



The metacognitive abilities of children and adults



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ABSTRACT

Metacognition, or the capacity to reflect upon one's own knowledge, is a key trait in our cognitive repertoire which is developed during childhood. Here, a direct comparison of metacognitive ability in children ($N=188$; 6–9 years old) and adults, ($N=47$) using a single perceptual task, was made. Results showed that 6–9 years old children have a level of metacognitive access similar to that of adults. Further, a signal detection theory model was applied in order to distinguish metacognitive ability from the propensity towards risk taking, two factors that have so far been confounded in studies. Children presented a sub-optimal tendency towards risky decisions and a natural predisposition to overconfidence that can be partially mitigated by imposing a conservative normative strategy.

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1. Introduction

Metacognition is the ability of thinking about what we know, an individual's knowledge about her cognitive processes and how to use this knowledge to control those processes accordingly. It constitutes a key trait in our cognitive repertoire (Dunlosky & Metcalfe 2009; Flavell, 1976; Lockl & Schneider, 2006).

Evaluating this ability is a subtle matter: one typically chooses a base cognitive task (type I task), and then asks participants to report how well they think they have performed it (type II task, confidence report). By relating the responses in both tasks one can then assess the metacognitive ability of the participants. Although metacognition is in principle independent of the skill in the type I task (which can range from a low level perceptual decision to tasks at a higher cognitive level such as memory or problem solving) (Baird, Smallwood, Gorgolewski, & Margulies, 2013; Metcalfe & Finn, 2013; Roebers, von der Linden, Schneider, & Howie, 2007; Zylberberg, Barttfeld, & Sigman, 2012), the direct confidence report can confound these two. For instance, if the type I task is extremely easy, type II reports will show a tendency towards high confidence, which prevents an accurate evaluation of metacognition. Even in a setting in which there is a reasonable range of performance in the type I task, it is not straightforward to extract a single measure from the type I and type II responses that directly quantifies metacognitive ability (Fleming & Lau, 2014; Maniscalco & Lau, 2012). These sort of confounds can lead to erroneous interpretations about

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the participants' metacognitive abilities. A clear example of this kind of incorrect assessments can be found in what used to be the established literature within children's metacognition research, which alleged that metacognitive skills emerge in development late in life, around age of 8 (Veenman, Van Hout-Wolters, & Afferbach, 2006). The main issue among these studies was the reliance on type I tasks that prove to be too demanding for younger children.

The proposal of a delayed emergence of metacognition has been challenged and mostly discarded over the past years by the realization that research relying on self-report or verbally-based experimental methodologies may significantly underestimate the metacognitive and self-regulated performance of young children (Cultice, Somerville, & Wellman, 1983; Schellings & Van Hout-Wolters, 2011; Whitebread et al., 2009; Whitebread, Almeqdad, Bryce, Demetriou, Grau, & Sangster, 2010; Winne & Perry, 2000). For example, Schneider (1985) demonstrated that many early studies, which examined the relationship between metacognition and performance in children, were based merely on the use of self-report techniques as a way of understanding individuals' metacognitive processes (Schneider, 1985). These depend heavily upon the respondents' ability to give reliable reports of their own mental experiences, which for younger children can derive in an underestimation of their regulatory abilities. An underestimation is particularly expected when the natures of the tasks that are used to test metacognition during toddlerhood or early childhood rely heavily on declarative memories and language-based procedures, which children do not master until later in life (for a revision, Whitebread et al., 2010). Nowadays, as a consequence of an increasing number of reports using a variety of age-appropriate methodologies, there is agreement that children as young as 2 years old can already exhibit metacognitive abilities, well before they can produce consistent verbal reports (Hembacher & Ghetti, 2014; Lyons & Ghetti, 2011; Marazita & Merriman, 2004; Ruffman, Garnham, Import, & Connolly, 2001). Furthermore, studies have identified metacognitive and self-regulatory behaviors, such as uncertainty and judgments of learning, in young children (Beran, Decker, Schwartz, & Smith, 2012; Destan, Hembacher, Ghetti, & Roebbers, 2014; Ghetti, Hembacher, & Coughlin, 2013).

The use of age-appropriate techniques is necessary for establishing how metacognitive abilities are developed. Regarding to this point, Winne and Perry (2000) have argued that observational methodologies are particularly crucial for establishing metacognitive abilities, because it allows the opportunity to evaluate non-verbal (such as eye gaze shifting, gestures, and pauses) as well as verbal behavior during the tasks (Winne & Perry, 2000). Accordingly, we agree that metacognition assessment in young children should be through tasks that are purely behavioral, nondeclarative, and as language free as possible. One example that began to fill the void in the understanding of early childhood metacognition by using a novel non-verbal metacognition task is the recent work by Vo, Kornell, Pouget, and Cantlon (2014). By introducing a comprehensive set of metacognitive measures to evaluate metacognition they could claim that metacognition is a fundamental domain-dependent cognitive ability in children (Vo et al., 2014).

Hence, if children develop metacognitive abilities, this would mean that they can (1) introspect on the current state of their cognitive processes (i.e., metacognitive monitoring) and (2) use the output of metacognitive monitoring to regulate these operations (metacognitive control). On this topic, recent research has shown that young children respond appropriately not only to their own knowledge or the lack of it, but as well as to the reliability on somebody else's knowledge, showing strong preferences towards those who they perceive as trustworthy (see Ghetti et al., 2013 for a review). For example, Koenig and Harris (2005) demonstrated that children as young as 4 years old assess the reliability of the source of information and further use that information to predict future assertions, seek information and even endorse their claims (Koenig & Harris, 2005).

Although the literature on metacognitive development has increased, still much work needs to be done. Particularly, it is not completely understood whether children represent their uncertainty during perceptual discriminations and base their confidence judgments on that uncertainty, and how metacognitive monitoring and control during those processes change during development, if they do.

Besides using age-appropriate tasks when studying children's metacognitive development, current research has argued that most of the available methods used to analyze metacognitive paradigms are inadequate because they are bias by factors such as type 1 sensitivity (Galvin, Podd, Drga, & Whitmore, 2003; Maniscalco & Lau, 2012). Research by Maniscalco and Lau (2012) has proposed that the signal detection theory (SDT) approach for measuring type II task sensitivity because it allows the discrimination the independent contributions of sensitivity and response bias during confidence reports.

Accordingly, with these two ideas on the use of (1) age-appropriate techniques and (2) SDT for the analysis of confidence reports, the aim of the current research is threefold. First, we present a direct comparison of metacognitive performance between young children and adults through the use of a perceptual base task adapted from a task designed for monkeys by Kornell and colleagues (Kornell, Son, & Terrace, 2007). Though comparisons between these different ages were attempted before, they were mostly limited by the fact that, in order to make them more accessible, both the base and/or the metacognitive tasks were simplified when presented to children (Finn & Metcalfe, 2014; Metcalfe & Finn, 2012; Roebbers, 2002). For example, in judgment of learning studies, the vocabulary materials used with children during the type 1 task is a comparable cued recall task, but not same, as the one employed for adults (Finn & Metcalfe, 2014).

Second, we aim at assessing metacognitive ability and tendency towards risk independently, since these two factors are generally confounded in the standard treatment of confidence in the literature. In order to achieve this, we apply a signal detection theory (SDT) model in terms of which we analyze our results. This model allows us (1) to treat metacognitive ability and risk attitude independently and (2) to resolve the confound of varying performance in the base task. Study 1 was designed to address these two first aims.

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