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**TOWARDS A BETTER UNDERSTANDING OF TACIT KNOWLEDGE IN
ORGANIZATIONS: TAKING STOCK AND MOVING FORWARD**

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Abstract

Tacit knowledge is the knowledge that we draw upon in use, but is difficult to have consciousness of, or to express in language. The proliferation in the use of tacit knowledge in management research has generated a diversity of understandings that has reduced the clarity of the concept. In this review, our main goal is to contribute to an integrative theorizing of tacit knowledge. In particular, we aim to grasp the different understandings of tacit knowledge, trace them to the onto-epistemological assumptions researchers make concerning the nature of knowledge and action, and suggest a framework that enables researchers to get a coherent understanding of the diverse literature. We identify three perspectives on tacit knowledge: the Conversion, Interactional, and Practice perspectives. We describe each perspective, trace its development to particular ontological and epistemological commitments, and discuss commonalities and differences. Furthermore, we reflect on methodological issues and suggest possibilities for further research, including the relationship between artificial intelligence and tacit knowledge.

Introduction

Tacit knowledge (hereafter TK) is the knowledge that we draw upon in action (e.g. driving, teaching, operating a machine, etc.), but is difficult to have consciousness of, or express in language (Polanyi, 1958, 1966b). Management researchers have assumed TK is linked to several organizational-related issues, ranging from strategy and organizational learning, to innovation and performance (Bloodgood, Morrow, & Morrow Jr, 2003; Clarysse, Wright, & Van de Velde, 2011; Yang, Zheng, & Zaheer, 2015). As is evident by the number of studies investigating TK, its popularity over the last thirty years has increased significantly. However, the proliferation of relevant research has yielded diverse and sometimes conflicting understandings of TK, calling for construct clarity and conceptual integration. For example, while some scholars maintain that “tacit knowledge can be best described as knowledge that has not yet been abstracted from practice” (Feller, Parhankangas, Smeds, & Jaatinen, 2013, p. 316), others maintain the opposite: TK cannot be abstracted as it is an inherent feature of all knowledge (Tsoukas, 2011). In addition, while some scholars argue that TK is held by individuals (Athanassiou & Douglas, 1999, p. 84), others argue that TK is held by groups (Brown & Duguid, 2001). Such a diversity of understandings has led some scholars to despair that there is “nothing inherently positive about knowledge talk (except for academics having stakes in it)” (see Alvesson & Kärreman, 2001, p. 1014).

Moreover, recent advances in Artificial Intelligence (AI) have enabled machines to execute a range of complex tasks for which TK was originally thought to be essential (Alpaydin, 2016). One has only to think of the development of self-driving cars, robots, and smart information systems such as AlphaGo¹ to realize that these machines and systems appear to have an ability to learn and adapt (Silver et al., 2016). Since through machine learning (Alpaydin, 2016),

¹ A computer programme that can play the board game “Go”.

computer systems have the ability to learn (i.e. to improve performance in the execution of a task through identifying patterns in sample inputs), the question concerning if and how TK is implicated in artifacts' intelligent functioning invites fresh thinking (von Krogh, 2018). In addition, new advances in phenomenologically oriented cognitive science and in organization theory, have problematized intellectualist understandings of TK (i.e. understandings that highlight the primacy of cognition), suggesting a line of research that is process-cum-practice oriented (i.e. views organizational phenomena as ongoing activities unfolding within normatively structured settings) (Gehman, Trevino, & Garud, 2013; Langley & Tsoukas, 2017; Tsoukas, 2019), and a style of theorizing that is integrative (i.e. seeks to overcome dualisms such as mind and body, cognition and affect) (Radman, 2012; Sandberg & Tsoukas, 2011; Tsoukas, 2017).

Undoubtedly, the increasing emphasis on the importance of TK has enriched management theorizing. However, without developing a coherent understanding of the different uses of TK in management research, limited progress can be hoped to be achieved. The reason is that “construct clarity” (Suddaby, 2010) is reduced when a construct becomes an “umbrella construct” (Kudesia, in press, p. 6), as TK has become. To enhance construct clarity, therefore, more refined conceptual distinctions need to be drawn. This requires mapping out systematically the different uses to which a construct is put, which is what we will do here (see Sandberg and Tsoukas, 2015 for a similar point with regard to “sensemaking”).

Our overall goal in this review is to contribute to the integrative theorizing of tacit knowledge in management research. To achieve this, we aim at the following. Firstly, to offer a theoretically insightful, state-of-the-art synopsis of the diversity of research related to how TK has been used in the field. Secondly, to address the conceptual confusion that is generated by the profligate use of tacit knowledge in management research. Thirdly, to discuss the commonalities and differences among the different perspectives we identify. And fourthly, to

identify areas of research currently under-developed and/or perspectives under-utilized, which offer new lines of research. Overall, we hold that the clarification of the strengths and limitations of each perspective will assist researchers to coherently understand differences, seek complementarities, and, thus, engage in more integrative theorizing (M. Thompson, 2011, p. 757; Tsoukas, 2017).

Although other researchers have usefully sought to review studies of TK, the frameworks they suggest have certain limitations, related to their narrow scope and/or thin analytical categories. Specifically, four reviews are limited in scope, focusing on very specific aspects of TK (e.g. at the individual level) or on the relationship between TK and a particular construct (e.g. innovation) (Gourlay, 2006b; Leonard & Sensiper, 2011; M. Li & Gao, 2003; Tamer Cavusgil, Calantone, & Zhao, 2003). Other studies that have had a broader scope are limited analytically due to the conceptually thin categories chosen for organizing the review. For example, Venkitachalam and Busch's (2012) review is organized around findings within management subfields, rather than identifying schools of thought, which could shed light on the diverse uses of TK as a concept. In contrast, Castillo's (2002) review, while identifying schools of thought, it does so by creating a typology that uses overlapping (and at times esoteric) categories (e.g. "nonepistemic tacit knowledge", "sagacious tacit knowledge"), leaves out the body, and takes no account of important developments in AI. Finally, one meta-analysis refers to TK but is not focused solely on the construct, but on the features of the learning organization at large, and its sampling population consists of only 20 studies (Thomas & Allen, 2006, p. 129).

In this review, we seek to overcome the preceding limitations of hitherto reviews by increasing the scope of our review and organizing it in terms of comprehensive analytical categories. Specifically, in terms of *scope*, we extend the range of our review by (a) including studies at both the individual and collective levels of analysis (cf. Gourlay, 2006b), and (b) focusing on the relationship of TK with a range of constructs in management research (e.g. performance,

strategy, knowledge sharing) (cf. Leonard & Sensiper, 2011; M. Li & Gao, 2003; Tamer Cavusgil et al., 2003).

In terms of *analytical categories*, we search for the underlying ontological-epistemological (hereafter: onto-epistemological) assumptions of the reviewed studies in order to identify distinct perspectives on TK (cf. Castillo, 2002; Venkitachalam & Busch, 2012). The reason for doing this is that onto-epistemological assumptions provide researchers with “a system of picturing” (Harré, 1985, p. 16; Tsoukas, 2019, p. 3; Tsoukas & Chia, 2011, p. 3) that structures how researchers conceptualize and empirically explore TK (Burrell & Morgan, 2016; Tsoukas, 2005, pt. III, 2019; Tsoukas & Chia, 2002). We distinguish two onto-epistemological platforms: intellectualist and phenomenological. An *intellectualist* onto-epistemology assumes that TK and other types of knowledge are discrete entities that have inherent and relatively stable characteristics (Dreyfus, 2014). A *phenomenological* onto-epistemology assumes that TK and other types of knowledge are intertwined, inscribed in bodily skills, and embedded in sociomaterial practices (Dreyfus, 2014, 2017; Sandberg and Tsoukas, 2011). The intellectualist onto-epistemology privileges the detached observer’s perspective, while the phenomenological gives priority to the embodied actor’s experience (Tsoukas & Chia, 2011).

Following an extensive review of the relevant literature (more about this shortly), we identify three perspectives in the literature: the Conversion, the Interactional and the Practice perspectives. Briefly, Conversion scholars argue that there are two distinct types of knowledge (tacit and explicit), each convertible to the other in the carrying out of action. Interactional scholars also identify tacit and explicit knowledge as two distinct types, arguing that they must be joined together by individuals for action to be performed. The Conversion and Interactional perspectives adopt an *intellectualist* onto-epistemology. Finally, the Practice perspective scholars see tacit and explicit knowledge as mutually constituted: the two types of knowledge

cannot be disentangled (not mutually converted, nor simply joined) when action is performed. The Practice perspective adopts a *phenomenological* onto-epistemology.

For our review, we carried out a database search in the ISI Web of Knowledge to identify studies that had the keywords “tacit knowledge” and its synonyms (i.e. “know-how”, “procedural knowledge”, “implicit knowledge”) in 17 leading journals (*Academy of Management Review*, *Academy of Management Journal*, *Academy of Management Learning and Education*, *British Journal of Management*, *Human Relations*, *Journal of Applied Psychology*, *Journal of Management*, *Journal of Management Studies*, *Journal of Organizational Behavior*, *Management Learning*, *Management Science*, *MIS Quarterly*, *Organization*, *Organization Science*, *Organization Studies*, *Personnel Psychology and Strategic Management Journal*). Three reasons underlie the selection of the journals chosen: (i) they are held in high esteem in relevant journal rankings (Laing, Sporn, Galliers, & Roe, 2015); (ii) they represent both U.S. and European journals, and (iii) they feature a diverse range of research approaches. The database search returned 251 articles. After reading each paper, we decided to exclude 80 studies from our review, thus leaving 171 articles. The reason for removing 80 studies was that tacit knowledge had not been central to them, despite its inclusion in the key words list. The centrality of “tacit knowledge” (or its synonyms) to each paper examined was determined by the extent to which TK (or its synonyms) was key, rather than auxiliary, to each study’s theory development. In addition to the studies returned by the database search, we also reviewed an additional 6 studies published in books (Collins, 2010; Nonaka & Takeuchi, 1995; Polanyi, 1958, 1966b; Ryle, 1949; Tsoukas, 2011). We did this because these studies contribute directly to the understanding of TK and, as indicated by citation patterns, they have been influential in management studies. In reading each study included in this review, we searched for their onto-epistemological assumptions and sought

commonalities across them. This exercise (which will be detailed later) enabled us to create an organizing framework for our review.

The review is organized as follows. Firstly, we offer a brief overview of how TK was philosophically developed. Following this, we review the management literature on TK and identify three perspectives in it. Within each perspective we further distinguish distinct streams in which research coalesces. Thirdly, we discuss the common themes across the literature. Then, after identifying their similarities, we outline the differences between the three perspectives by tracing them to their differing onto-epistemologies. Lastly, we discuss the implications of our review for future research.

Philosophical Foundations of Tacit Knowledge

The concept of TK was originally formulated and discussed in 20th century philosophy. The two philosophers who most organizational scholars cite when discussing this concept are Gilbert Ryle (1949) and Michael Polanyi (1958, 1966b). We briefly review their main arguments below.

In the *Concept of Mind*, Ryle seeks to argue against an intellectualist understanding of knowledge and its relationship to action. An intellectualist approach maintains that action is a two-step process. An agent first considers in his/her mind the fitting rules or propositions s/he wants to follow or make and, secondly, executes the action. Ryle makes the distinction between “know-how” and “know-that” to argue against the intellectualist view. Specifically, know-how, Ryle notes, is the tacit knowledge one requires to intelligently execute an action, whereas know-that is the explicit knowledge about the action (i.e. it describes the execution of action). In Ryle’s view, know-how is indispensable for action, while know-that is derivative from know-how. In other words, what Ryle argues is that agents do not necessarily need to reflect before acting. As Ryle (1949, p. 30) remarks: “efficient practice precedes the theory of it”.

Moreover, Ryle underscores the infinite regress that ensues when thinking is taken to necessarily precede acting: even considering the appropriate rules/propositions for action is itself a form of action, which, as such, involves know-how. Know-how, therefore, is a prerequisite for know-that; tacit knowledge comes first, explicit knowledge follows.

In *The Tacit Dimension* and *Personal Knowledge*, Polanyi makes a similar argument to that of Ryle but focuses more on formulating the underlying mechanisms of know-how. Polanyi defines know-how as tacit knowledge, or to be more precise, as *tacit knowing*. In particular, Polanyi argues that tacit knowing is not a static body of knowledge, but a perceptual process that relies on the integration of “focal” and “subsidiary” awareness. One must attend from aspects that are subsidiary to one’s attention in order to be focally aware of something else. For example, to recognize someone one must attend from the specific features of their face (e.g. nose, eyes, jaw, eyebrows, cheeks, forehead) to recognize the face as a whole. Tacit knowing is the process of integrating specific features one is subsidiarily aware of (e.g. features of a face), in order to become focally aware of an object (e.g. the face). The integration of subsidiary and focal awareness is referred to as *indwelling*. By stressing that indwelling occurs tacitly, Polanyi, like Ryle, maintains that all knowledge is rooted in tacit knowledge (or know-how). In Polanyi’s words (1966a, p. 7), “while tacit knowledge can be possessed by itself, explicit knowledge must rely on being tacitly understood and applied. Hence all knowledge is either tacit or rooted in tacit knowledge. A wholly explicit knowledge is unthinkable”.

From this very brief review, it follows that tacit knowledge or know-how (also called “procedural knowledge”, “implicit knowledge” - see Castillo, 2002, p. 47; Enberg, Lindkvist, & Tell, 2006, p. 145; Gupta & Govindarajan, 2000, p. 483) is seen by Ryle and Polanyi as the ground on which explicit knowledge necessarily rests. No matter how explicit knowledge is, insofar as it involves action (i.e. agents integrating subsidiary and focal awareness), it is always grounded on tacit knowledge. Management researchers have extensively drawn on Ryle and/or

Polanyi in their efforts to conceptualize and empirically explore TK. As will be seen in the next section, a central cause of debate in the field has been how tacit knowledge is related to explicit knowledge. Assumptions about the nature of that relationship are inevitably colored by onto-epistemological commitments.

The Literature on Tacit Knowledge in Management Research

In this review, we sought to explore the onto-epistemological assumptions underlying the use of TK in each study reviewed. Below, we explain the two-step process we followed. First, we searched for the underlying onto-epistemological “image of thought” (Morgan, 1997, p. 4; Tsoukas, 2019, p. 3) that underlies the conceptualization of TK in each study. Two images of TK were identified. Studies conceive of TK either as an entity that can be converted, transmitted, or combined (an intellectualist image) (see, for example, the work of Nonaka, 1994) or as an accomplishment that integrates subsidiary and focal awareness on an ongoing basis (a phenomenological image) (see Tsoukas, 2011).

Secondly, we searched for the relationship between tacit and explicit knowledge that is argued for, or presumed by, each study. Three different types of relationships were identified across the reviewed studies. The first type posits that TK can be *unconditionally* converted to explicit knowledge and vice versa, and that either type of knowledge can be used in action. For example, a recipe about how to bake bread is considered to be the result of converting a baker’s tacit into explicit knowledge. An individual can either use explicit knowledge (i.e. follow the steps of the recipe) or, if they possess the requisite skill, draw on their bread-baking know-how to bake bread.

The second type posits that explicit and tacit knowledge must be *joined together* to perform a task. For example, by itself, having explicit knowledge (e.g. a recipe) is not enough to perform a task (e.g. bake bread). To use explicit knowledge, the latter must be joined together with TK

(e.g. ability to: read the recipe, engage in the bodily movements required, etc.) (Ribeiro & Collins, 2007).

The third type posits that tacit and explicit knowledge are *mutually constituted*, and that TK can only be *partially articulated*. Articulation is different from conversion: it involves a new context, in which the TK that is related to the action under focus is revisited and re-punctuated (Tsoukas, 2011). For example, the bread recipe itself is *not* considered to be the result of converting tacit into explicit knowledge. Rather, it is evidence of agents' ability to partially articulate their TK, namely to revisit and re-punctuate key distinctions learned, in a new context. Articulation is necessarily partial: TK retains its inexhaustibility – what is articulated is not identical with what is (Shotter, 2005; Tsoukas, 2009a, 2011).

Through this two-steps process, we have identified three perspectives in which, broadly, relevant studies fall: the Conversion, the Interactional and the Practice perspective. Specifically, studies that conceive of TK as separate from explicit knowledge and assume the unconditional conversion of TK into explicit knowledge were grouped under the Conversion Perspective (an illustrative example is Nonaka, 1994). Studies that conceive of TK as separate from explicit knowledge and assume that TK must be joined together with explicit knowledge for a task to be performed were grouped under the Interactional perspective (an illustrative example is Cook and Brown, 1999). Finally, studies that conceive of TK as an accomplishment and assume the inseparability of tacit and explicit knowledge were grouped under the Practice perspective (an illustrative example is Tsoukas, 1996).

Not all studies we reviewed fitted neatly into the three perspectives. When in doubt, we looked closer to the argument at hand to interpret its underlying premises to enable us to make a plausible judgment as to what perspective the paper or chapter falls closest to. To show our

process of judging ambiguous publications, we discuss below three examples, one for each perspective.

First, Sternberg (1997, p. 487) specifies that knowledge can be tacit (“procedural”) or explicit (“declarative”), but does not explicitly specify whether TK is convertible. However, Sternberg (1997, p.484) suggests a methodology for measuring TK. Measuring tacitness assumes that it can be captured through a metric, which treats TK as similar and, therefore, potentially convertible, to explicit knowledge. Thus, we judged this study to be closest to the Conversion perspective.

Secondly, Athanassiou and Douglas (1999, p.84) note that knowledge in organizations has two dimensions - tacit and explicit – which, the authors argue, are interlinked. The language they use implies that the tacit and explicit dimensions must be viewed in tandem. We interpreted the emphasis on the links between tacit and explicit knowledge to indicate that this study is closest to the Interactional perspective.

Thirdly, Alvesson and Kärreman (2001) argue that knowledge is tied to community and norms, and argue “against the temptation to reduce the knowledge phenomenon into simple sets of distinctions” (p.1012). We took the underlying process-cum-practice imagery of their study to point to the direction of the Practice perspective.

 Insert Table 1 Here

Prior to discussing the three perspective in depth, it will be useful to offer some descriptive information for each. The Conversion perspective is the most popular in the literature: 113 out of the 171 (66%) returned studies are included in this perspective. Despite first emerging in the mid-1990s, it is still widely used. Relevant studies were initially either purely theoretical or

qualitative, although, increasingly, recent studies tend to utilize quantitative techniques. The locus of study is primarily the individual or aggregates of individuals. Highly influential and cited studies of this perspective include Nonaka (1994), Nonaka and Takeuchi (1995), and Nonaka and von Krogh (2009).

The Interactional perspective also emerged in the mid-1990s but has been less popular than the Conversion perspective. 39 out of the 171 (23%) returned studies are included in this perspective. Early studies were theoretical, but scholars gradually turned to using qualitative and quantitative methods. The locus of study is the individual-in-interaction-with-the collective. Some of the most influential studies include Collins (2010), Cook and Brown (1999), and Lam (2000).

Finally, the Practice perspective is the most recent and, at the same time, the least used. 19 out of the 171 (11%) returned studies are included in it. Only one study predates 2000, whereas the rest were published post-2000s. Most studies are theoretical, although scholars increasingly use qualitative methods to explore TK empirically. The locus of study is the embodied agent embedded in practice. Some of the most cited studies include Brown and Duguid (2001), Tsoukas (1996), and Tsoukas and Vladimirou (2001).

We consider, in more detail, each of the identified perspectives in turn (for an overview see table 2).

 Insert Table 2 Here

The Conversion Perspective

By mainly drawing on the work of Polanyi and referring in passing to Ryle, Nonaka (1994) popularized the notions of tacit and explicit knowledge in the management literature in the 1990s (Easterby-Smith & Lyles, 2011, p. 13). Nonaka and colleagues (Nonaka & Takeuchi,

1995; Nonaka & von Krogh, 2009) define TK as a type of knowledge that is subjective, largely inaccessible to consciousness, and intimately tied to action. In contrast, they define explicit knowledge as a type of knowledge that is objective, accessible to consciousness, and in close alignment with theory. Nonaka and colleagues (*ibid.*) argue that the two distinct types of knowledge exist at the two ends of a continuum and are, in principle, convertible to each other.

We have identified four research streams within the Conversion perspective: (i) the foundational (10 studies), (ii) the performance (27 studies), (iii) the knowledge management (61 studies), and (iv) the strategy stream (15 studies). All four streams are strongly associated to the resource-based view of the firm, namely the view that sees the competitive advantage of firms as deriving from how they use their resources and what capabilities they develop (Ambrosini & Bowman, 2001; Galunic & Rodan, 1998). As organizational capabilities are at the core of the resource-based view, researchers discuss TK not only at an individual level, but also at the group/organizational level. Individual TK is viewed as the knowledge that is stored in the individual's cognitive schemata and is hard to express. Group/organizational TK is knowledge that is "stored in a collective mind... [It] can be defined as the combination of individual cognitive schemata...acquired through mutual experience" (Berman, Down, & Hill, 2002, p. 16; see also Shamsie & Mannor, 2013, p. 519). The possession of TK is argued to be the key to the development of individual expertise and is critical to an organization's capacity to build and sustain a competitive advantage (Berman et al., 2002; Helfat, 1997; Lecuona & Reitzig, 2014).

Over the years quantitative methodologies have become increasingly popular in the Conversion perspective. Individual TK is measured through situational judgement tests (Griffith & Sawyer, 2010, p. 1014; Lievens & Sackett, 2012, p. 463; Sternberg, 1997, p. 484), work samples (Sitzmann, Bell, Kraiger, & Kanar, 2009, p. 507), and proxies, such as sequential variety (Pentland, 2003, p. 528), or past experience (Shamsie & Mannor, 2013, p. 521). A popular

measure for group/organizational TK is the “perceived codifiability” of process (Zander & Kogut, 1995, p. 88). The measure is used across different studies, albeit with minor adaptations (Barthélemy, 2008, p. 1456; Birkinshaw, Nobel, & Ridderstrale, 2002, p. 286; El Arkemi, Mignonac, & Perrigot, 2010, p. 937). An example of a proxy used to measure group/organizational TK is shared experience (Berman et al., 2002, p. 21; Shamsie & Mannor, 2013, p. 522).

The Foundational Stream

The foundational stream is focused on laying out explicitly the onto-epistemological assumptions of the Conversion perspective, through theoretical and empirical research that demonstrates the mutual convertibility of tacit and explicit knowledge (see Akbar, 2003; Dyck, Starke, Mischke, & Mauws, 2005; Nonaka, 1994). The emblematic empirical case has been the Matsushita bread-making machine, as reported by Nonaka and Takeuchi (1995). Specifically, Nonaka and Takeuchi (1995) describe how Matsuhita, an electronics corporation, developed the first “fully automated bread-making machine for home use” in Japan in 1987 (p. 95). Although Matsuhita faced difficulties with the temperature and some of the ingredients (e.g. various flours or yeast), its main problem was to decipher *how* to knead the dough, which was “essentially tacit knowledge possessed by master bakers” (1995, p. 63). To figure out how to overcome this problem, Ikuko Tanaka, a Matsushita software developer, was sent to learn how to make bread from a master baker. Spending time learning the skill of kneading, Tanaka noticed that the baker did not only stretch but also twisted the dough. The latter “turned to be the secret of making tasty bread’ (ibid., 1995, p. 64). So, when Tanaka returned to the company, she had to explain how dough was kneaded so the engineers could design the machine. In the words of Nonaka and Takeuchi (1995, p.104-105), Tanaka “was able to transfer her knowledge to the engineers by using the phrase ‘twisting stretch’ to provide a rough image of kneading...

Her request for a ‘twisting stretch’ movement was interpreted by the engineers... After a year of trial and error... The team came up with product specifications that successfully reproduced the head baker’s stretching technique... The team then materialized this concept, putting it together into a manual, and embodied it in the product”.

Nonaka and Takeuchi (1995, p.64) use this example as evidence to argue that the master baker’s TK would need to be converted to explicit knowledge, through “metaphors, analogies, concepts, hypotheses or models”. They further make the more general claim that TK is, in principle, convertible. Nonaka and von Krogh (2009) argue that “knowledge must move along the continuum from tacit towards...knowledge that eventually becomes knowledge independent of the scientist [or person] who created it in the first place”. This is argued to be the case not only in technical activities, such as bread making, in which an expert’s TK is captured and objectified in the form of a manual or a machine (Nonaka & Takeuchi 1995), but also in administrative tasks in bureaucratic organizations (Donaldson, 2001), as well as in the realm of science, where scientists constantly communicate their findings and claims (Nonaka & Von Krogh, 2009). Conversion allows subjective knowledge to become objective through being combined with and validated by the knowledge of other individuals (Nonaka, von Krogh, & Voelpel, 2006, p. 1182).

The knowledge conversion process goes through four steps: Socialization, Externalization, Combination, and Internalization (SECI) (Nonaka & Takeuchi, 1995, pp. 61–70). In socialization, individuals are posited to interact (e.g. master baker and Tanaka). In externalization, individuals articulate TK into explicit terms (e.g. via metaphors). In Combination, people combine different bodies of explicit knowledge (e.g. ‘twisting-stretch’ metaphor combined with engineering knowledge). Finally, in Internalization, explicit knowledge is embodied into TK (e.g. the new understanding of bread kneading is taken for granted by individuals). This process is theorized to go on, in principle, indefinitely. Each time

a cycle of knowledge conversion is finished, another may begin (von Krogh, Nonaka, & Rechsteiner, 2012, p. 242).

Other foundational studies have sought to confirm or build on the SECI model across diverse organizational settings, beyond Japanese technological firms (see Akbar, 2003; Kidd, 1998, p. 144). Akbar and Tzokas (2013, p. 248) highlight that the mutual convertibility between tacit and explicit knowledge is key to new product/service development. Like Nonaka and his associates, they argue that, during new product/service development, new knowledge is created through several phases, involving both socialization and explication processes. Similarly, Dyck and colleagues (2005) have confirmed that knowledge creation in a small manufacturing firm goes through all four SECI processes.

Several assumptions underlie the Nonakian conception of TK. Firstly, knowledge sits on a continuum ranging from tacit to explicit, with some knowledge aspects more tacit than others (Nonaka & von Krogh, 2009). Secondly, TK is theorized to be, initially at least, subjective, since it resides within individuals (see also Kogut & Zander, 1992). As Nonaka and Takeuchi (1995, p. 239) note, “only individuals think”. And thirdly, through conversion, TK can become objectified through language and diffused across individuals. For instance, Tanaka transferred the master baker’s technique by capturing it through the ‘twisting-stretch’ metaphor; the engineers further objectified the metaphor by translating it into engineering knowledge, following a year of trial and error.

The Performance Stream

Studies in the performance stream highlight that TK is implicated in performance at both the organizational/group and individual levels, which makes TK hard to imitate and transfer. Quantitative studies typically use the measures or proxies described above. Below, we consider each level separately.

Tacit Knowledge and Performance at the Organizational/Group Level. Several studies have shown that TK is related to organizational performance. Although the mechanism that connects the two is not explicitly specified, it is assumed that, just like at the individual level, organizational/group level TK makes team performance more fluent and discerning by creating common knowledge that is internalized and spontaneously available to team members (see Nonaka, 1994, pp. 16–17). Thus, in 250 teams across a Fortune 100 technology company, TK has been found to be related to customer satisfaction and manager-assessed performance (Griffith & Sawyer, 2010, p. 1022). The authors (ibid, p. 1010) theorized that the reason for the relationship of TK with team performance is because teams have “access to more overall tacit knowledge through their individual members”. Similarly, research into basketball teams (data from 23 National Basketball Association teams from 1980 to 1994) and US baseball teams (data from 30 Major League Baseball teams from 1985 to 2001) has shown that TK is linked to teams’ performance. As players in teams spend more time playing together, they generate and build up TK, which leads to greater performance (Berman et al., 2002; Shamsie & Mannor, 2013). However, this effect does not continue indefinitely. After a certain point, accumulation of shared experience is shown to negatively affect performance. This is because after a period of success, maintaining the same approach may lead the team to perform inflexibly. To combat this, an occasional change in the roster is recommended (Berman et al., 2002).

Researchers argue that TK contributes to the uniqueness of firms, which, in turn, assists performance (see Bloodgood et al., 2003; Mueller, 1996). In particular, TK was found to be linked to the ability of a firm to create new products in the petroleum industry, which was associated with sustaining a competitive advantage (see Helfat, 1997). Even corporate spin-offs were found to grow more when they initially have “a specific narrow-focused technology which is sufficiently distinct from the technical knowledge base of the parent company and

which is tacit ” (Clarysse et al., 2011, p. 1420). Companies that divest or spinoff their original or legacy business have been found to have a lower performance than firms that retain them because they lose their TK (Feldman, 2014). Similarly, the market performance of firms that rely on outsourcing was shown to be negatively affected due to losing out on TK and the associated knowledge that is generated through learning-by-doing (Weigelt, 2009). Organizations that are part of an alliance and have an increased ability to acquire know-how from their partners enjoy higher stock performance in comparison to their partners (Yang et al., 2015). However, not all TK is argued to be equally useful for organizations. A study by Lecuona and Reitzig (2014) suggests that personnel with firm specific TK are more likely to benefit organizations, rather than personnel that have general TK.

Tacit Knowledge and Performance at the Individual Level. TK and individual performance have been consistently linked in various studies. As members of organizations, individuals are typically limited to specific actions that form the basis for constructing work processes (Pentland, 2003, p. 530). Pentland (2003, p. 528) suggests that sequential variety (“variability in the sequence of steps used to perform a work process”) provides an index for TK. The author argues that process variation is key to performance viability in environments where flexibility is important (p.529). For example, sequential variety may be key to performance in customer service. In such a role, individual employees must change their response based on diverse customer needs. In the case of entrepreneurs, Baum and colleagues (2011, p. 402), found that individual practical intelligence (of which TK is a major component), in combination with business growth goals, predict higher venture growth across 4 years. Baldwin et al (2011) noted that, despite the enormous development of formal knowledge about management, both managers (sample size 21,319) and students (sample size 2,644) had “a disturbingly low level” of knowing how to apply it. Such a weak ability was found to have only a modest relationship with cognitive ability, specific personality traits, and academic performance. In other words,

unless knowledge about something (in this case, management) has become tacit, individual performance will be limited. On this note, Burke and Sadler-Smith (2006) have argued that the ability of instructors to convert their TK into explicit knowledge tends to increase the value of instructor performance.

Several studies have claimed that TK is related to the effectiveness of individual judgements (measured by situational judgement tests) and job performance (Motowidlo & Beier, 2010, p. 331; Sternberg, 1997). Along the same lines, results from situational judgement tests have been argued to be significant predictors of job performance (Christian, Edwards, & Bradley, 2010; Lievens & Patterson, 2011; Weekley & Casey, 1999). In one study, Lievens and Sackett (2012) followed medical students over their time as interns and then as employees. They found that TK about interpersonal relationships, as measured by a situational judgement test, is a valid predictor of job performance up to 9 years after administering the first test. It should be noted that as a predictor of interpersonal relationships tests, TK was found to have incremental validity over cognitive factors for predicting academic and post-academic success criteria (Lievens & Sackett, 2012, p. 461).

The Knowledge Management Stream

Given its links to performance, TK is seen to be a valuable resource. Consequently, a lot of interest has been generated about how knowledge as a resource could be managed and diffused within and across organizations (see Fey & Furu, 2008). Studies in the knowledge management stream focus on how TK conversion enables the diffusion of knowledge in and across organizations. They have tended to employ quantitative methodologies.

TK has been argued to “come packaged most efficiently in the form of individuals” (Hedlund, 1994, p. 79). The organizational importance of TK possessed by individuals who were hired by organizations based on their prior inventions, was found to remain constant in the long term.

This is because these individuals continued to be involved in how the organization used their ideas in the long term (J. Singh & Agrawal, 2011, p. 145). Researchers were surprised by this finding because they expected that the TK of the hired individual would be shared throughout the organization. It was assumed that if the recruit's TK was shared, their involvement in projects would not be required in the long term. This finding was explained by suggesting that the TK of individuals remains restricted to direct (rather than indirect) contacts (Burt, 2007; H. Singh, Dryscynski, Li, & Ram, 2016). Because the TK of the newly hired individuals is not transferred throughout the organization, their importance in projects remains intact.

When individuals work in the same field but work for organizations in different cultural settings, they were found to have difficulties understanding each other (Lam, 1997). Similar problems have been documented in organizational mergers (Leroy & Ramanantsoa, 1997), and expatriate managers adjusting to different cultures (Armstrong & Li, 2017). Huang and colleagues (2014), have also found this to be the case when staff, with different sets of expertise, are called to collaborate. The difficulties are largely attributed to different cultures/communities developing their "own separate TK environment[s]" (Lehrer & Asakawa, 2003, p. 788)

Although TK is portrayed as a type of non-systematized and non-disseminated knowledge that impedes knowledge transfer (Inkpen & Pien, 2006, p. 781), it is argued that TK is amenable to conversion to explicit knowledge. This, in turn, facilitates TK to be shared across and within organizations (Enberg et al., 2006; Feller et al., 2013; Kale & Singh, 2007). Explicit knowledge is understood as "codifiable knowledge that can be transmitted without loss of integrity, once the syntactical rules required for deciphering it are known. It includes facts, axiomatic propositions, and symbols" (Kale, Singh, & Perlmutter, 2000, p. 221). Thus, conversion "emphasizes externalizing the content residing within individuals" (Kale & Singh, 2007, p.

985) and turning their TK to “rules and procedures” (P. Thompson, Warhurst, & Callaghan, 2001, p. 927). In response to the above, some researchers have argued that developing a formalized knowledge system is especially helpful for organizations (Coff, Coff, & Eastvold, 2006; Salisbury, 2001; Trantopoulos, von Krogh, Wallin, & Woerter, 2017). Lee and Van den Steen (2010) maintain that the development of a formalized knowledge system is even more beneficial when organizations are large, face problems such as turnover, and rely on specialist knowledge. To create formalized knowledge systems, the conversion of TK to explicit knowledge tends to be required.

Strategic decisions that influence the conversion and transfer of TK have been identified. Tsang (2002) maintains that TK transfer is positively affected by management overseeing, and being involved in, the processes of knowledge diffusion. When partners are directly involved and oversee international joint ventures, this increases the opportunities for learning, which, in turn, is associated with higher knowledge transfer (Tsang, 2002, p. 838). However, evidence suggests that the transfer of TK is more effective during the initiation of the transfer process rather than during the implementation phase (Szulanski, Ringov, & Jensen, 2016). Early involvement in the process allows the involved parties to identify potential problems to the transfer process earlier. In turn, this increases the likelihood of mitigating identified problems early on, which can significantly decrease transfer costs (Szulanski et al. 2016, p. 308).

Several teaching methods that influence the diffusion of TK have been identified. TK can be transferred to employees by web-based means (i.e. via the computer using the internet) or traditional classroom teaching techniques. A meta-analysis has suggested that conveying TK through teaching is equally effective in both web-based and classroom instruction (Sitzmann, Kraiger, Stewart, & Wisher, 2006). In addition, a meta-analysis has found that computer based simulation games are positively related to the transfer of TK (Sitzmann, 2011). Sitzman’s analysis suggests that simulation games are more effective in transferring TK relative to other

instructional methods. However, Sitzman (2011) notes that the aforementioned results show evidence of publication bias. The transfer of TK can be more efficient via other instructional methods when the trainees are actively involved in the learning experience. According to Wollersheim and colleagues (2016), TK transfer is limited by knowledge scope. Specifically, Wollersheim et al (2016) found that providing a high number of training interventions does not necessarily result in imparting more TK when the objective of interventions is to teach employees a whole range of organizational processes.

Trust and emotions have been argued to affect TK transfer. Higher trust between the individual and the firm is consistently found to positively affect TK transfer (Becerra, Lunnan, & Huemer, 2008; Levin & Cross, 2004; J. J. Li, Poppo, & Zhou, 2010). In contrast, opportunistic behavior was found to hinder TK transfer (Barthélemy, 2008; El Arkemi et al., 2010). Moreover, sharing TK is linked to a fear of power loss (Chuang, Jackson, & Jiang, 2016, p. 544). It is argued that individuals need to be motivated to share their TK (Osterloh & Frey, 2000).

To assist knowledge sharing it is suggested that individuals of the interested parties should spend time with each other (Kale et al., 2000) - increased geographical proximity is assumed to facilitate the sharing process (Choudhury, 2017; Fabrizio & Thomas, 2012; Fu, 2012; Van Den Bulte & Moenaert, 1998). It is theorized that the latter occurs because the transfer of TK is “often dependent on informal interactions among individuals and organizations” (Fey & Furu, 2008, p. 1314), especially when the expectation of reciprocity exists (Kachra & White, 2008).

The Strategy Stream

Studies in the strategy stream focus on exploring how TK as a valuable resource affects organizational strategy. Strategic decisions affected by TK range from market entry and mergers and acquisitions to governance structure selection and plans to acquire, preserve and

share TK in and across organizations (see Gray, Siemsen, & Vasudeva, 2015; Le Breton-Miller & Miller, 2015; Nagarajan & Mitchell, 1998). The stream is dominated by the use of quantitative methodologies.

Consistent with the view that TK is unique, research has suggested that organizational expansion abroad (X. Martin & Salomon, 2003) or seeking strategic partners (Shenkar & Li, 1999) is motivated by the acquisition of TK. Gray et al (2015) have found that, to facilitate TK appropriation in the long-run, the collocation of manufacturing and R&D in pharmaceuticals is related to better conformance quality, despite the rapid development of information systems that enable work at a distance. This is because it is harder to appropriate TK when working at a distance (ibid., p.2764). The entry choices into foreign markets by small to medium enterprises with a high stock of proprietary TK have been found to be moderated by formal institutional risk (i.e. “constraints resulting from insufficiently developed market support institutions in the host country”) (Schwens, Eiche, & Kabst, 2011, p. 331). Specifically, when formal institutional risk is high, firms with high proprietary TK are more likely to secure knowledge internally rather than externally. This safeguards TK from expropriation from opportunistic behavior of foreign competitors (ibid, p.344). However, market entry is not only motivated by knowledge acquisition. Kim and Kogut (1996) have illustrated that organizations engaged in developing platform technology, enter new markets by drawing on their own TK acquired from technological experience. Because the latter has a large range of applicability, it allows them to identify new opportunities and thus diversify.

TK and its sourcing are linked to inter-firm agreements (e.g. alliances) and organizational forms (e.g. integration of departments). Birkinshaw and colleagues (2002) found that the degree of knowledge tacitness has an influence on organizational forms. Specifically, it was found that a lower degree of knowledge tacitness is associated with a lower likelihood of R&D department integration. The authors argue that lower tacitness of knowledge facilitates

transfer. Hence, R&D departments with low tacitness of knowledge are given autonomy because their knowledge can be easily shared (ibid, p. 278). Dutta and Weiss (1997) maintain that technologically innovative firms must guard their TK (see also Schwens et al., 2011), since it is a unique asset that differentiates a firm from competition. Thus, firms try to prevent TK from spilling over to other firms operating in the same country. Therefore, to safeguard their TK, firms tend to engage more in marketing agreements and licensing agreements than joint ventures. This is because marketing and licensing agreements minimize the transfer of TK (Dutta & Weiss, 1997). The higher the perceived threat of opportunism, the more likely it is for firms to make an acquisition rather than to sign a licensing agreement. Acquisitions ensure that TK remain within firm boundaries, whereas licensing does not.

Moreover, Almeida and colleagues (2002) found that in the semi-conductor industry, multinational corporations (MNCs) are a superior arrangement to alliances and market-based relationships for moving, integrating and developing new technical knowledge (which contains both explicit and tacit knowledge). The authors argue that MNCs are superior, because they can use multiple ways of knowledge transfer (e.g. formal means such as explicit knowledge in reports and informal means such as discussions), which assist in integrating and developing new technical knowledge (Almeida et al., 2002, p.158).

The Interactional Perspective

The Interactional perspective shares some commonalities with the Conversion perspective but differs from it in some important ways. The commonalities include, mainly, the acceptance of tacit and explicit knowledge as two separate types of knowledge and their mutual convertibility (see Kamoche, Beise-Zee, & Mamman, 2014, pp. 1379, 1383). However, whereas for the Conversion perspective convertibility is unconditional, for the Interaction perspective, it is conditional (i.e. it is possible under certain conditions only) and pragmatically limited (i.e. even

after conversion, converted knowledge by itself may not be enough to perform an action) (Collins, 2006). For example, making a robot that can cycle is dependent on science understanding the physics and mathematics of cycling, especially balancing on a bicycle. However, the equations of cycling cannot directly be used by humans to cycle. Humans require embodied tacit knowledge to do so. The defining feature of this perspective, therefore, is the assumption that in order to perform an action, different knowledge types need to be *joined* together. Thus, to ride a bicycle one needs not only individual embodied TK to balance on it but, also, collective TK: the norms that govern cycling in traffic (Collins, 2010). In our review, we have identified two streams within the Interactional perspective: the foundational (12 studies) and knowledge sharing (27 studies) streams.

The Foundational Stream

Relevant studies focus on articulating and elaborating the onto-epistemological assumptions that underpin the Interactional perspective, having a mainly theoretical focus. An influential advocate of this perspective has been Harry Collins (2010), who suggests that TK is only conditionally (or pragmatically) convertible. Advocates of conditional conversion accept that TK may be, in principle, convertible to explicit knowledge (i.e. under specific conditions, such as advances in technology), but, they also insist that, even when conversion occurs, individuals cannot always use explicit knowledge to perform a task (see Collins, 2006). Task performance is made possible insofar as TK, in its various types, is joined together with explicit knowledge (see Cook & Brown, 1999). Collins (2010) identifies three TK types and suggests why they are difficult to convert, and, furthermore, why, in some cases, even converted TK may not be usable in itself.

The first type of TK is *relational* TK. This type is argued to be embedded in human relationships (see also Blackman & Sadler-Smith, 2009; Ebbers & Wijnberg, 2009). According

to Collins (2010, pp. 91–92), if some people (e.g. craftspersons) have knowledge of something and want to keep it to themselves, there is little chance of others finding out about it, unless the people choose to share their piece of knowledge. Thus, Collins argues, this ‘secret’ knowledge is, in essence TK, which cannot be explicated, nor used, unless shared by the people who possess it.

The second type of TK is *somatic* TK. This is similar to “skill-based” TK outlined by Cook and Brown (1999, p. 391), Lam’s (2000, p. 492) “embodied” TK, and Tywoniak’s (2007, p. 61) “personal” TK. This type of TK, is related to humans’ bodily abilities and is hard to explicate. Even sophisticated technologies cannot adequately capture, nor fully replicate, the complexity of human bodies and the knowledge inscribed in them (Collins, 2010, p. 101). Hence, Collins (2006, p. 258) argues, with reference to the cycling example, insofar as the equation explaining balancing on a bicycle has been formulated and it has been put to use by bicycle riding robots, this is enough evidence to suggest that know-how can exist in different types: somatic (tacit) (for humans) and mechanical (explicit) (for robots). However, the mechanical type cannot be used by humans because they do not process information the way robots do.

The third type of tacit knowledge is collective TK, also referred to by others as “group TK”, “collective knowledge” or “organizational memory” (Cook & Brown, 1999; Hecker, 2012; Kayes, 2002; Lam, 2000; Lei, Hitt, & Bettis, 1996; Tywoniak, 2007). This is essentially the taken-for-granted “shared beliefs” within communities of practice (Tell, 2004; Williams, 2001, p. 73). According to Collins (2006), the inherent difficulty with converting this type of TK stems from its incessantly changing nature. Thus, although, in principle, collective TK is convertible, any conversion would be obsolete after a while and, therefore, unhelpful (Collins, 2010).

Interactionalists suggest that, although distinct, tacit and explicit knowledge “interact” (see Kayes, 2002, p. 145; Tywoniak, 2007, p. 54). Indeed, it is maintained that it is by joining together all knowledge types that the possibility for action and new knowledge creation exists (Collins, 2010; Cook & Brown, 1999; Miller, Zhao, & Calantone, 2006, p. 719; Raelin, 2007, p. 505). Take for example, the creation of the bread-making machine described by Nonaka and Takeuchi (1995). Even after Tanaka used the metaphor of the twisting-stretch to explain how the master bread maker dealt with the dough, the engineers could not still comprehend what Tanaka meant. To combat their incomprehension, the engineers spent time with the baker to gain haptic experience of dough kneading (Nonaka and Takeuchi, 1995, p. 104). This suggests that, to develop the bread-making machine, engineers did not rely only on Tanaka’s explicit knowledge (i.e. her verbal description). Rather, the engineers had to join together Tanaka’s explicit knowledge, as expressed through her twisting-stretch metaphor, with their own somatic TK of handling the dough and with their collective TK of how to socially interact with the bakers and Tanaka. This is why, Ribeiro and Collins (2007, p. 1429) argue that the bread-making machine was designed through joining together knowledge types (i.e. collective TK with somatic TK), not through knowledge conversion. Thus, to create the bread making machine, the engineers had to join together individual explicit (e.g. metaphor) and tacit (e.g. haptic experience of kneading) knowledge and collective types of explicit (e.g. formal terminology) and tacit (e.g. conventions for interacting) knowledge.

According to Cook and Brown (1999, p. 388), the types of knowledge that are joined together in action should be considered “as an aid to action, not part of action itself”. During action, what agents draw upon is *knowing*. Knowing is defined as know-how-in-action, which is used to achieve a specific purpose. Thus, TK, for Cook and Brown (1999), is considered to consist of search rules, or heuristics, whereas tacit knowing is seen as utilizing the rules/heuristics

during action. Hence, a number of authors hold that “knowledge is mental content” that is utilized for decisions during action (Dörfler & Ackermann, 2012, p. 551).

The Knowledge Sharing Stream

Similar to studies in the Conversion perspective, Interactional studies also recognize the importance of TK for sustaining a competitive advantage (Ebbers & Wijnberg, 2009; Hall, 1992). Thus, how knowledge is shared in and across organizations has been a major focus for researchers in this perspective. Since Interactionalists assume pragmatic conversion and the joining of distinct knowledge types together, a significant number of scholars have presented arguments for how TK is shared *without* conversion. Most empirical studies are either theoretical or qualitative.

Interactionalist researchers hold that TK is transferred via direct interaction between people over a period of time, during which people tacitly begin to acquire more and more understanding through experience and experimentation (Cunliffe, 2002; Raelin, 1997; Styhre, Josephson, & Knauseder, 2006). Both collective and individual TK are key for knowledge sharing, since : (i) the different types of knowledge must be joined together in order to develop expertise and perform tasks (Arnold, Clark, Collier, Leech, & Sutton, 2006, p. 84; A. Martin, Woods, & Dawkins, 2015, p. 53; McCloy, Campbell, & Cudeck, 1994; Ribeiro & Collins, 2007; Williams, 2001), and (ii) TK is embedded within specific contexts and, therefore, cannot be abstracted without losing its contextual nuances (Almond, 2011; Hong, 2012; Lei et al., 1996).

During knowledge transfer, rather than conversion, what occurs is knowledge bridging (Hong, 2012; Rouleau, 2005). By drawing on collective TK, agents seek to bridge their knowledge gaps through dialogue in interactional contexts (Gerpott, Lehmann-Willenbrock, & Voelpel, 2017; Leonardi & Bailey, 2008; Wang & Ramiller, 2009). How the interactional contexts are

set up and dialogue is conducted are underwritten by collective TK (see Cook & Brown, 1999). This suggests that, apart from individual TK, collective TK (i.e. knowledge embedded in organizational systems and culture) also differentiates firms. This is because collective TK produces spontaneous ways of cooperating that are hard to imitate (Mueller, 1996, p. 773). Cattani and colleagues (2013, p. 814), in a study of violin making, argue that TK is transferred “most effectively by direct observation, participation and close interaction” (see also Kamoche & Maguire, 2011; Ribeiro & Collins, 2007). If a skill is not practiced, TK may be lost, even if explicit instructions exist. Insofar as this is the case, TK must be reinvented (Cattani et al., 2013).

As sharing TK is complex and time consuming (Spencer, 2008, p. 347), it is argued that creating suitable conditions to facilitate knowledge transfer is helpful. At an organizational level, forming alliances with or acquiring other firms has been argued to affect knowledge transfer (Gerwin & Ferris, 2004; Schweizer, 2005). In the context of the acquisition of biotech firms by pharmaceutical companies, the autonomy given to the acquired was a key factor for knowledge transfer (Schweizer, 2005). Higher autonomy is given when the acquisition is motivated by accessing new knowledge, whereas lower autonomy is provided when the acquisition is motivated by improving market position. The reason for this is this: know-how is tied to (embedded in) organizational systems and culture. When acquisition is motivated by accessing new knowledge, changing the organizational systems and culture may jeopardize the newly acquired know-how. However, when acquisition is motivated by improving market position, changing the organizational systems and culture of the acquired organization will not jeopardize losing the relevant know-how, because the acquiring organization already has it (Schweizer, 2005, p.1068).

Interactionalists, like Conversionists, maintain that trust and emotions are key to transferring TK (Janowicz-Panjaitan & Noorderhaven, 2009). In particular, staff were more motivated to

transfer when they perceived a common advantage in doing so (Ivory, Alderman, Thwaites, McLoughlin, & Vaughan, 2007), or when their sense of identity was not perceived to be threatened (Kamoche et al., 2014). If these conditions are not upheld, individuals may choose to protect their TK by not sharing it (Kamoche et al., 2014). According to Ebbers and Wijnberg (2009), organizational memory not only contains declarative and procedural knowledge, but also knowledge of expectations. If individuals' expectations are violated, they are likely to seek to protect their knowledge, focusing, instead, on their individual advancement (ibid.). Protecting TK has been argued to be a type of "silence" (similar to Collin's (2010) concept of relational TK discussed above). In particular, two types of silence have been identified. On the one hand, when staff are *unable* to articulate their knowledge, this is referred to as being "silent". On the other hand, when staff are *unwilling* to articulate their knowledge is referred to as being "silenced" (Blackman & Sadler-Smith, 2009, p. 571).

The Practice Perspective

The Practice perspective is the least used of the three we have identified in our review. Its distinguishing features are the following three: (i) tacit and explicit knowledge are irreducible and mutually constituted; (ii) TK and sociomaterial practices are inseparable, and (iii) embodiment matters (Tsoukas, 2011). Accordingly, the locus of study is the embodied agent embedded in practice. To see best how the Practice perspective views TK, we revisit the bread making illustration used throughout this review.

For Tanaka to express how the master-baker kneaded bread, she relied on her understanding derived from personally observing and participating in the bread making sociomaterial practice. Through the twisting-stretch metaphor, Tanaka did not convert, nor translate, her TK into explicit knowledge. Rather, Tanaka reflected on her embodied experience and partly *articulated* it. From a Practice perspective, experience is complex and cannot be fully captured

by language; several aspects of an agent's experience remain inexpressible or partially expressible (e.g. the haptic feeling of kneading dough) (see Ribeiro & Collins, 2007, p.1429). Language shapes – gives form – rather than converts or translates one's experience (Rorty, 1979). The twisting-stretch metaphor was Tanaka's way of making sense of her own experience in a publicly communicable manner. By articulating her experience through this metaphor, she brought forward and underscored particular aspects of her experience. Language, therefore, provided a particular form to Tanaka's experience. The engineers, initially, had trouble fully understanding what Tanaka meant by the metaphor and what the implications were. They had to participate in the bread making sociomaterial practice themselves in order to comprehend what Tanaka was referring to and see possibilities for action. The development of the bread making machine would have been impossible without all parties dwelling in their own TK and finding ways of partly articulating and sharing it.

Research from a Practice perspective has been, mainly, theoretical or qualitatively empirical. We have identified two streams in our review: the foundational (12 studies), and the skillful performance stream (7 studies). Below we consider each.

The Foundational Stream

Several management scholars have engaged with Polanyi's original work (1958, 1966b), attempting to show its implications for organizations. Thus, they have been keen to point out that TK is not a body of rules, but a *process* that relies on the spontaneous tacit integration of focal and subsidiary awareness, as discussed earlier (Miller, 2008; Shotter, 2005; Tsoukas, 2011). In skilled work, such as, for example, a carpenter hammering a nail, driving the nail down is the *focus* of his/her attention, while, at the same time, s/he is *subsidiarily* aware of the feeling in the palm of holding the hammer. As Polanyi and Prosch (1977, p. 33) remark: "I know the feelings in the palm of my hand *by relying on them for attending to the hammer*

hitting the nail. I may say that I have a *subsidiary* awareness of the feelings in my hand which is merged into *my focal awareness* of my driving the nail” (italics in the original).

Focal and subsidiary awareness have a *from-to* relationship: agents must attend *from* subsidiary aspects of their experience *to* become focally aware of an object (Polanyi & Prosch, 1977; Tsoukas, 1996, 2011). As Tsoukas (2011, p. 461) remarks: “tacit knowing is from-to knowing: we humans know the particulars by relying on our awareness of them for attending to something else”. If agents focus on one of the features of their subsidiary awareness, they lose sight of what they are focally aware of, just like when focusing on grammar while speaking jeopardizes its fluency.

As discussed earlier, the process of an agent interiorizing the subsidiary aspects *from* which s/he attends *to* perceive something, is referred to as ‘*indwelling*’ (D’Eredita & Barreto, 2006; Gueldenberg & Helting, 2007; Miller, 2008; Tsoukas, 2009a). Oborn and Dawson (2010) have suggested that the process of indwelling allows cross-functional medical teams (i.e. surgeons and radiologists) in a British hospital to make decisions about complex treatments. By dwelling in different details, medical specialists could bring into focus different understandings, which, through dialogue, allowed teams to make more informed decisions about treatment (ibid., p. 1842-43).

Indwelling is accomplished through socialization into a sociomaterial practice (Brown & Duguid, 2001). To become a practitioner, say a teacher, a doctor or a design engineer, a person must learn to normatively use language, shared standards of excellence, routines and terminologies that are taken for granted by their peers (Pyrko, Dörfler, & Eden, 2017). Thus, to become a member of a practice, “is to experience one’s situation in terms of *already* constituted distinctions” (Tsoukas, 2009a, p. 943, emphasis in original). The backbone of practice is intuitive normativity – intuitively taking things for granted in the same way others

do (Gueldenberg & Helting, 2007). When something is taken for granted, indwelling is in process (Shotter, 2005, p. 601). Indwelling structures agents' perception by enabling them to attend *from* subsidiary particulars (e.g. particular terminology or certain standards of excellence) *to* the focal situation at hand. Put differently, against this tacit background, possibilities and impossibilities for action are opened and closed depending on what is routinely acceptable or unacceptable comportment within a community of practice (Gueldenberg & Helting, 2007). For example, when doctors discuss possible treatments, they do so by dwelling in the shared medical understanding and the legitimate sources of knowledge (e.g. journals) (see Oborn & Dawson, 2010).

Through socialization into a practice, we attain "particular skills through training our *bodies* to relate in certain ways to the world" (Tsoukas, 1996, p. 17, emphasis added). Action is enabled or directly carried out by our bodies, whose senses, most of the time, are drawn upon in a subsidiary manner: we subsidiarily attend from the senses to focally perceive and respond to situations. We are normally unaware of the movement of our eye muscles when we observe, the movements of our mouths and tongues when we speak, the distance we keep from others, how our mouth curls in response to a joke, and so on (Tsoukas, 2011, p. 462).

Indeed, we are normally unaware that tasks that require even a fragment of specialized knowledge also require a series of bodily functions. To illustrate this Tsoukas (2011, p. 462) refers to Polanyi's (1958, p. 101) example of how medical students learn to diagnose pulmonary diseases by using X-rays. Students are initially puzzled. Looking at the X-ray picture of a chest, they can see "only the shadows of the heart and ribs, with a few spidery blotches between them" (Polanyi, 1958, p.101, as quoted in Tsoukas, 2011, p. 462). Initially, students find nearly incomprehensible what the teaching radiologist is talking about. They have not learned yet how to observe an X-ray because they do not know what to look for. If, however, they persist with their training, they "will gradually forget about the ribs and begin

to see the lungs. With more time and even more perseverance, “a rich panorama of significant details will be revealed to [them]: of physiological variations and pathological changes, of scars, of chronic infections and signs of acute disease. [They have] entered a new world” (ibid.). Thus, students learn, in practice and through practice, to ‘see’, that is, they learn which aspects of the X-ray to attend by internalizing normative distinctions from the practice of radiology. By doing so, what was initially an unclear picture of blotches appears to be a meaningful ensemble of a lung. Thus, more broadly, carrying out tasks ranging from trivial, such as reading the newspaper, through those involving moderate skills, such as driving, to specialized ones, such as cancer research, and/or architecture and design, requires the tacit integration of normative distinctions permitted by our bodily functions.

Following from the above, whenever agents are engaged in action, they do so without being focally aware of the subsidiary elements they are attending from (Shotter, 2005; Tsoukas, 1996). However, the open-endedness of the social world (i.e. agents are constantly faced with novel situations) calls for novel responses (Shotter & Tsoukas, 2014). Insofar as situations diverge from what is typically expected, they often result in ‘breakdowns’ in agents’ performances (Tsoukas, 2011), bringing engaged action to a halt. During such breakdowns agents bring forward (i.e. become *focally* aware of) what, during action, they took to be subsidiary particulars, in order to articulate (and, therefore, re-punctuate) them, and find a new way to continue their action in congruence with their practice (Tsoukas, 2009a, 2011). For example, during a lecture, an eerily silent class may cause a teacher to revisit the particular examples they have been using (Yanow & Tsoukas, 2009, p. 1355).

Reflecting on and articulating what one was subsidiarily aware of during action is an endless process (Brown & Duguid, 2001, p. 204). “Rationality can never be fully articulated; it always has a tacit dimension” (Miller, 2008, p. 945). Articulation depends on reflection, and reflection itself is a form of action (Tsoukas, 2011). Thus, to reflect on (i.e. to have focal awareness of)

something one must already dwell in a specific set of subsidiary particulars. Hence, even when agents retrospectively offer explicit insights into their performance, their articulation depends on tacitly taking for granted a host of other subsidiary (i.e. unarticulated) particulars. Consequently, explicit and tacit knowledge are not (cannot be) separate – they are mutually constituted (Spender, 2008). In Tsoukas' (2011, p. 472) words: “tacit and explicit knowledge are not the two ends of a continuum but two sides of the same coin: even the most explicit kind of knowledge is underlain by tacit knowledge.”

The Skilful Performance Stream

Studies in this stream focus on exploring how individuals experience and enact different skills across different practices. All studies are qualitative. They share the assumption that skillful performance depends on dwelling in contextual nuances (e.g. local conventions, unique circumstances).

In a study of a call center of a major Greek telecommunication company, it was found that the effective performance of employees was accomplished not simply by following organizational rules (i.e. some general statements abstracted from context) but by employees constantly adapting rules to particular contexts through drawing on collectively shared taken-for-granted ways of doing things (Tsoukas & Vladimirou, 2001, p. 983). For example, although two customers may have the same query, the operator may not approach both in the same way, especially if the one customer is calm and the other is frustrated. Although the same solution may be proposed, the operator must use a different approach if s/he wants to effectively address the particular customer's concern.

These findings are supported by an action research study of Martensson and Lee (2004), which focused on how Martensson and the managing director of a European company interacted dialogically in response to arising situations. The researchers noticed that “the practitioner's

experience, expertise, and tacit knowledge, or praxis, largely shapes how he understands the suggested actions and appropriates them as his own” (ibid., p.507). Through dialogical interaction, the practitioner learned about organizational theory from the researcher. However to use theory, the director had to “read the situation at hand” and judge how the theory could be applied in relation to the organization’s unique circumstances. As Shotter and Tsoukas (2014) show, to be able to judge effectively (especially in ambiguous situations), individuals not only harness technical skills and taken for granted values (e.g. concerning justice), but they also attend to their emotions.

Indeed, a key reason that skillful performance depends on contextual nuances is because individuals become skilled through socialization in sociomaterial practices. In an empirical study of the UK National Health System, Pyrko and colleagues (2017, p. 390) illustrate that for communities of practice to function, practitioners need to “think together”. The latter is achieved by learning “to be interlocked on the same cue”. In other words, to skillfully carry out a task in alignment to others’ actions, requires individuals to dwell in the same subsidiary particulars, since such indwelling enables individuals to share their focal awareness. For example, for doctors to discuss the details of carrying out a procedure (e.g. nephrostomy) on a patient, they must share the same understanding (Oborn & Dawson, 2010). Likewise, in an empirical study of corporate lawyers, it was shown that practice is so interlocked with taken-for-granted knowledge that professional competence should properly be understood as a way-of-being that enables the spontaneous relating of lawyers to arising situations, based on tacit professional understandings (Sandberg & Pinnington, 2009). Similarly, Gherardi and Nicolini (2000), illustrate that the proliferation of safety knowledge in the Italian construction industry is a matter of ongoing socialization via repeated micro interactions among staff. Although individuals may initially have different conceptions of safety, they gradually learn to perform safety in a shared way through constant feedback from seasoned peers.

Discussion

In this review, our main goal has been to grasp the different understandings of tacit knowledge in management and organizational research, trace them to the onto-epistemological assumptions researchers make concerning the nature of knowledge and action, and suggest a framework that enables researchers to get a coherent understanding of the diverse literature. In this section, we discuss (i) the commonalities and differences between the three perspectives identified, (ii) methodological implications, and (iii) directions for future research.

Commonalities across the Three Perspectives on Tacit Knowledge

We identify three common themes across the three perspectives: firstly, TK is key to organizational and individual performance; secondly, TK is necessarily related to individuals; and thirdly, sharing TK is fundamental for cooperative action in and across organizations. We discuss each of the themes below.

Tacit Knowledge and Performance. Evidence across the perspectives suggests that the vast majority of researchers accept the importance of TK for enabling individual and organizational performance (Ambrosini & Bowman, 2001; Ebbers & Wijnberg, 2009; Sternberg, 1997; Tsoukas, 1996). In the Conversion perspective, this is evident in studies conducted across different contexts, ranging from sporting (Berman et al., 2002) to new product development (Bierly, Damanpour, & Santoro, 2009; Helfat, 1994, 1997) and management (Ambrosini & Bowman, 2005; Armstrong & Mahmud, 2008; Feller et al., 2013). Similar results are evident in empirical studies in the Interactional perspective (e.g. violin making and mining, see Cattani et al., 2013; Kamoche & Maguire, 2011) and Practice perspective (e.g. complying to safety in the construction industry, treating patients, practicing corporate law and customer service, see Gherardi & Nicolini, 2000; Oborn & Dawson, 2010; Sandberg & Pinnington, 2009; Tsoukas & Vladimirou, 2001).

Moreover, scholars accept that the tacitness of knowledge has additional benefits to enabling performance. Conversionist and Interactionalist scholars maintain that tacitness confers individuals and firms hard-to-imitate advantages, across a variety of contexts, ranging from the technology sector to management learning (Blackman & Sadler-Smith, 2009; Coff et al., 2006; Kamoche et al., 2014; Schilling & Steensma, 2002). This is because TK is “sticky” (Brown & Duguid, 2001, p. 199; Griffith et al. 2003, p. 271), that is TK is inherently difficult to imitate and transfer beyond its originating context due to its embeddedness in particular bodies and settings (Galunic & Rodan, 1998, p. 1196; Salomon & Martin, 2008, p. 1267). Moreover, all perspectives not only recognize that TK is key to performance but, implicitly or explicitly, accept that tacitness enables *spontaneous* performance. This is important because it enables agents to respond to situations with minimal time and effort (Collins, 2006; Ebbers & Wijnberg, 2009; Inkpen & Dinur, 1998; Shotter, 2005; Tsoukas, 2011).

Tacit Knowledge and Individuals. Studies across the three perspectives highlight that TK is necessarily related to individuals. A number of Conversionist researchers maintain that TK is “obtained or held by individuals” (Lindley & Wheeler, 2000, p. 361), which, when aggregated, makes up the stock of TK in organizations (Feller et al., 2013; Griffith, Sawyer, & Neale, 2003; Hedlund, 1994; Kale & Singh, 2007; Kalnins & Mayer, 2004; Moreno-Luzón & Begoña Lloria, 2008; H. Singh et al., 2016). Similarly, Interactional researchers, despite their particular emphasis on collective-level TK, accept that TK, being embedded in bodily and cognitive schemata, also resides at the individual level (Collins, 2010; Cook & Brown, 1999; Dörfler & Ackermann, 2012; Ribeiro & Collins, 2007; Tywoniak, 2007). Likewise, although Practice scholars maintain that knowledge is inherently social, they emphatically underscore the *personal* nature of knowing (D’Eredita & Barreto, 2006; Pyrko et al., 2017; Tsoukas, 2009a), since it is an agent’s tacit integration of focal and subsidiary awareness that makes knowledge possible (Polanyi & Prosch, 1977, p. 44; Tsoukas, 2011, p. 457).

Sharing Tacit Knowledge. Scholars across the three perspectives agree that sharing TK is necessary for cooperation in and across organizations. This is so insofar as sharing TK allows organizational members to have a common point of reference, which facilitates communication and coordination (Enberg et al., 2006; Hong, 2012; Leonardi & Bailey, 2008; Pyrko et al., 2017; Subramaniam, Rosenthal, & Hatten, 1998). It is accepted that first-hand experience of carrying out an activity is a major way of learning TK (Collins, 2006; Gherardi & Nicolini, 2000; Kim & Kogut, 1996; Nonaka & Takeuchi, 1995; Raelin, 1997; Swart, 2011). However, scholars from the Conversion and Interactional perspectives view TK as a type of non-systematized and not easily shareable knowledge. As a result, the tacit nature of TK is seen to pose challenges when diverse agents seek to cooperate (Akbar & Tzokas, 2013; Gerwin & Ferris, 2004; Gray et al., 2015; Inkpen & Pien, 2006; Lei et al., 1996).

Despite the challenges posed by tacitness, studies from all three perspectives highlight that TK can, indeed, be shared. Scholars from all perspectives agree that social interaction is the key mechanism for the transfer and acquisition of TK. As part of social interaction, trust is underlined as a key condition to enable people to share their TK (Becerra et al., 2008; Ivory et al., 2007; Janowicz-Panjaitan & Noorderhaven, 2009; J. J. Li et al., 2010; Pyrko et al., 2017; Tsoukas, 2011). As well as trust, studies from both the Conversion and Interactional perspectives, recognize that motivation to share TK is an important issue (Chuang et al., 2016; Gupta & Govindarajan, 2000; Ivory et al., 2007; Osterloh & Frey, 2000).

Differences across the Three Perspectives on Tacit Knowledge

Despite their commonalities, there are also considerable differences between the three perspectives, which can be traced to their different onto-epistemological assumptions. Specifically, scholars working from each perspective take a different stance on the following three controversies: first, the *separability controversy* (i.e. whether TK can be separated from

explicit knowledge); secondly, the *explication controversy* (i.e. whether TK can be explicated); and thirdly, the *outcome/process controversy* (i.e. whether TK should be best analyzed as a fait accompli or as an ongoing activity). (see Table 3). We expand on each controversy below.

 Insert Table 3 Here

The Separability Controversy. Conversion scholars assume there is separability between tacit and explicit knowledge (Clarysse et al., 2011; Kale & Singh, 2007; Nonaka & von Krogh, 2009). The assumption of the separability of knowledge types influences Conversionist interpretations of how TK is related to performance, individuals, and knowledge sharing. Performance-wise, it is assumed that tacit or explicit knowledge alone is sufficient to carry out a task. For example, having been trained with the master baker, Tanaka internalized the requisite TK that enabled her to knead dough. By contrast, the twisting-stretch metaphor (i.e. a piece of explicit knowledge) was argued to adequately represent the baker's TK to perform dough kneading (Nonaka & Takeuchi, 1995). In turn, explicit knowledge, even of metaphorical nature, was sufficient for engineers to design the bread making machine (cf. Ribeiro & Collins, 2007). Individuals are seen to possess TK, which is stored in their cognitive schemas, but they cannot easily convert it to explicit knowledge (Enberg et al., 2006; Sternberg, 1997). The aggregation of tacit knowledge held by individuals is argued to form the capabilities of organizations (i.e. the ability to accomplish organizational objectives). The tacit or explicit nature of knowledge is seen as both a blessing and a curse. Tacit knowledge is a blessing because it is hard to imitate by competitors (Coff et al., 2006). It is a curse since it makes it hard for employees to share their knowledge amongst themselves, especially if they are embedded in different settings (national, divisional, departmental, etc.), or if they possess different bodies of expertise, and need to collaborate (Inkpen & Pien, 2006). The reverse is true of explicit knowledge: it is a blessing insofar as it is easy to share across individuals and

settings; and it is a curse since competitors can easily imitate it. Therefore, sharing knowledge is seen as a conversion-cum-protection challenge: how TK may be converted into an explicit form and, also, protected from competitors (Dutta & Weiss, 1997; Dyck et al., 2005; Schwens et al., 2011).

Interactional scholars accept the separability between tacit and explicit knowledge, albeit with qualifications. They assume that the different knowledge types have different roles and are shared differently (Cook & Brown, 1999). Individual TK allows people to know how to perform tasks (e.g. haptic sensation of dough-kneading, knowing how to apply engineering techniques to mimic the notion of dough-kneading). Collective TK is related to the taken-for-granted norms of a community (e.g. using established engineering techniques; the implicit norms of the engineering community). Individual explicit knowledge is related to knowing-that (e.g. verbalizing one's understanding of dough kneading through the twisting-stretch metaphor), whereas collective explicit knowledge is related to explicit rules communities may have (e.g. shared engineering terminology). Individual TK is seen to be acquired by the individual through developing cognitive and bodily schemas. Collective TK is seen to be acquired through socialization (Ribeiro & Collins, 2007). TK, at both the collective and individual levels, is seen to be related to organizational capabilities (Cook & Brown, 1999). To a large degree, studies view TK as a resource that must be protected and efficiently harnessed. As a result, sharing TK is studied both from the perspective of the individuals who must build up their cognitive and bodily schemas, and from the perspective of the mechanisms that enable the proliferation of collective knowledge (Hong, 2012; Williams, 2001).

Practice scholars deny the separability of knowledge when an agent is engaged in action. They do not see TK as separate from explicit knowledge, nor as located at different levels of analysis (Shotter, 2005). The focus, rather, is on the continuity of human experience. However, this is not to deny that knowledge shows up differently to agents, depending on how agents are related

to the world (Gourlay, 2006a, pp. 1427–28). Thus, in the midst of action, knowledge shows up as know-how, while, when reflecting retrospectively on action, knowledge shows up as know-that (Yanow & Tsoukas, 2009). Moreover, Practice scholars insist that, even in reflection, explicit knowledge (know-that) is necessarily grounded on tacit knowledge (know-how), albeit a different kind of TK compared to action-related know-how (Tsoukas, 2011).

Practice scholars argue that to be knowledgeable in anything, one must first be socialized into a way of life (i.e. practice), in which people learn to attend from certain subsidiary particulars to become focally aware of an object of perception (Miller, 2008; Tsoukas, 2009a). Thus, for any performance to be possible (ranging from a predominantly physical one such as bicycle riding to a mainly cognitive one, such as strategic planning), TK is seen as a prerequisite. This is because action essentially depends on the agent dwelling in subsidiary particulars that enable focal awareness. Since noticing subsidiary particulars depends on socialization, the individual is seen as always dwelling in social knowledge (Gueldenberg & Helting, 2007).

With regard to knowledge sharing, practice scholars focus on understanding how knowledge is experienced by the agent during the process of refining perception (D'Eredita & Barreto, 2006; Pyrko et al., 2017). Returning to the design of the bread-making machine, in order for the engineers to understand the twisting stretch metaphor, the engineers had to dwell in the haptic experience of kneading dough (see Nonaka & Takeuchi, 1995, p.104). Prior to dwelling in dough-kneading, they could not understand the metaphor (Tsoukas, 2011).

The explication controversy. Each perspective takes a different view on the explication of tacit knowledge. In particular, Conversion scholars maintain that tacit and explicit knowledge are, in principle, mutually convertible to each other. For many, conversion is argued to occur via the SECI process (Nonaka & von Krogh, 2009). Feller and colleagues (2013, p. 316), go so far as to state that “tacit knowledge can be best described as knowledge that has not yet been

abstracted from practice” – it is always waiting to be explicated through conversion. Studies illustrate how TK is convertible and thus explicable, insofar as it is put into words, numbers or any other explicit form (Akbar & Tzokas, 2013; Ambrosini & Bowman, 2001; Dyck et al., 2005; Nonaka & Takeuchi, 1995). The use of quantitative methodologies further reinforces and seeks to operationalize explication (see Birkinshaw et al., 2002; Robins & Wiersema, 1995). Once TK has been converted to explicit, the latter may, in turn, be re-converted to tacit and re-internalized to enable individual performance (Nonaka & von Krogh, 2009). Accordingly, sharing knowledge is studied from the perspective of how individuals and, by extension, organizations, can convert and transfer their tacit knowledge (Dyck et al., 2005).

Interactional scholars accept explication only conditionally and do not consider explication as necessary for sharing TK. Interactionalists maintain that explication depends on the further development of technology and/or the willingness of individuals to share knowledge they keep under their control. Whenever conversion is possible, it should be pursued, but this is not what is most important. What is critical, they argue, is the realization that different knowledge types are not mutually substitutable: converting tacit to explicit knowledge does not obviate the important and independent role of TK in human action (Cook & Brown, 1999; Lam, 2000; Tywoniak, 2007). Different knowledge types need to be joined together in order to perform a task. Knowledge sharing is accomplished through agents drawing on collective TK to bridge the differences in their individual knowledge via dialogue (see Hong, 2012; Rouleau, 2005). Beyond human action, however, Interactionalists accept that the conversion of bodily individual TK to computer-used data can be directly used by AI, as, for example, is the case with robots learning to walk or drive (Aplaydin, 2016; Collins, 2006).

Practice scholars hold a different view on the explication of TK. Denying that TK is convertible, they argue that tacit knowing is a process in which different perceptual elements are integrated in an ongoing fashion (Sandberg & Pinnington, 2009; Shotter, 2005). As

discussed above, Practice researchers highlight the *from-to* structure of perception (Oborn & Dawson, 2010; Pyrko et al., 2017): to be focally aware of an object, one must tacitly integrate various subsidiary particulars. Hence, when one is focally perceiving an object, they are necessarily *not* paying attention to the subsidiary particulars that make focal awareness possible. One can articulate aspects of their TK by reflecting on subsidiary particulars, but that is different from conversion (Shotter & Katz, 1996, p. 230). This is so because *to* articulate something always presupposes tacitly attending *from* subsidiary particulars (Miller, 2008; Tsoukas, 2009a). Thus, for example, as Tsoukas (2005, p. 157) notes, Tanaka's transfer of bread-kneading know-how into Matsushita did not rely on the conversion of her TK, but on re-punctuating the distinctions implicated in the activity of bread-kneading. What happened, Tsoukas (*ibid*, p.157) argues, is that "through her subsequent conversations with the [Matsushita] engineers, Tanaka was able to form an explicit understanding of the activity she was involved in, by having her attention drawn to how the master baker was drawing her attention to kneading – hence to concept of 'twisting stretch'".

In other words, practitioners, aided by dialogical types of interaction that draw their attention to aspects of their experience (Tsoukas, 2009a), re-punctuate their know-how (tacit understandings), thus "seeing connections" (Wittgenstein, 1986, §122) among aspects of their experience their ordinary forms of language made them overlook (Wittgenstein, 1986, §132). Articulating TK via re-punctuation does not mean that TK is fully rendered explicit. It rather means that certain aspects of TK, in particular contexts, have been illuminated, thus entering human discourse. Articulating aspects of TK does not make all the subsidiaries of human action visible, but it does enable an imaginative reconsideration of the premises of human action – it suggests a particular possibility. Of course, other possibilities - other articulations - may be available. The process does not come to an end. From this, it follows that sharing TK is possible

insofar as people draw each other's attention to certain subsidiary particulars that were previously unnoticed (D'Eredita & Barreto, 2006; Oborn & Dawson, 2010; Tsoukas, 2009a).

The outcome/process orientation controversy. Lastly, to a large extent, Conversionist and Interactionalist scholars tend to consider TK as a *fait accompli* (an outcome of an already completed activity), whereas Practice scholars consider TK as an ongoing activity. As a result, different methodological approaches, with different analytical foci, are utilized for researching TK.

Specifically, Conversion and Interactional studies tend to conceptualize TK as an outcome that is systematically related to other outcomes (e.g. performance). Both perspectives favor explanations that are removed from the everyday experience of agents. As a result, individuals, performance, knowledge sharing, and TK itself, are approached as quasi-causally related entities (Griffith & Sawyer, 2010). Examples of outcome-oriented studies include the association of the dimensions of knowledge with organizational structure (Birkinshaw et al., 2002), and technological innovativeness with partnership agreements (Dutta & Weiss, 1997).

Practice studies tend to conceptualize TK as a process. Specifically, TK is understood as *indwelling*: the ongoing process of integration between subsidiary and focal awareness (Tsoukas, 2011). Practice scholars maintain that *indwelling* is an ongoing process that is constantly refined by agents engaging in normatively-bound activities. TK and the sociomaterial context are understood as inextricably intertwined (Gueldenberg & Helting, 2007). Therefore, Practice scholars attempt to describe how it is to be 'inside the moment' of experiencing TK (Shotter, 2005).

Unlike Conversionists and Interactionalists, Practice scholars do not conceptualize TK as a completed process (a resource to be acquired), nor do they seek to identify the effect of one TK characteristic on a performance feature. Practice scholars view individuals as drawing on

TK in order to cope with the dynamic context they inhabit (Sandberg & Pinnington, 2009). To learn to perform in an ever-evolving context, individuals are understood to be gradually eased into practices – to normatively defined ways of performing activities (Gherardi & Nicolini, 2000; Sandberg & Pinnington, 2009). Thus, knowledge sharing is understood as an ongoing reflexive process in which agents learn to make new distinctions by dialogically engaging with others (Tsoukas, 2009a). The strong emphasis on process leads empirical studies to mainly adopt qualitative methodologies to illustrate their insights. Most empirical studies are ethnographies of workplaces. A variety of contexts have been studied, ranging from call centers to hospitals (Oborn & Dawson, 2010; Tsoukas & Vladimirou, 2001).

Methodological Implications

Each perspective orients research towards those elements of TK it identifies as important – that is why onto-epistemological assumptions matter. Our framework alerts scholars that posing the question ‘which perspective is the right one?’ is misleading. Rather, our review suggests that a more fruitful question is: ‘what is it that you want to understand?’ Each perspective sheds light on aspects of TK other perspectives do not (and cannot).

Specifically, Conversion and Interactional studies, by building on an intellectualist onto-epistemological platform, can explain how relevant constructs are related, by examining TK across different settings and larger samples. However, their insights tend to be a-processual and often, in the case of Conversion studies, a-contextual. Inasmuch as process and context are taken into account, it is usually done by highlighting the abstract principles the study seeks to illustrate, not the singularities of agents’ experience (Tsoukas, 2017). Consequently, Conversion and Interactional studies focus on TK not as an ongoing activity but as an outcome - an *already completed* process (Langley & Tsoukas, 2017). Indeed, the main value of Conversion and Interactional studies is to provide outcome explanations (Mohr, 1982; Tsoukas

& Knudsen, 2009), that is, they show TK to be systematically related to other constructs usually on a macro-scale. However, outcome-focused studies tend to offer their insights without exploring the intervening mechanisms in depth (Elster, 2015; Tsoukas & Knudsen, 2005).

Practice studies may complement the findings of outcome-focused Conversion and Interactional studies by zooming into the micro-processes that underpin TK from the viewpoint of the engaged agent (see Pyrko et al., 2017; Tsoukas, 2009a). By building on a phenomenological onto-epistemological platform, TK is not researched as a *fait accompli*, but as an ongoing accomplishment (Gehman et al., 2013; Tsoukas & Chia, 2002). The main value of the Practice perspective, is elucidatory (see Tsoukas, 2017) – it seeks to offer process-sensitive and contextualized accounts of how agents use and experience TK (Tsoukas, 2019). However, due to the contextual specificity of Practice studies the generalizability of their findings may be limited across contexts. Since the dominance of the Conversion and Interactional perspectives has resulted in knowing more about the properties of TK *in abstracto*, we know less about how TK is enacted *in concreto* (Sandberg, Rouleau, Langley, & Tsoukas, 2017). In that sense, there is considerable scope for more research from within the Practice perspective.

In the rest of this subsection we discuss the differences between explaining outcomes and elucidating processes (Tsoukas & Knudsen, 2005), as well as new methodological approaches.

Identifying Outcomes from the Outside: Researching outcomes is especially suitable for scholars seeking to theorize TK via the identification of patterns of association of variables across large samples. Since Conversionists and Interactionalists tend to adopt an intellectualist onto-epistemology, they abstract the unique features that characterize a phenomenon, in order to subsume them under generic categories that have already been defined in the literature (Tsoukas, 2009b, p. 286). This is useful insofar as it generates theory that is generalizable

across contexts (Eisenhardt & Graebner, 2007). As a result, claims from studies utilizing these methods are especially useful for understanding how TK is related to outcomes ranging from individual and organizational performance to knowledge transfer. However, although valuable, outcome-centered studies are unable to capture *how* TK related processes lead to the observed outcomes (see Tsoukas, 2017).

Capturing the Process from Within: Process-oriented research is especially suitable for scholars seeking to theorize TK as an ongoing accomplishment: how sociomaterially grounded agents carry out their organizational tasks in context (Langley & Tsoukas, 2017). Traditionally, qualitative methods are used to capture the tacit knowing from within. Methodologies include the use of case studies and ethnographies, drawing their data from interviews, field observations and archives. This approach offers rich contextualized accounts of how TK-related phenomena unfold by being sensitive to the uniqueness of particular cases (see Martenson & Lee, 2004; Oborn & Dawson, 2010; Sandberg & Pinnington, 2009).

The Practice perspective is particularly well equipped to address process questions (Langley & Tsoukas, 2017), since it focuses on how agents draw upon TK to carry out their organizational tasks. The emphasis is on how the TK-related phenomenon unfolds in relation to each case's specificity and uniqueness. Instead of searching for associations between already-accomplished outcomes, practice-oriented research seeks to capture how "outcomes" are produced and sustained (Tsoukas, 2017). The emphasis on contextual uniqueness enables practice-based studies to research a phenomenon in depth by seeking to overcome unnecessary dualisms (Tsoukas, 2017). Thus, practice studies illustrate how individual TK is inseparable to collective TK (Pyrko et al., 2017), how TK, although non-abstractable, is partially articulable (Gherardi & Nicolini, 2000), and how TK is essentially (non-contingently) shaped by context (Sandberg and Tsoukas, 2011).

New Methodological Approaches. Researchers are encouraged to use a wider range of methods than hitherto used to study TK. Irrespective of their onto-epistemological commitments, scholars could utilize mixed methods to address a wide range of questions. Although seven studies that adopt an intellectualist onto-epistemology have used mixed methods, this does not mean that studies adopting a phenomenological onto-epistemology cannot also use mixed-methods to answer process-oriented questions (Almeida et al., 2002; Attewell, 1992; Dyck et al., 2005; Kidd, 1998; Lecuona & Reitzig, 2014; Munoz, Mosey, & Binks, 2011; Wang & Ramiller, 2009). Although phenomenological studies predominantly use case studies and ethnographies to study TK processes, value can be found in less popular methods such as conversation and discourse analyses, which have rarely been used (cf. Rouleau, 2005; Wang & Ramiller, 2009). The benefit of such methods is that they enable a closer, in-depth focus on micro-practices and micro-processes (see Alvesson & Kärreman, 2000). Discursive approaches, in particular, can be used in the other direction as well: to illuminate some of the macro-issues that impinge on TK use. For example, institutionalized understandings of important issues (e.g. corporate responsibility, disruptive innovation, professional competence) and taken-for-granted ways of thinking and acting at the level of institutional fields can be fruitfully analyzed via discourse analyses (Chia, 2000, pp. 514–515; see Phillips, N., Lawrence, T. B., & Hardy, 2004) to show how the knowledge categories used in organizational practices are constructed (Gehman et al., 2013). Moreover, methods such as computer simulations have also been rarely used and could be employed to offer new ways of examining questions about TK (Miller et al., 2006).

Directions for Future Research.

Our review of research on TK has enabled us to shed light on the under-researched topics and under-utilized perspectives that lend themselves for further research. Below, we suggest new directions research on TK may take.

Context and the Operationalization of TK. In light of our review, to explicate TK through quantitative methodologies does not preclude the study of TK in context. Contextual features, especially in quantitative studies, are usually relegated to a peripheral status. As findings from studies that have taken into account contextual features are limited, further research is required (cf. Lecuona & Reitzig, 2014; Shamsie & Mannor, 2013). In line with these observations, and in conjunction with calls for better operationalization (direct and indirect) of TK (Ambrosini & Bowman, 2001; Levitas & Chi, 2002; Munoz et al., 2011), the latter can be improved if scholars specify which ability/skill and organizational process TK is related to. Methodologically, a notable exception to the downplaying of context, at least on the individual level, are situational judgement tests because to a certain extent they can take into consideration situational circumstances (see Krumm et al., 2015).

Interrelatedness of Knowledge Types. Although the Interactional perspective assumes that different knowledge types (e.g. somatic TK, collective TK) are joined together to contribute to skillful action, beyond conceptual studies, there is little empirical work examining this dimension (Collins, 2006, 2010; Cook & Brown, 1999; cf. Gerpott et al., 2017). Therefore, empirical studies could examine how and what the effects of joining knowledge types together are on both the individual and collective levels. Questions that empirical studies could focus on include: What conditions facilitate the sharing of particular types of TK (somatic, collective, relational)? Are different social contexts more effective in sharing particular types of TK?

Indwelling, Embodiment, and Sociomateriality. Indwelling, although widely accepted and referenced, has not been used extensively and consistently by management scholars (cf. Miller, 2008; Oborn & Dawson, 2010; Pyrko et al., 2017; Tsoukas, 2011; Tsoukas & Vladimirou, 2001). The study of indwelling treats TK not merely as articulable or as an ineffable resource, but as an embodied and embedded capacity that is ever refinable over time via discursive interaction (Tsoukas, 2009a, 2011). The embodied and sociomaterial nature of TK are

recognized as important in the Interactional and Practice perspectives. However, despite their acknowledgment, in most studies, embodiment and sociomateriality have not been the core focus (cf Kamoche & Maguire, 2011; Sandberg & Pinnington, 2009; Maitlis & Christianson, 2014, p. 100; Orlikowski & Scott, 2008, p. 466). Future studies could elaborate on how embodied TK is acquired and developed in organizational settings, and how this is mediated by the context's sociomaterial infrastructure.

Knowledge Sharing. As discussed above, a wide variety of methods for helping people acquire TK have been studied (e.g. web-based instruction, practical experience, simulations games). However, further research could further evaluate whether the effectiveness of imparting TK by using web-based, classroom instruction and computer based simulations depend on the type of skill they seek to teach. Another question, which has not been considered so far, is whether the combination of the methods and the timing of use of each could increase the acquisition of TK (e.g. Szulanski et al., 2016). Moreover, with an increasingly aging workforce in rich countries, further attention needs to be paid to how teaching methods fit trainee learning styles and age groups (Armstrong & Li, 2017, p. 19; Gerpott et al., 2017; Ng & Feldman, 2008).

Furthermore, process-sensitive research could complement the above outcome-focused research by developing a better understanding of the practices of learning and teaching (see Raelin, 2007). Research in this direction is scarce despite some scholars arguing that TK is shared by people drawing each other's attention to aspects of situations that were previously unnoticed (see D'Eredita & Barreto, 2006; Oborn & Dawson, 2010; Pyrko et al., 2017; Tsoukas, 2009a). The continuation of these efforts is strongly encouraged because pursuing a process-sensitive approach could assist to further clarify the processes with which each teaching method and learning style enables trainees to acquire TK and, as a result, identify and encourage best practices.

Emotions and Tacit Knowledge. As previously outlined, the relevance of emotions to sharing TK has received a great deal of attention from scholars adopting the Conversion and Interactional perspectives. Beyond implications for knowledge transfer, research on the relatedness of emotions and TK is limited (cf. Shotter & Tsoukas, 2014). The Practice perspective is especially suitable for further investigating this topic, especially since practice studies show that individuals *care* about what they do (see Gherardi & Nicolini, 2000; Sandberg & Pinnington, 2009). Although the emotional background of TK has been pointed out (expertise develops to the extent people *care* for what they do), research remains scarce about how relevant emotions develop, with what effects.

TK and Artificial Intelligence (AI). All three perspectives have researched TK in relation to a broad domain of constructs, contexts and practices. However, none of the reviewed studies has focused on exploring the development of AI in relation to TK in the workplace. AI applications can now reliably offer medical diagnoses, win against humans in certain board games, and are even learning to drive (Aplaydin, 2016; Silver et al., 2016; von Krogh, 2018). What do such developments imply for TK in organizations? The distinctions drawn in this review allow us to address this question.

Employing an intellectualist onto-epistemological prism (Dreyfus, 1988) (as manifested in the Conversion and Interactional perspectives), computer scientists can partly capture knowledge that is taken for granted by experts in certain domains (in the form of sound, text, images and numbers), which can then be fed into AI algorithms (von Krogh, 2018, p. 405). By continuously inputting the latter, an AI system learns from repetition and/or feedback from their environment to perform certain tasks. Tasks include performing analyses to identify patterns or achieve a structured pre-specified goal (e.g. a medical diagnosis). This has enabled AI to do rather well in highly structured domains (in which clear rules are in place), such as board games and diagnosing pathologies from images (ibid., p.405). However, AI is limited in understanding

context and, thus, does not respond effectively (yet, at least) to contextual changes and nuances. In general, “machine performance may degrade dramatically if the original task is modified even slightly” (Shoham, Perrault, Brynjolfsson, Clark, & LeGassick, 2017, p. 37).

The Practice perspective allows us to understand that contextual sensitivity, which is major feature of TK, is still highly relevant to action in organizations (Dreyfus & Dreyfus, 2005). Even when AI empirically assists in the carrying out of tasks, a contextually sensitive practitioner (who dwells in TK) is still necessary to judge whether AI is relevant to a problem (von Krogh, 2018, p. 406) and, if so, make sense of the computations (especially in open-ended tasks) and undertake reflective action (Ribeiro, 2017). For example, AI may be able to diagnose skin cancer, but the diagnosis does not mean anything to the AI system. A medical practitioner is required to make sense of the diagnosis and sympathetically suggest a treatment to the patient. To do this, the practitioner must *dwell in* the shared normative distinctions that are prevalent in their practice.

The everyday world of human agents is not experienced as a set of contingently interrelated facts (Dreyfus, 2017). Rather, it is experienced as a meaningful ensemble (a relational whole) wherein perceiving the usefulness of various objects (i.e. what they are for) presupposes *indwelling* – immersion in practices and skills. A skin cancer diagnosis, for example, may suggest physical and psychological suffering and the possibility of death. Such consequences have an experiential quality and valence that cannot be captured by merely stating facts (see Nagel, 1974). Medical practitioners are called to pick up and suggest a course of treatment to the patient, as well as sustain the patient’s cooperation throughout by sympathetically attending to those human-related issues that are beyond the grasp of algorithms (e.g. psychological state of patient).

In short, the possibility of holding and analyzing vast amounts of data does not render TK irrelevant to organizations, far from it. To be skilled entails to have acquired contextual sensitivity; it is not simply a matter of knowing facts, but knowing which facts are relevant to what situation, and act on that knowledge competently (Dreyfus, 2007, p. 248). This is not done on the basis of strict rule following but on the basis of judgement (Ribeiro, 2017; Shoter & Tsoukas, 2014). As Ryle (1949) has insightfully argued, to be knowledgeable is not equivalent to be a rule follower: to be able to apply a rule, one would have to rely on another rule for applying the first rule, and so on ad infinitum.

Rather than making TK irrelevant, the introduction of AI to the workplace highlights the need for developing new skills that reap the benefits of AI, while *maintaining* individuals' critical capacity for *situational discretion* and *human meaning* in the deployment of AI and the use of AI-generated outputs. Advances in AI are speeding processes up, transforming expertise, work boundaries, control and decision making (Barrett, Oborn, Orlikowski, & Yates, 2012; Beane & Orlikowski, 2015; Faraj, Pachidi, & Sayegh, 2018; von Krogh, 2018). Despite these developments, we know little about how advances in AI are changing the development and use of TK in the workplace (e.g. creating new skills while making others redundant). Outcome-focused approaches, as manifested by the Conversion and Interactional studies, could illuminate the effects of AI on TK-related phenomena (e.g. knowledge sharing and knowledge creation). Practice studies could illuminate the micro-processes with which AI is transforming TK the workplace. For example, how is AI-related TK acquired? What difference does the acquisition method make to how TK it is put into practice?

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TABLE 1

Assumptions of Perspectives on Tacit Knowledge (TK)

	Conversion	Interactional	Practice
Image of Knowledge	Outcome	Outcome	Process
Relationship between tacit and explicit knowledge	Tacit and explicit knowledge are interchangeable and mutually convertible	Tacit and explicit knowledge must be joined together	All knowledge is grounded in tacit knowledge
Locus of Study	Primarily Individual	Individual-cum-Collective	Agent embedded in practice

TABLE 2

Overview of Perspectives

Conversion Perspective	
Key Concepts	
Tacit Knowledge	A type of knowledge that is subjective, largely inaccessible to consciousness, tied to activity and awaiting conversion into an explicit form.
Explicit Knowledge	A type of knowledge that is objective, accessible to consciousness and in close correspondence with theory.
Group/Organizational Tacit Knowledge	A type of knowledge that is difficult to articulate and is the result of the combination of individual cognitive schemata acquired through mutual experience.
Primary Mechanism	
Conversion	Conversion of tacit knowledge into explicit knowledge and vice-versa. It is the key to becoming aware of tacit knowledge and being able to share it.
Research Streams	
Foundational	Outlines key assumptions of the perspective e.g. Nonaka and Takeuchi (1995). Through the discussion of different empirical cases, the authors illustrate the importance of tacit knowledge and the process of how it is converted to explicit knowledge and vice-versa.
Performance	Outlines the links between tacit knowledge and performance e.g. Shamsie and Manor (2013). Through an analysis of data from Major League Baseball teams, the authors provide evidence of the importance of TK to team performance.
Knowledge Management	Outlines ways of managing tacit knowledge in and across organizations e.g. Lam (1997). The author suggests that the explication of tacit knowledge, is essential to make it “easily understood and accessed by those who do not share a common experience or background” (p.987).

Strategy	Outlines the links between tacit knowledge and strategic decisions (e.g. planning, mergers, acquisitions and organizational structure). e.g. Le Breton-Miller and Miller (2015). The authors highlight that organizations should pay attention to the vulnerability of their resources (e.g. tacit knowledge and its ambiguity). To counter this issue, the authors suggest that organizations should strategize ways to codify and share tacit knowledge.
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Interactional Perspective

Key Concepts

Tacit Knowledge	A type of knowledge largely inaccessible to consciousness, tied to activity that can only be conditionally converted.
Explicit Knowledge	A type of knowledge that is objective, accessible to consciousness and in close correspondence with theory.
Individual Tacit Knowledge	Tacit knowledge which is part of the cognitive and bodily schemata of individuals.
Collective Tacit Knowledge	Tacit knowledge embedded in norms of appropriateness; it is manifested in stories.
Individual Explicit Knowledge	Information/facts known by individuals.
Collective Explicit Knowledge	Information/facts shared by groups.

Key Mechanism

Interaction	Actions require the individual to join together tacit/explicit and collective/individual types of knowledge.
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Research Streams

Foundational	Outlines key assumptions of the perspective. e.g. Cook and Brown (1999). The authors argue that organizations can be better understood when explicit, tacit, individual and group knowledge are treated as four separate, but equal types of knowledge, which are enjoined through knowing during action.
Knowledge Sharing	Outlines ways of sharing tacit knowledge in and across organizations. e.g. Ribeiro and Collins (2007). The authors revisit the classic case of bread-making machine. Instead of conversion, they maintain that different types of tacit knowledge were joined together to design the bread-making machine.

Practice Perspective

Key Concepts

Tacit Knowledge	Knowledge that is hard to express and be conscious of, which stems from the constant process of indwelling.
Explicit Knowledge	Partially articulable knowledge which is embedded in tacit knowledge.

Key Mechanisms

Indwelling The spontaneous integration of focal and subsidiary awareness in the act of knowing.

Practice Normatively defined, taken for granted ways of performing activities and using language.

Research Streams

Foundational Outlines key assumptions of the perspective.
e.g. Brown & Duguid (2001). Through the lens of communities of practice it is suggested that epistemic differences are the result of different practices, rather than different types of knowledge (e.g. tacit/explicit).

Skill Outlines how practitioners experience tacit knowledge in organizations.
e.g. Tsoukas & Vladimirou (2001). By drawing on a case study of a telecommunication organization, the authors argue that organizational knowledge is simultaneously social and personal.

TABLE 3
Differences of Perspectives on Tacit Knowledge

Onto-Epistemological Assumptions	Intellectualist <i>Emphasis on abstraction</i>		Phenomenological <i>Emphasis on experience</i>
	Conversion	Interactional	Practice
Separability Controversy (Tacit knowledge and other related constructs as separable entities)	Separable (tacit/explicit)	Separable (tacit/explicit & individual/collective)	Non-separable (tacit and explicit knowledge mutually defined)
Explication Controversy (Tacit knowledge is potentially transformed to other types of knowledge.)	Explicable (unconditional conversion)	Explicable (conditional/pragmatic conversion)	Not explicable (partially articulable, but not convertible)
Outcome/Process Orientation (Scholarly accounts emphasize outcomes or process.)	Outcome	Outcome	Process
