

Theories of mind and personal epistemology: their interrelation and connection with the concept of metacognition

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Abstract This paper seeks to highlight the links and discrepancies between three contemporary theoretical fields. The first part is devoted to theories of mind and personal epistemology. Both fields deal with naïve theories relating to the nature of knowledge and can be integrated within the concept of *folk epistemology* (Kitchener New Ideas Psychol 20:89–105, 2002). We argue that analyzing both domains from a developmental perspective may provide evidence for the origins of epistemological beliefs and the reasons for their evolution. The second part of the paper extends the discussion to the concept of metacognition and to its potential links with the two previously mentioned fields. In the past, theories of mind and metacognition have mainly developed as independent fields, but recent studies have highlighted a possible developmental lineage between them that needs further investigation. As the influence of the procedural component of metacognition (the regulation process) seems obvious in the personal epistemology perspective, we suggest that conducting more in situ studies will enable us to deepen our understanding of the links between the multiple components of the epistemological perspective and the reasons for epistemic change.

Résumé Cet article vise à éclairer les liens et divergences possibles entre trois courants théoriques contemporains. La première partie est consacrée aux théories de l'esprit et à l'épistémologie personnelle. Les deux courants s'intéressent aux théories naïves relatives à la connaissance et peuvent être intégrés sous le concept d'épistémologie populaire (*folk epistemology*, Kitchener New Ideas Psychol 20:89–105, 2002). Nous défendons l'idée selon laquelle analyser les deux domaines dans une perspective développementale permet de

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mieux cerner les origines des croyances épistémiques et les raisons de leur évolution. La deuxième partie de l'article étend la discussion au concept de métacognition et envisage de possibles liaisons avec les deux champs susmentionnés. Par le passé, les théories de l'esprit et la métacognition se sont développées essentiellement comme des champs de recherche indépendants. Des études récentes ont permis d'éclairer une possible continuité développementale entre ces champs, ouvrant dès lors la voie à de nouvelles investigations. Dans la mesure où la composante procédurale de la métacognition (le processus de régulation) semble assez clairement présente dans le champ de l'épistémologie personnelle, nous suggérons de conduire davantage de recherche in situ en vue d'approfondir notre compréhension des liens entre les multiples composantes de la perspective épistémologique ainsi que des éléments explicatifs des changements épistémiques.

Keywords Knowledge · Metacognition · Personal epistemology · Regulation · Theories of mind

Introduction

This paper seeks to highlight links and discrepancies between three contemporary theoretical fields: theories of mind, personal epistemology and metacognition.

The first part of the paper deals with *theories of mind* and *personal epistemology*, two fields that Kitchener (2002) proposes to unify under the term of *folk epistemology*, an integrator concept that he defines as 'the ordinary ('folk'), common-sense theory of knowledge present in the average person' (Kitchener 2002, p. 89). Ever since the 1980s, theories of mind have been a flourishing field of research, as shown by the numerous publications on this topic. Flavell (1999) contributed an interesting summary article, published in the *Annual Review of Psychology*. He calls this field 'one of the liveliest, most productive research areas in all developmental psychology' (Flavell 2000, p. 16). The complex area of personal epistemology was presented by Hofer and Pintrich (1997) in a famous paper published in the *Review of Educational Research* and was also the subject of a book by these same authors in 2002 (Hofer and Pintrich 2002), as well as the focus of a special issue of the *Educational Psychologist* (Hofer 2004a). Largely on the basis of these theoretical papers, Crahay and Fagnant (2007) have recently proposed a synthesis of this topic in French. After a brief presentation of these two fields, this paper attempts to demonstrate the relevance of considering theories of mind and personal epistemology as part of a developmental trajectory; this enables the emergence of new views on the origins of epistemological beliefs and the reasons for their evolution.

The second part of the paper extends the discussion to the concept of *metacognition* and to its potential links with the two previously mentioned fields. We will first lay out why it may be possible to consider that folk epistemology is part of the declarative component of metacognition. Afterwards, we will present discrepancies and potential developmental links between metacognition and theories of mind, and we will end the chapter by investigating the potential influence of the procedural metacognitive process (the regulation process) within the epistemological perspective.

We believe that highlighting the links between different theoretical fields will help unify these three strands of the psychological universe and, consequently, encourage researchers to conduct new investigations in order to explore developmental trajectories from the birth of theories of mind to the development of epistemic reflection, with a focus on the role of metacognition within this process.

‘Theories of mind’ and ‘personal epistemology’

While theories of mind and personal epistemology are completely independent in their origin, they present interesting similarities, mainly because both deal with the nature of knowledge and knowing. This part of the paper proposes a brief incursion into each of these two fields, and then tries to discuss possible links and discrepancies between them.

Theories of mind

Theories of mind explore how children construct their understanding of the mental world. Astington (1999) states that, in order to discover what is the mind, a child must find out two important things: what the mind *is* (needs, desires, emotions, intentions etc.—the mind is the totality of these mental states; in other words, the totality of these representations) and what the mind *does* (it represents, i.e. it produces mental states).

According to Wellman (1990), understanding the mind is a major accomplishment of childhood; it is an essential step towards a series of subsequent conceptual developments. An understanding of the mind is also fundamental in order to develop an understanding of the social world (Astington and Jenkins 1995).

When we speak of theories of mind, we are referring to a naïve, popular or common-sense psychology; we are speaking about *folk psychology* or psychology of beliefs and desires (Wellman 1990; see also, Wellman et al. 2001).

Research on theories of mind has been related to a multitude of domains concerning the developments occurring during early childhood, and, a bit later, during the pre-school period and early primary schooling (Flavell 1999, 2000). Knowledge and beliefs are interrelated concepts, which both belong to the broad domain of emotional and cognitive concepts studied in a ‘theories of mind’ perspective (aside from ‘desires’, ‘emotions’, ‘pretence’...). In a paper published in 1992, Montgomery proposed a summary of the contributions relating to the nature of knowledge (and beliefs), taken from papers about theories of mind (see also, Miller 2000). Montgomery was therefore the first to propose the term *folk epistemology* to describe that part of *folk psychology* (i.e. theories of mind) that is specifically concerned with the nature of knowledge and its acquisition. As mentioned at the beginning of this article, the expression *folk epistemology* was later adopted by Kitchener (2002) with a different breadth of meaning, in reference to the combination of two fields of research: personal epistemology as well as constructs and empirical results from theories of mind relating to knowledge (and knowing).

Personal epistemology

‘Personal epistemology [is] a field that examines what individuals believe about how knowing occurs, what counts as knowledge and where it resides, and how knowledge is constructed and evaluated’ (Hofer 2004a, p. 1). The term ‘personal epistemology’ refers to different theoretical approaches, which are still not functioning in synergy and which use different terminologies.

Historically, the concept was first characterized as a cognitive developmental process. The researchers adopting this approach (King and Kitchener 2002, 2004; Kuhn 2000, 2001, in particular) consider that individuals progress ‘through a developmental sequence that reflects an evolving ability to coordinate the subjective and objective nature of knowing’ (Hofer 2004b, p. 44). Perry’s work in the 1950s is often mentioned as the starting point of the developmental field. On the basis of interviews with college students from his own university,

Perry elaborated a nine-step model, which is usually summarized in four sequential stages called ‘*dualism*’ (or *absolutism*), ‘*multiplicity*’, ‘*relativism*’ and ‘*commitment with relativism*’ (see Hofer and Pintrich 1997, for a synthesis of Perry’s work). In a first stage, individuals consider knowledge in a black or white perspective: They set what is true against what is false, and knowledge is conceived as definitive and absolute. In a second stage, the knower becomes aware of the uncertainty of knowledge. The individual accepts that a plurality of points of view exists in some areas, such as opinions (but not in others, such as science, for instance); he/she recognizes that knowledge may be uncertain, but this uncertainty is provisional while waiting for the absolute truth. In a third stage, the recognition of plurality of viewpoints gives birth to a period of extreme subjectivity, when knowledge is considered to be a matter of opinion and any opinion is placed on the same level as any other. Finally, to reach the ultimate stage, individuals have to recognize that certain points of view or positions may be supported by scientific arguments, facts or material proofs, and are therefore of greater value than others. In most models, the final stage is characterized by a vision according to which knowledge is actively built by the subject, thus suggesting a reconciliation between the objective and subjective aspects of knowledge. According to traditional research in the developmental perspective, students generally move through these different stages during their university training.

In contrast with the developmental models, Schommer (1990) suggests that personal epistemology may be viewed as a collection of more or less independent beliefs, which do not necessarily evolve in a synchronous developmental pattern. From this point of view, the usual methodology consists in asking subjects to position themselves on a Likert-type scale with regards to various questionnaire statements. The underlying idea is that beliefs are cognitive *constructs* that can be accessed by the individual and sufficiently consistent and stable to be measured in a decontextualized way. Schommer’s work highlighted four cognitive constructs summarized as follows (Hofer and Pintrich 1997): ‘*Fixed ability*’ (intelligence is perceived as a fixed entity versus intelligence is incremental and can be improved); ‘*Quick learning*’ (learning has to occur quickly or it will never occur versus learning as a gradual process); ‘*Simple knowledge*’ (isolated vs highly interrelated concepts) and ‘*Certain knowledge*’ (knowledge is certain and absolute vs knowledge is tentative and evolving). According to Hofer and Pintrich (1997; see also, Hofer 2004b), some constructs are genuinely embedded in the field of personal epistemology but others—such as ‘quick learning’, for instance—belong to another related domain. Nonetheless, one of the significant outcomes of this line of research was to link epistemological beliefs with various academic fields (see for instance, Schommer et al. 1992; Schommer and Walker 1995).

More recently, alternative approaches have emerged. One of them considers personal epistemology ‘as beliefs organized into theories’ (Hofer 2004b). This view is important mainly because it is a way to reconcile the developmental perspective and the independent beliefs paradigm: ‘they are potentially compatible views, as beliefs, organised and structured as theories, might be expected to develop over time in somewhat predictably patterned ways’ (Hofer 2004b, p. 45). Hofer (2001, 2004b) views these theories as explicitly multidimensional and constituted of different integrated aspects. According to this point of view, the theory does not simply operate as a sum of beliefs, but reflects an organized way of developing epistemological concepts, both from a general point of view and from a view specific to various fields. The proposed model of epistemological theories consists of four dimensions that were highlighted in a review of both the developmental models and the independent beliefs model (see Hofer and Pintrich 1997, for an analysis of the boundaries of the personal epistemology field). Only those dimensions, which fit into

the conventional definition of epistemology are kept (Hofer 2004b; Hofer and Pintrich 1997); they are clustered into two areas: on the one hand, the nature of knowledge (*certainty of knowledge* and *simplicity of knowledge*) and on the other hand, the nature of knowing (*source of knowledge* and *justification for knowing*).

Possible links and discrepancies between theories of mind and personal epistemology

The nature of knowledge and the nature of knowing are both areas of interest within theories of mind and personal epistemology. However, these concepts do not occupy the same place in both fields. Theories of mind cover a broad area of research, in which the issue of knowledge does not have a central position, although it is not negligible (Flavell 2000). In contrast, researchers in the field of personal epistemology are directly concerned with this question, but combine a variety of theoretical approaches (Hofer and Pintrich 1997; Hofer 2001, 2004a, b). Theories of mind principally focus on early childhood and are mainly interested in children's first understanding of a variety of mental objects (from cognitive and emotional domains). Personal epistemology has historically and primarily focused on the end of adolescence and early adulthood. This field is mainly interested in people's deep understanding of the nature of a cognitive concept (knowledge) and a cognitive process (knowing).

Since the research subjects' ages are consecutive, it is worth trying to place the two areas in a developmental perspective.

From a theoretical point of view, we can imagine at least two possible conceptual links. The issue of *certainty of knowledge* is a common focus of interest that can be investigated in a developmental perspective. In personal epistemology (Hofer 2004b), the dimension 'certainty of knowledge' has to do with the degree to which a person conceives knowledge as fixed or 'malleable', ranging from a point of view where absolute truth exists with certainty to a position where knowledge is experimental, tentative and evolving (Hofer 2004b). In the field of theories of mind, experimental situations are organized to test children's ability to distinguish knowledge (in the sense of empirical evidence) from beliefs (in the sense of a personal idea about a situation). In this kind of paradigm, knowledge differs from other mental states because it is not only true (whereas beliefs may be erroneous) but also certain (the feature that makes it possible to distinguish knowing from guessing—Montgomery 1992). While attempts have been made to reconcile both approaches, one might conceive that a child first needs to consider that knowledge is true and certain (to distinguish this mental state from other types of mental states), then he/she must realize that this certainty is questionable since knowledge does not consist of absolute truth but is relative, contingent and provisional.

The issue of *source of knowledge* provides another interesting example. In most of the developmental models of personal epistemology, this line of research refers to a progression ranging from a vision of knowledge as located outside the person and transmitted by a sensorial experience or by an external authority, to a vision in which the person is viewed as an active constructor of meaning (Hofer 2004b). Source of knowledge is a field widely investigated in research relating to theories of mind (Montgomery 1992; Miller 2000). In some experiments (e.g. O'Neill et al. 1992), the child has simply to identify the source of information, meaning that he/she has to perceive the link between access to the information and knowledge acquisition. For instance, to distinguish two different objects that look the same but feel different; one needs to touch the object to gain access to the relevant information. In other words, if someone can only look at these objects, he/she does not have access to the relevant information allowing knowledge construction (here, simply to

identify the object). In such an experiment, knowledge may be conceived of as residing outside the person; it is transmitted directly by an external individual, typically an adult or a sensory experience (mind receptacle, Wellman 1990). In other experiments (e.g. Sodian 1988; Taylor 1988), emphasis is put on the 'quality of the source of information' or on the accessibility of prior knowledge. For instance, in Taylor's study, a picture representing a giraffe and another representing an elephant are shown to children. Then, the interviewer shows them different pieces of information that represent a part of the picture: some pieces are totally white (no drawing), others represent a part of the picture that is not recognizable by a naïve observer (i.e. someone who didn't see the whole picture before) and the last ones represent a significant piece of the picture (i.e. a part of the animal that is recognizable by everyone, whether he or she has seen the whole picture before, or not). The children are then asked if it is possible for a naïve observer to recognize the animal from the different pieces of information. Children have to understand that the answer depends on the type of information shown to the subject and on his/her own prior knowledge. In other words, the children must understand that two different persons may build a different mental representation on the basis of the same information. More generally, since knowledge is constructed, the same information may be received and integrated differently by two different individuals, depending, in particular, on their prior knowledge and on how the information is processed. With development, knowledge no longer resides outside the person, it is no longer simply 'imprinted' within the individual having access to the source of information. The person is gradually viewed as playing an active role in the construction of knowledge (*mind constructor*; Wellman 1990).

From an empirical point of view, it is interesting to mention a study carried out by Burr and Hofer (2002). In the personal epistemology tradition, few studies were carried out with children, probably because many authors consider that epistemological development seems to begin during late adolescence. Burr and Hofer (2002) question this idea inasmuch that very young children may demonstrate sophisticated cognitive achievements. Indeed, around the age of 4 or 5 years, most children appear to possess a certain theory of mind. 'Within this context, and with recognition that there are undoubtedly certain cognitive precursors to thinking epistemologically', Burr and Hofer (2002, p. 206) claim that 'researchers have much to gain by investigating young children's beliefs about knowledge and knowing'. Curiously, the few epistemological studies conducted with individuals who were younger than those usually questioned for such research have identified similar stages to those observed in older individuals, as if the starting point was the same, regardless of children's age. At the very least, 'it seems counterintuitive that at whatever age we study students, dualism is the initial phase identified' (Burr and Hofer 2002, p. 206). Burr and Hofer (2002) have suggested the existence of an earlier stage, even before the *dualistic perspective*, which is generally considered as constituting the first step of most developmental models. This 'pre-dualist' stage (that hypothetically occurs before the *dualistic* and *absolutist* stage) could be characterized by 'egocentric subjectivity' (Burr and Hofer 2002) or 'naïve realism' (Kuhn 2001).

In order to empirically investigate the origins of epistemic thinking and its relationship to theory of mind, Burr and Hofer (2002) have carried out an explanatory investigation in which they administered measures of both constructs. The participants were 25 children ranging in age from 3 to 5 years old. The authors proposed two types of tasks: (a) 'source-of-knowledge tasks' to assess epistemological awareness (i.e. tasks that require subjects to determine the link between access to the relevant information and knowledge construction) and (b) 'false-beliefs tasks' to assess their theory-of-mind competencies (i.e. tasks that require an understanding of the fact that someone can have a belief different from reality,

i.e. a false belief that is different from factual knowledge). The results have highlighted a developmental progression along three stages: a period of *pre-dualism or naive realism* (when children fail to succeed in both types of tasks); a *transitional dualistic period* (when children succeed in 'source of knowledge tasks' but fail to succeed in 'false-belief tasks') and a *dualistic period* (when children succeed in both types of tasks). Burr and Hofer (2002) argue that the existence of a transitional stage 'provides support for the hypothesis that epistemological awareness is a precursor of theory-of-mind development' (p. 218).

Intuitively, one would think that the developmental lineage would be in the opposite direction and that the acquisition of a theory of mind would be the precursor of epistemological thinking. What is confusing here is that the tasks proposed by Burr and Hofer (2002) to assess the epistemic level of the children are also used in conventional research carried out under the label of theories of mind (see for instance the synthesis proposed by Montgomery 1992). In a recent study, Wellman and Liu (2004) developed a scaling of theories of mind tasks: they tested 75 children (aged from 2 years 11 months to 6 years 6 months) on seven tasks, assessing different aspects of the understanding of individual mental states. One of the proposed tasks was called *knowledge access* (children see what is in a box and have to judge the knowledge of another person who does not see what is in the box), besides a variety of tasks dealing with *false beliefs*, *desires* and *emotions*. The results obtained by Wellman and Liu (2004) confirmed those obtained by Burr and Hofer (2002): the *knowledge access task* was easier (subjects managed it successfully at an earlier age) than the classical *false beliefs* tasks.

While we admit that success in the source-of-knowledge tasks can be considered a sign of 'awareness' of epistemological thinking (a sign that precedes success in false-belief theories of mind tasks), we nevertheless question the impact of other theory-of-mind competencies on a deeper epistemic reflection. More precisely, should we consider the links to be unidirectional or should we assume that the acquisition of the different components of theory of mind and the development of different kind of epistemic reflection may influence each other at the infancy of folk epistemology?

According to the developmental trajectory embedded in the epistemological thinking field, the results of the study conducted by Burr and Hofer (2002) lead them 'to concur with those who have proposed a stage of epistemological development that exists prior to dualism' and they think that their explanatory study 'provides some evidence for a pre-dualistic period of naive realism' (p. 219). This pre-dualistic stage is not characterized by objectivity but, on the contrary, by egocentric subjectivity: young children have a purely subjective view of the world because they think that their perspective is the only one. They fail to succeed in false-belief tasks because they cannot imagine that someone else can ignore what they know. In this sense, we agree with Burr and Hofer (2002) that this pre-dualistic period 'prefaces the achievement of theory of mind' (the child has not totally acquired all the components of a complete theory of mind, but he/she may have already acquired some precursor aspects).

More research is needed on this issue. We hope that the information discussed above convincingly shows that studying the links between theories of mind and personal epistemology may stimulate reflections on the origin of epistemic beliefs and the reasons for their evolution.

Metacognition in theories of mind and personal epistemology

As mentioned above, theories of mind and personal epistemology can be integrated into the wider concept of *folk epistemology* (Kitchener 2002), a field interested in the beliefs

concerning the nature of knowledge and how it occurs (the nature of knowing). Since *folk epistemology* and *metacognition* take place on a meta-level, the relationships between meta-knowledge (or meta-knowing) and metacognition need to be investigated.

Let us consider the definition of metacognition. 'Metacognition was originally referred to as knowledge about and regulation of one's cognitive activities in learning processes' (Veenman et al. 2006, p. 3). In parallel with the idea that *folk epistemology* deals with 'beliefs' about knowledge and knowing, we will speak about 'beliefs' (or 'personal knowledge') about one's cognitive activity.

We follow with Focant et al. (2006) who argue that at present - and despite the diversity of extended definitions and the variety of its uses in numerous studies, most researchers agree with the basic definition of John Flavell, pioneer in this field of research, who described the metacognitive phenomenon along two dimensions : (1) the knowledge (i.e. personal knowledge or beliefs) that an individual possesses concerning his/her own cognitive processes (and the factors that can promote or inhibit those processes); (2) the active control and regulation of these processes in order to achieve a specific purpose. The first part of the definition covers the declarative component of metacognition and the second part refers to the executive or procedural component.

If we accept the idea that knowledge (and knowing) are components of cognition (a particular object of cognition and a particular cognitive process), we can imagine that meta-knowledge (i.e. *beliefs about* the nature of knowledge) and meta-knowing (i.e. *beliefs about* the nature of the process of knowledge acquisition) are included in the declarative dimension of metacognition (i.e. *beliefs about* one's own cognitive processes). But what about the second dimension? Is there a place for the executive component of metacognition in the fields of theories of mind and personal epistemology? To what extent does considering meta-knowledge and meta-knowing as part of the metacognitive field necessarily mean that the different theoretical fields are integrated and reciprocally influence each other?

The following sections attempt to highlight the relationships between metacognition and theories of mind on the one hand and between metacognition and personal epistemology on the other hand.

Metacognition and theories of mind

Flavell (2000, 2004) argues that, from a general point of view, both research traditions share the same general objectives: 'to investigate the development of children's knowledge and cognition about mental phenomena' (Flavell 2000, p. 17). Moreover, Flavell (2000, p. 17) claims that several psychologists consider the terms *theory of mind* and *metacognition* as 'alternative ways of designating the same general set of cognitive phenomena'. Despite these major commonalities, the research literature related to theories of mind and to metacognition have remained surprisingly distinct and unconnected. What are the reasons for this gap?

According to Flavell (2000), research on metacognitive development is principally based on what the subject knows about his or her own mind. Understanding how another individual (or people in general) uses his or her mind in different situations is not a core concern of those who study metacognition. On the contrary, it is generally the understanding of the functioning of other people's minds, or even the functioning of the mind in general, which is at the centre of theories of mind (and, more widely, of personal epistemology). For example, in false-belief tasks, researchers ask a child to imagine the reaction of another child, often called a naïve subject (i.e. someone who did not have access to some information).

Another hypothesis, advanced by Flavell (2000), is that the two currents are focused on different research subjects. Fully within the tradition of child psychology, research relating to theories of mind mainly focused on the origins and first expressions of knowledge (or beliefs) about the most elementary mental states (desires, perception, beliefs, knowledge, thoughts, intentions etc.) and especially focused on (very) young children. By contrast, the studies carried out in the field of metacognitive development focused on mental activities linked to specific tasks: 'Often on what one should do with one's mind in trying to solve some problems or task' (Flavell 2000, p. 17). These metacognitive activities include strategies relating to control, monitoring, and regulation processes inherent to the realization of complex tasks. In so doing, these processes contribute to the appropriate realization of these tasks (memorization, understanding, or problem-solving tasks, for example). Since knowledge and the tools investigated in research on metacognition generally presuppose the understanding of mental states, they principally focused on older children and adolescents. For instance, we may imagine that it is not possible to evaluate children's understanding of memorization strategies (metamemory, in the field of metacognition) if they are too young to know what it means to remember something (which relates to theories of mind). According to Veenman et al. (2006), from a developmental point of view, it is commonly admitted that a child's theory of mind develops between 3 and 5 years and considered that metacognitive skills emerge towards the age of 8 to 10 years. These authors state that recent research identifies earlier metacognitive skills (towards 5 years), which can open the door to more links between the two domains. In this perspective, a recent study by Lockl and Schneider (2006) was interested in the complementarities between both theoretical fields. They conducted a longitudinal study with children aged 4.5 to 6 years; they submitted several tasks to the children, in order to assess their theory-of-mind and metacognitive competencies (especially metamemory). One of the main results from the Lockl and Schneider study is that they find 'a predictive relation between children's ability to attribute false-belief (i.e. their theory of mind), their acquisition of metacognitive vocabulary, and their knowledge about variables that influence memory' (Lockl and Schneider 2006, pp. 28–29). In other words, the results lead the authors to claim that their 'data provide some evidence for the hypothesis that early theory-of-mind competencies can be considered as a precursor of subsequent metamemory and that the acquisition of the concept of representation might be a crucial step in children's development, which in the end enables them to think about their own and other people's memories' (Lockl and Schneider 2006, p. 29).

This study highlights some interesting links between theories of mind and a specific area of metacognition called metamemory. Metamemory is not primarily centred on knowledge and knowing and thus one can claim that the study presented here goes beyond the domain of folk epistemology. Likewise, it can be argued that the metacognitive vocabulary tasks are not focused on proper epistemic questions. However, this test handles issues such as knowledge and uses the verbs *to know* and *to guess*, which according to Montgomery (1992), are crucial in the theory-of-mind perspective.

The study of Lockl and Schneider (2006) supports the idea that 'theory of mind has to be considered as a precursor of metacognition', but research on the links between theories of mind and metacognition still needs to continue.

Metacognition and personal epistemology

Metacognition is involved in the different approaches of personal epistemology, as stated by Bendixen and Rule (2004) when describing their *integrative personal*

epistemology model, which attempts to summarize the different approaches relating to this field. Speaking of metacognition, they write: ‘similar to an executive control process, it oversees our model, including the mechanism of change [...] and epistemological beliefs themselves’ (Bendixen and Rule 2004, p. 74). Both components of metacognition can be found in this model: on the one hand, the executive or procedural component throughout the model and which regulates epistemic change and, on the other hand, the declarative component, which is mainly concerned with beliefs about knowledge and knowing.

Hofer (2004b) states at the outset that the wish to position personal epistemology in the field of *metacognition* is not new; it was initially put forward by Kitchener, within the framework of the *reflective judgment model* (see King and Kitchener 2002, 2004); it was then taken up and further developed by Kuhn (2000, 2001).

The investigations by King and Kitchener (2002, 2004) are based on interviews which focus on ill-structured or controversial problems. These problems present two characteristics: they cannot be defined with a high degree of precision and they cannot be resolved with a high degree of certainty. These problems relate, in particular, to the objectivity of information transmitted by television or radio and to concepts relating to the creation and evolution of the world. The participants were invited to state their own point of view on these issues and to answer questions intended to pinpoint their beliefs relating to knowledge and knowing. For more than twenty years, King and Kitchener have been doing research on this topic and they have built a *reflective judgment model* on this basis. Reflective judgments ‘are initiated when an individual recognises that there is controversy or doubt about a problem that cannot be answered by formal logic alone, and involve careful consideration of one’s beliefs in light of supporting evidence’ (King and Kitchener 2004, p. 6). These reflective judgments may be considered a particular form of metacognition relating specifically to knowledge. At the origin of the *reflective judgment model*, Kitchener, in the 1980s, had developed a cognitive model consisting of three levels, each level functioning as a platform for the following level. According to Hofer (2004b), this model can be described as follows: the first level (*cognition*) includes tasks such as calculating, reading, perceiving, etc. and the second level (*metacognition*) permits the development of knowledge in relation to these cognitive tasks, such as the use of strategies and monitoring. The third level (*epistemic cognition*) ‘involves monitoring the epistemic nature of problem solving, including awareness of the limits and of the certainty of knowledge and the criteria involved in the process of knowing’ (Hofer 2004b, p. 47). According to this model, the different components of personal epistemology (*nature of knowledge*—at least ‘certainty of knowledge’—and *nature of knowing*—mainly ‘justification for knowing’) are principally located at the third level, which ‘operates in conjunction with the first two levels’ (Hofer 2004b, p. 47).

Partly on the basis of King and Kitchener’s papers (2002, 2004), Hofer (2004b) proposes a new model called *epistemic metacognition*, which attempts to position *epistemological awareness* in relation to the metacognitive model of Pintrich et al. (2000). In order to do this, she locates the different epistemological components with regards to the components of Pintrich et al.’s (2000) model. In particular, she distinguishes *beliefs about knowledge*, *beliefs about knowing* and *regulation of cognition during knowledge construction*.

Hofer (2004b) decided to test her model empirically through research tasks on the Internet in order to analyze the epistemological theories in context. She was interested in the different epistemic components and wondered if it would be possible to analyze them in situ and in relation to the metacognitive model. In three experiments described by Hofer (2004b), students (from colleges or universities) were placed alone in a laboratory and had

to perform Internet research tasks for a science course, while speaking out loud constantly (*think aloud* technique). After 20 min of research, they had to choose their three best sources of information and explain their choice. A retrospective interview was also conducted to gain a better understanding of their research procedures.

The main results can be summarized in five points (Hofer 2004b): (1) students can and should make epistemic judgments while searching online. They also monitor the epistemological nature of their learning. Comments and feedbacks during the research process bear out this claim, even if they are not necessarily of high epistemic levels. (2) There is clear evidence of the four expected epistemic dimensions; the dimension most complex to capture is ‘source of knowledge’, which requires significant inferences. (3) Beliefs seem to operate interactively, which is in line with the hypothesis of ‘theory-like nature’ instead of independent beliefs as in Schommer’s theoretical model. (4) Individual expertise seems more related to school curriculum (types of courses) than to the age of the students or to the school year they attended. (5) Transfer between expertise in a specific domain and more general considerations are lower than expected; the relationship between domain-specific vs general is still widening. The first results of Hofer’s studies are encouraging, in particular (a) as a possible technique to assess epistemic reflection in an authentic and everyday-life context, (b) as a way to organize epistemological beliefs into theories and (c) as an integration of epistemic reflection into a metacognitive model.

From our point of view, the interactive play of the three components distinguished by Hofer (2004b) should be investigated further, as does the role of metacognition in the regulation process of epistemic change (Bendixen and Rules 2004). Firstly, how do *beliefs about knowledge*, *beliefs about knowing* and *regulation of cognition* interact during knowledge construction? Secondly, what is the possible influence of *beliefs about knowledge* and *knowing* on the *regulation process of epistemic change*? It seems logical to hypothesize that *beliefs about knowing* operate as the main influential factor on the process of regulation of cognition during knowledge construction. However, do *beliefs about knowledge* act during the process in which a subject has to decide which information is valuable? To explore this question, it would be interesting to examine the process of knowledge construction in a quasi-longitudinal perspective (for instance, by adopting Hofer’s research design—a task requiring information selection—and replicating this design with the same subjects at different times). By combining the thinking-aloud technique with retrospective interviews, it would be possible to analyze how the process of regulation of cognition evolves over time and—in parallel—to observe if beliefs about knowledge and knowing are changing. We put forward the hypothesis that different trajectories of transformation may be observed. Fundamentally, we postulate that it is time to concentrate our research efforts on the process of epistemic beliefs’ transformation and, complementarily, on the evolution of the regulatory process of cognition. The research design created by Hofer (2004b) seems particularly fruitful because it allows the analysis of students’ thought processes on line and in situ. Nevertheless, the one-shot perspective chosen in the three experiments is unable to capture the micro-developmental transformation process of the different components that her experiments distinguished. It would also be interesting to explore in a quasi-longitudinal design how interactions between students may facilitate the evolution of epistemological beliefs and the metacognitive regulatory process. Moreover, it would be productive to replicate the same kind of experimental design at different ages, in order to examine if the same processes occur throughout the developmental trajectory.

Conclusion and discussion

This paper starts by focusing on two fields of contemporary research which are both concerned with naïve theories relating to the nature of knowledge and knowing and which can be integrated in the concept of *folk epistemology*: theories of mind and personal epistemology. In the first part of the paper, we discussed links and discrepancies between these fields, which can be summarized as follows: firstly, the field of personal epistemology is composed of multiple theoretical approaches, which have not yet functioned in synergy, whereas the field of theories of mind can be described as a unique and well-organized field. Secondly, the centre of interest of personal epistemology is one's deep understanding of a single cognitive object (the nature of knowledge) and of a single cognitive process (the nature of knowing), whereas the centre of interest of theories of mind is children's initial understanding of a variety of objects and processes from the cognitive and emotional domains. It is the presence of knowledge in both fields, which joins them in the concept of *folk epistemology*.

We propose to consider both research fields as part of a developmental trajectory. This enables us to highlight the idea that studying the links between theories of mind and personal epistemology may generate some reflections on the origins of epistemological beliefs and the reasons for their evolution (Burr and Hofer 2002). The exploratory study conducted by Burr and Hofer (2002) provides interesting insights into this question. One of their main results is the identification of a stage of epistemological development that exists prior to dualism (a pre-dualistic stage or a period of naive realism) and to highlight the existence of a transitional period between the pre-dualist stage and the dualist stage. Burr and Hofer (2002) conclude that the existence of this transitional stage 'provides support for the hypothesis that epistemological awareness is a precursor of theory of mind development' (p. 218).

The second part of the paper extends the discussion to the concept of metacognition. One component of metacognition includes personal knowledge and beliefs about one's own cognitive processes, including knowing and its product (knowledge). The declarative part of metacognition seems de facto linked with folk epistemology.

Despite being related to 'the same general set of cognitive umbrella', Flavell (2000) pointed out that metacognition and theories of mind are mainly characterized by a lack of links rather than by real complementarities. Nevertheless, recent research investigated possible complementarities and suggested that metacognition is accessible to children younger than had been established in the past (Veenman et al. 2006). The longitudinal study carried out by Lockl and Schneider (2006) provides evidence of interesting links between the two domains. One of their main results is that there is 'a predictive relation between children's ability to attribute false belief (i.e. their theory of mind), their acquisition of metacognitive vocabulary, and their knowledge about variables that influence memory' (pp. 28–29). In other words, some links between the two domains are clearly highlighted because 'early theory-of-mind competencies can be considered as a precursor of subsequent metamemory' (p. 29).

Combining the results of Burr and Hofer (2002) on the one hand with those of Lockl and Schneider (2006) on the other hand suggests a linear progression which can be summarized as follows: 'epistemological awareness is a precursor of theory of mind development' (Burr and Hofer, 2002, p. 18) and 'early theory-of-mind competencies can be considered as a precursor of subsequent metamemory' (Lockl and Schneider 2006, p. 29). Should we conclude that there is a linear progression from *epistemological awareness* to *metacognition* through *theory of mind*? This idea seems somewhat reductive and does not show how access to an accurate theory-of-mind influences deeper epistemological reflection.

While the sources-of-knowledge tasks used by Burr and Hofer (2002) assess ‘epistemic awareness’, one can argue that it is really a ‘primitive’ epistemological reflection because the tasks simply involve identifying the links between a piece of information and one’s access to it. Which progress, in terms of epistemological thinking, can we expect when a child successfully manages false-belief tasks (when he/she acquires the concept of representation) and reaches the dualist stage? With the aim of assessing a deeper epistemological reflection, it would be interesting to use tasks that assess the awareness of the importance of the ‘quality of the source of information’ (see for instance work carried out by Sodian 1988; Taylor 1988; see also, Montgomery 1992; Miller 2000 for a synthesis). These experiments, also commonly used in the theory-of-mind tradition, allow us to determine whether a child understands that information is not just ‘impregnated’ but that knowledge is ‘constructed’ by the subject (opposition between ‘mind receptacle’ and ‘mind constructor’ in the theory-of-mind’s tradition—Wellman 1990). More studies are needed to demonstrate the developmental lineage between the acquisition of the different components of theory-of-mind and the evolution of epistemic reflection.

Moreover, as mentioned earlier, it would also be interesting to further investigate the links between the mastery of metacognitive vocabulary and the studies that focus on the identification of the source of knowledge. For example, the understanding of verbs such as ‘to know’ and ‘to guess’ is embedded in the metacognitive vocabulary test of Lockl and Schneider (2006) and, in the theory-of-mind perspective, some studies (see for instance, Sodian and Wimmer 1987) were interested in children’s capacity to distinguish *to know* from *to guess*, depending on access to perceptive information (see also, Lockl and Schneider 2007; Schneider 2008, for a discussion concerning the role of language development in both research fields).

Another idea developed in the paper concerned the procedural component of metacognition that deals with the *regulation of cognitive processes*. We propose to extend this idea, following Bendixen and Rule (2004) as well as Hofer (2004b), to the *regulation of cognition during knowledge construction* and the *regulation of epistemic change*. We also formulate the hypothesis that epistemic beliefs about the nature of knowledge and the nature of knowing influence the regulatory process of cognition during knowledge construction: thus, beliefs about knowing seem to influence the regulation process itself and beliefs about the nature of knowledge appear to act at the final stage when subjects must decide which sources of information are most valuable. Again, more studies are needed.

Therefore, we argue that the coordination of research traditions linked to theories of mind, personal epistemology and metacognition would create a dynamic synergy enabling us to explore the longitudinal process of interactive transformation of the cognitive components, which have been identified through previous research in the various domains.

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Current themes of research:

Mathematical problem solving (mainly in primary school). Large scale studies (PISA) and standardized evaluation. Teacher's beliefs (personal epistemology, beliefs about learning,...).

Most relevant publications in the field of Psychology of Education:

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Current themes of research:

Teacher's beliefs (personal epistemology, beliefs about learning,...). Teacher's beliefs, teacher's planning and teaching practice. Teacher's beliefs and school learning, school success and failure. Teacher's beliefs and pupils motivation.

Most relevant publications in the field of Psychology of Education:

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