above, Monds et al. (2017) found trauma film participants to endorse more misinformation on a recognition test, but not on a free recall test. Hess et al. (2012) found the misinformation effect to be stronger for negative than positively valenced events. Zhang et al. (2021) found participants had

more false memories for negative than positive scenes (see interaction results with mood below).

Relatedly, four studies included a major misleading detail (i.e., a false suggestion of the existence of something or someone not present in the material; Peace & Constantin, 2016; Porter et al., 2010). Three studies found that negative images were associated with the highest false recall of the major misleading detail compared to positive or neutral images (Peace & Constantin, 2016; Porter et al., 2003; 2010). Porter et al. (2014) found that images negatively primed at encoding were associated with more endorsement of the major misinformation compared to non-primed, but not positively primed, images.[5]

Affect and Suggestibility

Ten studies measured how participant affect was related to suggestibility. These studies used the Positive And Negative Affect Scale (PANAS) (Ecker et al., 2011; Frenda et al., 2014; Hess et al., 2012; Nahleen et al., 2020; Porter et al., 2003; Segovia et al., 2017), self-rated measures of current mood (Forgas et al., 2005; English & Nielsen, 2010; Zhang et al., 2021), Emotional Contagion Questionnaire (Porter et al., 2003), and Brief Mood Introspection Scale (Van Damme & Seynaeve, 2013).

Six studies found no effect of mood or affect on misinformation endorsement. Mood was unrelated to misinformation (Van Damme & Seynaeve, 2013; English & Nielson; Frenda et al., 2014; Ecker et al., 2011). Segovia et al. (2017) found no differences between false memories for crux clips (i.e., those critical to the actions and found to be more traumatic in pilot testing) and non-crux clips. Zhang et al. (2021) found that mood induced at encoding alone did not account for any differences in false

[5]Note that while Hess et al. (2012) didn't identify their questions as 'major misinformation', some of their misleading questions also "introduced a new object or action" (p.19).

memory, but its interaction with valence yielded different results. Negative and positive scenes were associated with a similar level of misinformation endorsed regardless of mood, while neutral scenes were associated with more misinformation when participants were in a positive mood.

Two studies found negative affect/mood to be associated with lower misinformation. Hess et al. (2012) found that negative affect negatively correlated with misinformation. Across three experiments, Forgas et al. (2005) found induction of negative mood after encoding protected against the misinformation effect, compared to positive or neutral mood. When instructed to suppress the influence of their mood, participants in a positive mood showed fewer false alarms, but participants in a negative mood showed no significant difference. No interaction with valence was found.

Two studies found negative affect to be associated with greater misinformation. Porter et al. (2003) found that negative emotional contagion (i.e., a susceptibility to others' negative expressions) was negatively correlated with accuracy for central misleading details. Nahleen et al. (2020) found that participants endorsed more misinformation for crux details (i.e., rated as moderately traumatic in pilot testing) than non-crux details. However, these results were not due to the presentation of misinformation, as misled participants did not make more errors on crux clips than non-misled participants. Importantly, source memory results suggested that participants did not report the misleading clip as belonging to the original film.

Affective Valence

Two studies reported the relationship between affective valence and suggestibility. Assessing participants' source memory, Van Damme et al. (2017) found that differences in false memory were explained by the motivational intensity of participants' assigned emotion, and not by its valence. On the other hand, Van Damme and Seynaeve (2013)

found that negative valence (measured through the induction of sadness) was associated with greater confidence in incorrect responses to misleading questions.

Anger

Greenstein and Franklin (2020) found that participants high on state anger after experimental induction were more susceptible to the misinformation effect compared to those in a neutral mood. Anger did not affect source memory. Weeks (2015) found that when misinformation was sourced from a political party that participants aligned with, angry participants held stronger false beliefs than neutral participants. When misinformation was corrected by experimenters, there were no differences in false beliefs between conditions. Van Damme and Seynaeve (2013) did not find any effects of anger on susceptibility to misinformation.

Distress

Paz-Alonso et al. (2013) found that self-rated distress was associated with lower endorsement of misinformation for central details. Two studies (Monds et al., 2013; 2016) measured distress through intrusions and avoidance symptoms after watching a traumatic film. Both studies found that intrusions showed no relationship with suggestibility. Additionally, Monds et al. (2013) found that experiencing symptoms of avoidance (e.g., suppression) right after the film predicted lower misinformation, but persistent avoidance measured a week after encoding (and right after receiving misinformation) was associated with greater misinformation.

Emotional Elaboration

Drivdahl et al. (2009) found that participants who were instructed to imagine *their own* emotional reactions to a suggested, false event showed more false memories than those

asked to imagine a *character's* emotional reactions to the suggested event. Elaboration on emotional details (e.g., embarrassment at a fall) was associated with more false beliefs and false memories than elaboration on non-emotional details (e.g., how hard a character fell). Van Damme et al. (2017) found that when participants elaborated on a character's suggested feeling of *hope* or *fear*, they endorsed more goal-irrelevant misinformation but were more confident in rejecting goal-relevant misinformation, than those who elaborated on a character's feelings of *happiness* or *devastation*.

Emotion and Suggestibility to Central and Peripheral Details

Five studies investigated emotional differences in misinformation for central and peripheral information. Paz-Alonso et al. (2013) found that self-rated distress was associated with lower endorsement of central misinformation. Echterhoff and Wolf (2012) found no significant findings for central or peripheral misinformation. Van Damme and Smets (2014) found that, compared to positive (with low arousal), neutral, and ambiguous pictures, central misinformation was only endorsed for negative pictures (with high and low arousal) and for positive pictures (with high arousal). This finding was explained by these pictures being remembered especially well by control participants, rather than being especially susceptible to errors by misled participants.

Van Damme and Smets (2014) also found that misleading peripheral details were endorsed more for the negative than the positive image, and for the ambiguous image (average valence, average arousal) than the neutral image (average valence, low arousal). Peace and Constantin (2016) reported different results. For the negative image, misled participants showed higher accuracy of peripheral details but lower recall of central details than non-misled participants. For the positive image, misled participants showed lower accuracy of peripheral details than non-misled participants. Porter et al.

(2003) did not find significant differences between negative, positive, and neutral images.

Discussion

This systematic review sought to discern the relationship between emotion and suggestion-induced false memories. Various aspects of emotion were measured across the studies, including dimensions of affect (e.g., arousal, valence), overall current mood, and specific emotional states (e.g., anger, distress). Studies on discrete emotional states were heterogeneous and limited. When assessing arousal, valence, and affect, studies commonly reported a lack of relationship between emotion and the misinformation effect. However, for reasons that are outlined below, these findings should be interpreted with caution.

Arousal was commonly found to be unrelated to suggestion-induced false memories. This is surprising given that arousal has been associated with lower spontaneous false memories (Mirandola & Toffalini, 2016), greater memory accuracy (Kensinger et al., 2006; Mather & Sutherland, 2009), and memory enhancement (Kensinger, 2009). Given these findings in the wider applied memory literature, it was expected that arousal would be associated with fewer suggestion-induced false memories. This lack of a relationship may reflect methodology. Most of the studies reporting no relationship between arousal and misinformation did not include a delay before the retrieval phase (except Roos & Gow, 2007, whose delayed retrieval of 90-120 minutes which may have been too short; Nielson et al., 2005). Given that the effect of arousal on memory is thought to function through consolidation processes (Nielson et al., 2005), it may be that if the retrieval test occurs too early post-encoding, arousal has little impact on memory (also discussed by Van Damme & Seynaeve, 2013). There is

some support for this suggestion as one study has shown that arousal protected participants against suggestion-induced false memories when retrieval was delayed (English & Nielson, 2010). It is important future research investigates this hypothesis as delayed retrieval is likely to occur in many real-world settings, such as the reporting of trauma months after first experiencing it.

There was some evidence that stress before encoding may guard against suggestion-induced false memories (Hoscheidt et al., 2014; Zoladz et al., 2017). The mechanism underpinning this effect may be that stress instigates a shift to habitual memory, which is associated with reduced flexibility and greater rigidity (Wirz et al., 2018; Quaedflieg & Schwabe, 2018). This shift impedes the updating of encoded information (Quaedflieg & Schwabe, 2018), which may play a role in reducing susceptibility to the presentation of misinformation. However, this protective effect of stress on suggestion-induced false memories was only found in studies that included a delay (of at least one day) before retrieval. In contrast, experimental studies that did not include a delay between any of the phases (i.e., encoding, emotion induction, misinformation, or retrieval) found no relationship between stress (Echterhoff & Wolf, 2012) or arousal (Van Damme & Seynaeve, 2013) and misinformation. Thus, as in the instance of arousal, a delay may be required for stress to influence suggestion-induced false memory.

It is important to note that the stress levels induced in these experimental studies are moderate and may not represent the intensity of stress encountered in clinically and forensically relevant situations. The above findings may reflect the facilitative effects of stress when it occurs in small amounts, but may not capture the damaging effects that can arise when stress is present in higher doses or for longer durations (Joels et al., 2006). As such, the extent to which these protective effects of stress may extend to real-

life situations is difficult to assess. Indeed, there was some evidence that greater reactivity to stress (measured as a greater cortisol response) may be associated with greater suggestibility (Zoladz et al., 2017; Monds et al., 2016), although one study did not find this effect (Hoscheidt et al., 2014). These findings are consistent with studies reporting greater cortisol increase to be associated with greater memory impairment (Buchanan, et al. 2006; Tollenaar et al., 2008). It is possible that while moderate stress may protect against misinformation, greater reactivity to stress may increase suggestibility. However, given the limited number of studies, further replication is needed.

Stimuli valence was not generally found to be related to suggestibility, with 9 of 15 reviewed studies reporting this result. This is interesting, as the literature on spontaneous false memories suggests a relationship between negative valence and greater spontaneous false memories (Bookbinder & Brainerd, 2016; Brainerd et al., 2008). These findings could be taken as further evidence that the mechanisms of spontaneous and suggestion-induced false memories differ (Calvillo & Parong, 2016; Ost et al., 2013). However, findings on stimuli valence should be interpreted cautiously, given the similarity of questions across multiple studies. For example, Peace and Constantin (2016) used identical questions to Porter et al. (2010) for the negatively valenced image, while Monds and colleagues (2013, 2016, 2017) included the same questions across their studies. This similarity in material, along with a similar sample of undergraduate students, may compromise generalisability of these results.

Considering the effects of emotion on central and peripheral misinformation, high arousal seems to be associated with greater accuracy about central details, but its effects on central misinformation are not yet clear. Negative stimuli valence seems to be associated with greater peripheral misinformation. One consistent finding across four

studies was that negatively valenced material was associated with greater incorporation of major misinformation (i.e., a misleading detail that suggests the existence of a person/object/animal) (Peace & Constantin, 2016; Porter et al., 2010). These findings align with the attentional narrowing hypothesis (see Kaplan et al., 2016), showing that emotionally arousing material may be met with attention focused away from peripheral information and towards central information. Bookbinder and Brainerd (2016) also discuss how negative content can foment false memories of the gist of the material. Given that the major misleading details in these studies were, both, peripheral and schematic in nature (Peace & Constantin, 2016), greater endorsement is understandable. In real-world contexts, this finding suggests that individuals witnessing a negative event may be more likely to accept misinformation about details occurring in the background of the event that are consistent with its schema, or what might be expected of the event. It would be interesting for future studies to assess whether participants' memories would be similarly vulnerable for a major *central* misleading detail.

Affect/mood was commonly found to be unrelated to misinformation endorsement. When considering specific aspects of mood, we found anger was associated with increased misinformation, which is consistent with the understanding that anger is associated with heuristics (Semmler & Brewer, 2002) and superficial information processing (Walter et al., 2021, but see McKasy, 2020). Furthermore, distress may reduce misinformation, while persistent distress (specifically, avoidance) may leave the memory more vulnerable to misinformation. Additionally, Monds et al. (2013; 2016) also reported immediate intrusions to enhance recognition accuracy, while week-long intrusions had no effect. These findings suggest a facilitative effect of distress on memory only in the short-term. However, due to the few studies reporting

these effects, further interpretation is limited. Future studies assessing the role of distress, intrusions, and avoidance in the formation of false memories are needed.

Source memory (i.e., remembering where misinformation was encountered) does not appear to be affected by emotion. These findings have been previously reported in other contexts (see Lane & Zaragoza, 2007; Lindsay & Johnson, 1989) and remind of earlier debates on whether misinformation updates the original memory or simply leads to confusion about its source (see Loftus, 2005; Lindsay & Johnson, 1989). Limiting this discussion, only six studies measured participants' source memory and its relationship to emotion (Nahleen et al., 2020; Drivdahl et al., 2009; Greenstein & Franklin, 2020; Brown & Schaefer, 2010; Van Damme et al., 2017; Ridley & Clifford, 2006). Source memory should be explored in future studies to understand whether it does, in fact, remain relatively unaffected by misinformation, under circumstances of high emotions. This clarity in source memory may not necessarily prevent false memories (Mitchell & Zaragoza, 2001; Lindsay & Johnson, 1989) but can inform practice guidelines, which are discussed below.

Implications

If the above findings are replicated and shown to be robust, there are potential forensic implications. First, the effects of misinformation could be reduced by asking individuals to identify the source of the recalled information (a suggestion also made by Lindsay & Johnson, 1989) to best access the original memory. Certainly, this should be done in careful, non-suggestible language to avoid distorting the memory further. Second, if further replicated, the lack of relationship between arousal and suggestibility is critical to communicate to legal and clinical practitioners. Police officers have been found to report differing beliefs about the effect of arousal on memory, with those believing arousal to enhance memory also endorsing a more leading style of questioning (Kleider-

Offutt et al., 2015). This is problematic, as the results of our review do not support this relationship. Similarly, there is uncertainty regarding the effects of stress on misinformation endorsement amongst eyewitness memory experts (Marr et al., 2021, see responses to question 20), demanding replication of the effects of stress discussed in the present review. At present, limited studies suggest that individuals who experienced moderate levels of stress after an event may be less vulnerable to misinformation, but special care must be taken to avoid suggestible language with individuals who experienced anger after an event or those who may be persistently avoiding reminders of the event. Finally, as the reviewed studies were only conducted with non-clinical populations, practitioners should note that the above discussions cannot yet be applied to clinical populations including those with intellectual disabilities.

Limitations

Our review presented some important limitations shared by the studies. First, there was a lack of diversity in the studies' samples, in that they were conducted with healthy and non-clinical participants. Given the centrality of emotional disturbances in psychopathology, the relationship between emotion and suggestibility in clinical populations may vary and the present findings cannot be generalised to these populations. The samples also predominantly comprised undergraduate students with a mean age of around 20 years. While certain memory processes like activation spreading may not be age dependent (Balota & Duchek, 1989), one study in the review did report a stronger misinformation effect for older than younger adults (Hess et al., 2012). Future studies should aim to recruit more representative samples to ensure that findings can be reliably applied to all demographics interacting with clinical and forensic contexts. Second, quality assessments revealed some methodological issues that should be addressed in future studies. For example, many studies used non-validated visual

analog scales to measure participants' emotions, raising the question of whether the variability in some findings may be due to differences in measures of emotion. Numerous studies also did not include blinding procedures. Absence of blinding procedures may not pose a threat where memory tests are forced-choice and/or the study is computerised. However, these procedures are critical to reduce risk of bias where studies include open-ended memory tests or heavy interactions between experimenter and participants. Finally, the type of material used in the studies ranged from written scenarios to pictures and films, and a discussion about the ecological validity of the materials used appeared in only a few studies. Dynamic stimuli may be more memorable (Candan et al., 2015) and produce more emotion-specific brain activation than static stimuli (Trautmann et al., 2009). Consistently, we noted that a greater proportion of studies using static stimuli reported no relationship between emotion and misinformation, compared to those using dynamic stimuli (refer to Table 2). Future studies should consider these differences and comparative ecological validities when selecting stimuli.

The results of the present review are also affected by some limitations. First, we included studies that validated valenced stimuli using a pilot sample. Mirandola and Toffalini (2016) reported that *self*-assessment of emotions better predicted memory performance than splitting participants into mood groups. Thus, pilot validation of emotion may not always be reliable, especially as many of the studies used a small pilot sample. Second, our review did not include motivation, which may be an essential component of emotion (Levine & Pizarro, 2004). Indeed, Van Damme et al. (2017) in the present review found misinformation results to be explained by motivational intensity. Third, our study only included studies published in English. Finally, there was large heterogeneity across the included studies. This was observed even when analysing

subset of studies that measured similar aspects of emotion. There was variability in emotion induction methods, duration of experiment, and outcomes and effects measured. Thus, we were unable to conduct a meta-analysis.

Conclusions

This systematic review aimed to clarify how two important sources of memory distortion- emotion and misinformation- are related. Results showed that the relationship depends on the type or aspect of emotion measured. The valence of the event and individual affect/mood may not affect suggestibility. Similarly, levels of arousal may not influence suggestibility when information is recalled without a delay. In contrast, stress experienced before encoding could protect against misinformation. Limited evidence also suggests that short-term distress may reduce suggestibility, while persistent distress, anger, and a greater reactivity to stress may engender suggestion-induced false memories.

Throughout this review, many promising avenues of research have been discussed. Some methodological considerations are also recommended. More reliability and consistency in misinformation studies is desirable, including more representative samples spanning across age groups, validated measures of emotion, and the use of dynamic over static visual stimuli to achieve greater ecological validity Research with clinical populations should also be conducted to ensure findings can be reliably applied to all populations who interact with forensic and clinical settings.

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