



# Feeling Uncertain and Acting on It During the Preschool Years: A Metacognitive Approach

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**ABSTRACT**—*The ability to experience uncertainty (i.e., uncertainty monitoring) is an important skill that enables us to optimize our performance by acting cautiously or seeking additional information when we feel uncertain, and by expressing our knowledge when we feel certain (i.e., uncertainty control). Research reveals that even young preschoolers can introspect on uncertainty and act appropriately based on these introspections. We conclude that uncertainty monitoring and control can be driving forces of cognitive development during the preschool years. In this article, we review the emerging literature on this topic, highlight open questions, and draw connections with other research domains.*

**KEYWORDS**—*uncertainty; metacognition; preschoolers*

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Imagine asking two preschoolers a question. One of them gives you a big smile as she begins to utter a response, whereas the other gives you a blank stare. You will likely infer that the former knows the answer and the latter does not, but you may also wonder: Did these two children experience feelings of certainty or uncertainty about their knowledge? And if so, did those

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feelings guide their actions, spurring one to provide an answer and the other to wait to see if someone else answered first?

Within a metacognitive framework, feelings of uncertainty about our knowledge are related integrally to our ability to make optimal decisions (Koriat & Goldsmith, 1996; Nelson & Narens, 1990). First, individuals introspect on the current state of their cognitive operations (i.e., metacognitive monitoring); then, they use the output of metacognitive monitoring to regulate these cognitive operations (i.e., metacognitive control). On the basis of this framework, we can introspect on fundamental aspects of our cognition and regulate our functioning as a result. Some have argued that the product of introspection is mere epiphenomenon (e.g., Linser & Goshke, 2007; Wegner, 2003), given that many behaviors are driven by complex mechanisms that elude consciousness (e.g., Dijksterhuis & Aarts, 2010; van Gaal & Lamme, 2012). However, it is difficult to imagine how the ability to engage in such sophisticated self-reflective processes evolved, if only unconscious mechanisms orchestrate the operations necessary for learning, making decisions, and socializing. In fact, introspective acts do guide decisions, at least in some situations: For example, adults allocate more time to relearn material they perceive to have learned less well than other material, even when actual learning was comparable (Finn, 2008; Metcalfe & Finn, 2008).

Solid metacognitive monitoring and control skills are evident during middle childhood and continue to improve during this period (e.g., Lock & Schneider, 2004; Roebers, 2002). How do these skills emerge? In this article, we show that uncertainty monitoring and related control operations emerge during the preschool years. We then outline areas for research, including the boundary conditions of uncertainty monitoring and control, their developmental precursors and later development, and their connections with other domains of research in cognitive development.

## THE JUDICIOUS PRESCHOOLER

If you hand a young preschooler a new, colorful, multipart toy, she may look puzzled before starting to experiment with its parts. If she can glean how the toy works, she may grin with

satisfaction. Young children commonly respond to their daily experiences with behaviors that seem to track their level of knowledge: They hesitate when their knowledge is limited and appear confident when they have relevant information. These observations are consistent with research showing that preschoolers ask relevant questions when they lack knowledge (e.g., Chouinard, 2007) and are more likely to request clarification when they receive ambiguous compared to informative messages (Patterson, Cosgrove, & O'Brien, 1980; Pratt & Bates, 1982). They respond appropriately not only to their own knowledge or lack thereof but also to that of others, selectively seeking information from reliable sources (e.g., Koenig & Harris, 2005; Pasquini, Corriveau, Koenig, & Harris, 2007) or from informants who appear more certain (Jaswal & Malone, 2007). Although this research suggests that preschoolers act differently as a function of their knowledge levels, it does not tell us whether they are aware of their uncertainty and whether introspections on these subjective experiences of uncertainty play any role in guiding their actions.

Early research on young children's abilities to introspect on their own mental states suggested that children as old as 5 years cannot access the contents of their thoughts (e.g., Flavell, Green, & Flavell, 1995). If this were the case, judicious responding in the face of uncertainty would not be mediated by children's introspective acts. However, the methods used in these early investigations may account for these results; introspection skills were probed with open-ended prompts, which arguably provide too little support for young children to organize verbal descriptions (Fivush, 1997). In contrast, metacognitive methods provide more support because, instead of requiring verbalizations on mental states, they elicit discrete cognitive acts (e.g., perceptual decisions) and specific introspections about them (e.g., assessments of level of subjective uncertainty about response accuracy).

Using metacognitive methods, we have begun to address questions that have eluded previous research. First, are preschoolers aware of their uncertainty? If so, is this awareness useful? Can preschoolers act on the basis of their uncertainty and enjoy performance benefits? Studies have begun to show that young children are indeed aware of their experiences of uncertainty and seem to adjust their behaviors accordingly.

### **CAN PRESCHOOLERS INTROSPECT ON THEIR OWN UNCERTAINTY?**

We hypothesized that preschoolers could introspect on uncertainty based on two lines of evidence. First, preschoolers routinely face situations in which they have absent or incomplete knowledge and, as discussed earlier, respond to these uncertain situations appropriately (e.g., Chouinard, 2007; Patterson et al., 1980). Second, preschoolers understand to some degree the difference between certain and uncertain outcomes (Deák, Ray, & Brenneman, 2003). Introspection on one's own uncertainty

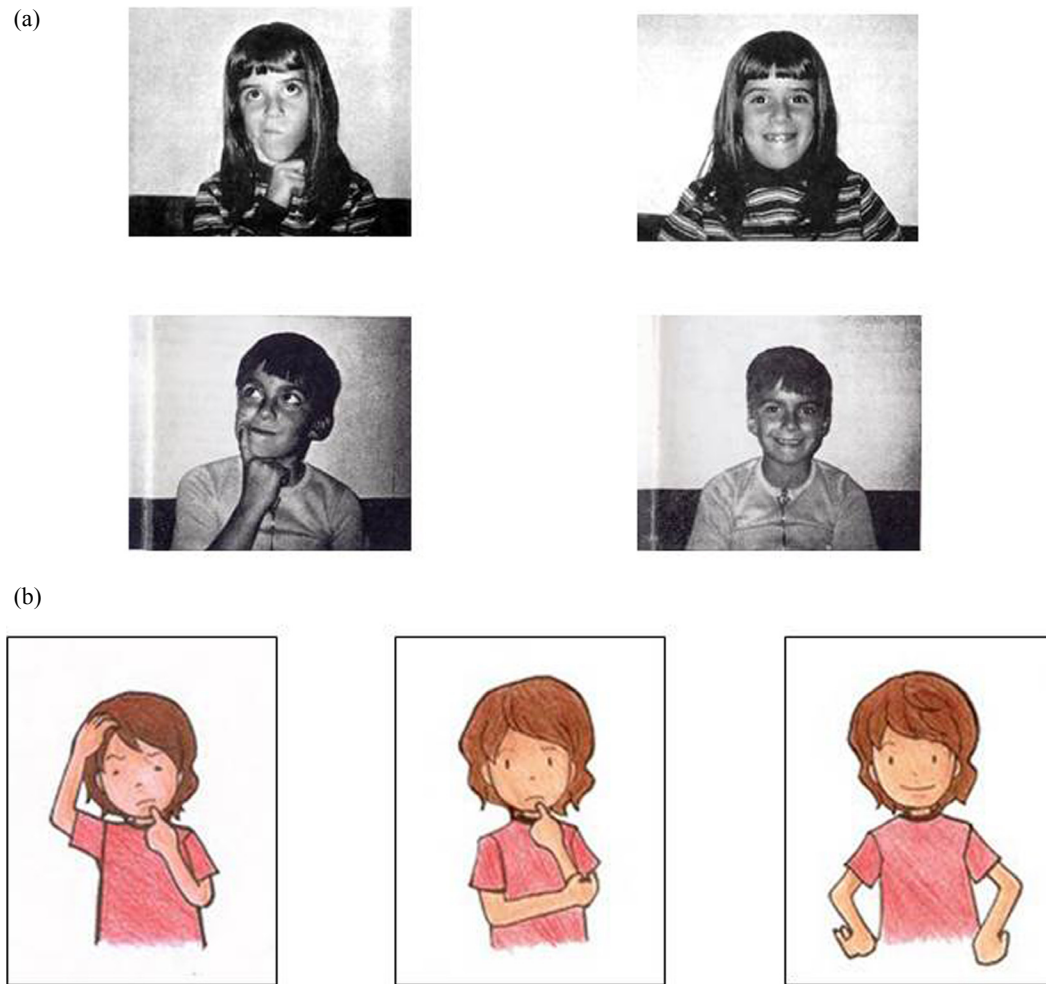
may emerge from repeated experience of uncertain situations or outcomes, which may in turn lead to a conceptual understanding of uncertainty.

From a methodological standpoint, introspections on uncertainty are the most widely used indices of metacognitive monitoring in research with older children (e.g., Ghetti, 2003; Ghetti, Castelli, & Lyons, 2010; Roebers, 2002), adults (Mazzoni & Kirsch, 2002), and nonhuman species (Kornell, Son, & Terrace, 2007; Smith, Shields, & Washburn, 2003); thus, investigations of preschoolers promise to connect directly with extant metacognitive literature.

To begin to test preschoolers' ability to introspect and report on their subjective feelings of uncertainty, 3-, 4-, and 5-year-olds were asked to report confidence ratings on the perceived accuracy of their own perceptual and lexical judgments (Lyons & Ghetti, 2011). In a perceptual-identification task, children identified common objects from line drawings that had been degraded by the removal of randomly selected pixels; in a lexical-identification task, children named common objects that were clearly visible but varied in familiarity (e.g., shoe vs. artichoke). Children were asked to provide an open-ended response and to report how confident they felt about their answer using pictorial representations (see Figure 1a). Even 3-year-olds expressed more confidence for correct versus incorrect responses, a difference that increased with age. Confidence ratings associated with "I don't know" responses or approximation responses (e.g., "food" for "artichoke") were excluded from this analysis, so the results could not have been driven by children assessing their own complete ignorance or their inability to generate candidate answers.

In this first study, children were instructed to select the appropriate confidence picture based on (a) whether they felt the way the child in the picture seemed to feel and (b) whether they felt that they came up with the answer right away or first had to think hard. These instructions were meant to encourage children's attention to several aspects of their mental experience (i.e., retrieval fluency, time to decide) that are known cues of subjective uncertainty (e.g., Kelly & Lindsay, 1993; Koriat & Ackerman, 2010; Robinson, Johnson, & Herndon, 1997). Although the cuing instructions were helpful in obtaining initial evidence of uncertainty monitoring, they may have induced children to rely exclusively on their perceived decision time when assessing confidence, suggesting that although this assessment requires some form of introspection, it may not necessitate a full appreciation of subjective uncertainty.

A follow-up analysis examined the role of perceived decision time in children's confidence ratings: When children's response latency for accurate and inaccurate responding was included as a covariate in the main analysis, 3-year-olds' confidence ratings no longer reliably differentiated between accurate and inaccurate responses, whereas 4- and 5-year-olds' continued to do so. We have since used instructions that do not refer to time to decide, focusing instead on facial expressions of uncertainty and



*Figure 1.* Pictorial representation of confidence levels: (a) two-level confidence photographs used in Lyons and Ghetti (2011, 2013), originally used and published in Berch and Evans (1972) to examine memory monitoring in middle childhood; (b) three-level confidence drawings used in Coughlin, Hembacher, Lyons, and Ghetti (2013) and Hembacher and Ghetti (2013a, 2013b).

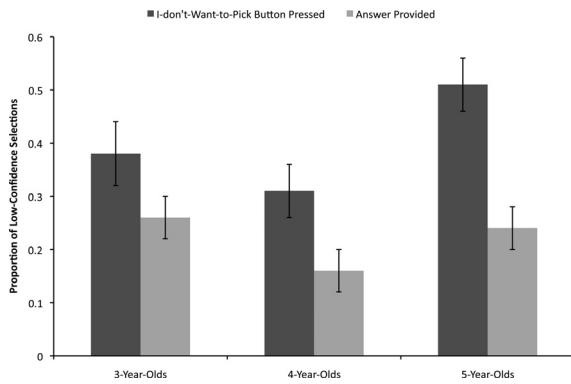
related feelings (Coughlin, Hembacher, Lyons, & Ghetti, 2013; Lyons & Ghetti, 2013; see Figure 1b for an example of confidence depictions in these studies). Three-year-olds reliably provided greater confidence ratings for accurate compared to inaccurate responses, even accounting for response latencies. Children reflected and reported on their feelings of uncertainty about perceptual and lexical decisions as early as age 3, though this ability improves during the preschool years; later, we discuss whether this result extends to other cognitive functions.

#### **CAN PRESCHOOLERS MAKE DECISIONS BASED ON THEIR OWN UNCERTAINTY?**

Now that we know that preschoolers can introspect on their subjective uncertainty, we should ask whether these introspective experiences inform their decisions. As we have already seen, children naturally regulate their accuracy by hesitating or asking questions under conditions that elicit uncertainty (Patterson

et al., 1980; Pratt & Bates, 1982). Thus, it was predicted that subjective feelings of uncertainty support these behaviors.

To test the prediction that preschoolers rely on their feelings of uncertainty to guide their decisions to withhold responses, 3-, 4-, and 5-year-olds completed a perceptual-identification task in two separate sessions (Lyons & Ghetti, 2013). In a forced-report session, children responded on trials that involved identifying a target object in one of two degraded images; confidence judgments were then elicited for each selection. In the free-report session, test trials were identical to the forced-report section, but children could elect to refrain from responding by choosing the “I don’t want to pick” option. Children were more likely to withhold responses on trials for which, in the forced-report condition, they had reported feeling uncertain compared to feeling certain; this effect was statistically reliable in 3-year-olds, but was more robust in older preschoolers as indicated by a significant Age  $\times$  Answer Type interaction (see Figure 2). As a consequence, overall accuracy



**Figure 2.** Mean proportion of low-confidence selections when participants are required to provide a response as a function of whether they volunteered a response or opted not to select an answer when participants are allowed to choose (reproduced from Lyons & Ghetti, 2013).

was greater across all ages in the free-report compared to forced-report condition.

Finally, ability to monitor uncertainty in the forced-report condition (indicated by the average difference in confidence between accurate and inaccurate responses) positively predicted accuracy in the free-report condition, even when controlling for parent-reported inhibitory control (Rothbart, Ahadi, Hershey, & Fisher, 2001). This result indicates that uncertainty monitoring contributes to preschoolers' regulation of their accuracy above and beyond general abilities in self-regulation.

A subsequent study extended these findings by examining whether introspections on uncertainty were associated with help-seeking behaviors (Coughlin et al., 2013). The paradigm was the same as that used in the earlier study (Lyons & Ghetti, 2013) except that the free-report condition was replaced by a help-available condition: Children could push a button to ask for help from an ally (instead of withholding an answer). When 3-, 4-, and 5-year-old children were tested in the help condition, they were more likely to ask for help (vs. respond without asking for help) in trials for which they had reported more uncertainty and had responded less accurately in the forced-report condition. Overall, these findings suggest that uncertainty monitoring during the preschool years is associated with metacognitive control. Even young preschoolers can assess their uncertainty and take their introspection into consideration to optimize task performance.

## CONSIDERING ONGOING STUDIES AND LOOKING AHEAD

### Boundary Conditions

Although the findings to date are quite promising, they have been observed in a narrow range of contexts. Specifically, assessments of uncertainty monitoring were elicited largely after perceptual decisions. The ability to introspect and report on

uncertainty may vary as a function of the cognitive act being evaluated. For example, our study has begun to show that 3-year-olds do not reliably monitor uncertainty on memory decisions, despite their demonstrated introspective skills regarding perceptual decisions (Hembacher & Ghetti, 2013a). This discrepancy may emerge for a number of reasons: First, percepts may be easier to assess because they include more visual information and may be more vivid than memories, which would make the latter less salient or differentiated for young children to evaluate and report on (Harris, 1995). Second, uncertainty monitoring on perception may be less cognitively demanding than uncertainty monitoring on memory. When a child is asked to monitor uncertainty about a perceptual identification (i.e., when the child assesses his or her feelings of uncertainty after identifying an object that is partially degraded), the presence of the percept may continue to induce feelings of uncertainty about the identification that the child's overt confidence assessment is meant to capture. In contrast, when a child is asked to monitor uncertainty about a memory, he or she needs to retrieve that memory, hold it in mind, and evaluate his or her certainty about this purely mental entity, which may change as a function of retrieval attempts.

Third, the factors attended to when introspecting on uncertainty also may differ as a function of cognitive domain. We mentioned earlier that adults base their confidence ratings on response latency and retrieval fluency (e.g., Koriat & Ackerman, 2010) and that response latency fully accounted for 3-year-olds' confidence ratings but not for those of older preschoolers (Lyons & Ghetti, 2011); this finding suggests that response latency may be particularly important early in development in assessments about perceptual decisions. However, with age, response latency increasingly serves as a basis for confidence judgments about memory decisions across middle childhood (Koriat & Ackerman, 2010). These results stand in apparent contradiction, but they suggest that there may be developmental differences in the variables one attends to when assessing uncertainty in different cognitive domains.

In addition to examining factors affecting uncertainty monitoring, researchers should look at factors affecting uncertainty-based control. Thus far, we have indexed control by observing preschoolers' tendencies to withhold responses or ask for help; their likelihood of using subjective uncertainty to guide behavior may vary depending on the control behavior being measured. Our ongoing research extends this line of investigation by examining the early development of other forms of metacognitive control, such as selecting favorite answers immediately after they are provided: In various learning contexts, including the classroom, it is useful to be able to take back responses that are not deemed accurate and keep only the best responses. We are now examining this capacity during the preschool (Hembacher & Ghetti, 2013a) and elementary school (Hembacher & Ghetti, 2013b) years.

### Developmental Precursors and Later Development

Researchers should examine the developmental precursors and later development of uncertainty monitoring and control. Behavioral indicators such as wavering and deliberating over problems may exist before children are aware of their connection with accuracy; for example, insofar as introspection on uncertainty requires repeated observation of the association between response latency and accuracy, young children's ability to introspect may emerge from these earlier skills. After the preschool years, it is well established that children's metacognitive monitoring and strategic control become more sophisticated in later childhood and beyond (e.g., Ghetti, 2003; Ghetti, Lyons, Lazzarin, & Cornoldi, 2008; Roebers, 2002). Furthermore, in middle childhood, children are aware of subtle differences in memory quality: Children as young as 6 years are more likely to claim to recollect a studied item when, in addition to recognizing the item, they can recall qualitative details associated with learning the item; when they recall these details inaccurately, they are more likely to claim that the item is familiar (Ghetti, Mirandola, Angelini, Cornoldi, & Ciaramelli, 2011; Hembacher & Ghetti, 2013b). Researchers should address these transitions and map uncertainty monitoring from its earliest precursors to its mature functioning in adulthood through a longitudinal approach that traces early behavioral indicators of uncertainty to more overt behaviors in childhood and beyond.

### Connections With Other Skills

We began this article outlining the numerous domains in which young children seemingly exert control over their knowledge by either accepting information when provided by more accurate (e.g., Koenig & Harris, 2005) or more confident (Jaswal & Malone, 2007) informants, or by correcting their mistakes (e.g., DeLoache, Sugarman, & Brown, 1985). We hypothesized that the ability to introspect on uncertainty may underlie these skills but note that researchers are just beginning to examine the possible links between uncertainty monitoring and other domains (Coughlin et al., 2013).

More generally, the ability to introspect on uncertainty may lead to a conceptual understanding of uncertainty (Deák et al., 2003) and be associated with theory of mind (Wellman, Cross, & Watson, 2001). All of these constructs reflect some form of understanding of mental states and their connections to behavior, and develop substantially between 3 and 5 years (e.g., Wellman & Liu, 2004). Their relations should be addressed because they may support one another developmentally or rely on similar underlying mechanisms.

In conclusion, we propose that uncertainty monitoring and control may be fundamentally connected to knowledge acquisition and decision making during the preschool years, with implications for concurrent and later learning and educational outcomes. By adopting a metacognitive framework, we have discovered skills in introspection and control earlier in develop-

ment than previously believed, which has opened exciting avenues of inquiry.

### REFERENCES

- Berch, D. B., & Evans, R. C. (1973). Decision processes in children's recognition memory. *Journal of Experimental Child Psychology, 16*, 148–164.
- Chouinard, M. M. (2007). Children's questions: A mechanism for cognitive development. *Monographs of the Society for Research in Child Development, 72*(1, Serial No. 286), 1–129.
- Coughlin, C., Hembacher, E., Lyons, K. E., & Ghetti, S. (2013). *Introspection on uncertainty and judicious help-seeking during the preschool years*. Manuscript under review.
- Deák, G. O., Ray, S. D., & Brenneman, K. (2003). Children's perseverative appearance-reality errors are related to emerging language skills. *Child Development, 74*, 944–964.
- DeLoache, J. S., Sugarman, S., & Brown, A. L. (1985). The development of error correction strategies in young children's manipulative play. *Child Development, 56*, 928–939.
- Dijksterhuis, A., & Aarts, H. (2010). Goals, attention, and (un)consciousness. *Annual Review of Psychology, 61*, 467–490.
- Finn, B. (2008). Framing effects on metacognitive monitoring and control. *Memory & Cognition, 36*, 813–821.
- Fivush, R. (1997). *The development of memory in childhood*. Hove, UK: Psychology Press/Erlbaum (UK) Taylor & Francis.
- Flavell, J. H., Green, F. L., & Flavell, E. R. (1995). Young children's knowledge about thinking. *Monographs of the Society for Research in Child Development, 60*(1, Serial No. 243), v-96.
- Ghetti, S. (2003). Memory for nonoccurrences: The role of metacognition. *Journal of Memory and Language, 48*, 722–739.
- Ghetti, S., Castelli, P., & Lyons, K. E. (2010). Knowing about not remembering: Developmental dissociations in lack-of-memory monitoring. *Developmental Science, 13*, 611–621.
- Ghetti, S., Lyons, K. E., Lazzarin, F., & Cornoldi, C. (2008). The development of metamemory monitoring during retrieval: The case of memory strength and memory absence. *Journal of Experimental Child Psychology, 99*, 157–181.
- Ghetti, S., Mirandola, C., Angelini, L., Cornoldi, C., & Ciaramelli, E. (2011). Development of subjective recollection: Understanding of and introspection on memory states. *Child Development, 82*, 1954–1969.
- Harris, P. L. (1995). The rise of introspection. *Monographs of the Society for Research in Child Development, 60*(1, Serial No. 243), 97–103.
- Hembacher, E., & Ghetti, S. (2013a). *Memory monitoring and decision making during the preschool years*. Manuscript in preparation.
- Hembacher, E., & Ghetti, S. (2013b). How to bet on a memory: Developmental linkages between subjective recollection and decision making. *Journal of Experimental Child Psychology, 115*, 436–452.
- Jaswal, V. K., & Malone, L. S. (2007). Turning believers into skeptics: 3-year-olds' sensitivity to cues to speaker credibility. *Journal of Cognition and Development, 8*, 263–283.
- Kelly, C. M., & Lindsay, D. S. (1993). Remembering mistaken for knowing: Ease of retrieval as a basis for confidence in answers to general knowledge questions. *Journal of Memory and Language, 32*, 1–24.
- Koenig, M. A., & Harris, P. L. (2005). Preschoolers mistrust ignorant and inaccurate speakers. *Child Development, 76*, 1261–1277.

- Koriat, A., & Ackerman, R. (2010). Choice latency as a cue for children's subjective confidence in the correctness of their answers. *Developmental Science, 13*, 441–453.
- Koriat, A., & Goldsmith, M. (1996). Monitoring and control processes in the strategic regulation of memory accuracy. *Psychological Review, 103*, 490–517.
- Kornell, N., Son, L., & Terrace, H. S. (2007). Transfer of metacognitive skills and hint seeking in monkeys. *Psychological Science, 18*, 64–71.
- Linser, K., & Goshke, T. (2007). Unconscious modulation of the conscious experience of voluntary control. *Cognition, 104*, 437–674.
- Lockl, K., & Schneider, W. (2004). The effects of incentives and instructions on children's allocation of study time. *European Journal of Developmental Psychology, 1*, 153–169.
- Lyons, K. E., & Ghetti, S. (2011). The development of uncertainty monitoring in early childhood. *Child Development, 82*, 1029–1033.
- Lyons, K. E., & Ghetti, S. (2013). I don't want to pick! Introspection on uncertainty supports early strategic behavior. *Child Development, 84*, 726–736.
- Mazzoni, G., & Kirsch, I. (2002). Autobiographical memories and beliefs: A preliminary metacognitive model. In T. J. Perfect & B. L. Schwartz (Eds.), *Applied metacognition* (pp. 121–145). New York: Cambridge University Press.
- Metcalfe, J., & Finn, B. (2008). Evidence that judgments of learning are causally related to study choice. *Psychonomic Bulletin & Review, 15*, 174–179.
- Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings. *The Psychology of Learning and Motivation, 26*, 125–173.
- Pasquini, E. S., Corriveau, K. H., Koenig, M., & Harris, P. L. (2007). Preschoolers monitor the relative accuracy of informants. *Developmental Psychology, 43*, 1216–1226.
- Patterson, C. J., Cosgrove, J. M., & O'Brien, R. G. (1980). Nonverbal indicants of comprehension and noncomprehension in children. *Developmental Psychology, 16*, 38–48.
- Pratt, M. W., & Bates, K. R. (1982). Young editors: Preschoolers' evaluation and production of ambiguous messages. *Developmental Psychology, 18*, 30–42.
- Robinson, M. D., Johnson, J. T., & Herndon, F. (1997). Reaction time and assessments of cognitive effort as predictors of eyewitness memory accuracy and confidence. *Journal of Applied Psychology, 82*, 416–425.
- Roebbers, C. M. (2002). Confidence judgments in children's and adults' event recall and suggestibility. *Developmental Psychology, 38*, 1052–1067.
- Rothbart, M. K., Ahadi, S. A., Hershey, K. L., & Fisher, P. (2001). Investigations of temperament at 3–7 years: The Children's Behavior Questionnaire. *Child Development, 72*, 1394–1408.
- Smith, J. D., Shields, W. E., & Washburn, D. A. (2003). The comparative psychology of uncertainty monitoring and metacognition. *Behavioral and Brain Sciences, 26*, 317–373.
- van Gaal, S., & Lamme, V. A. F. (2012). Unconscious high-level information processing: Implication for neurobiological theories of consciousness. *Neuroscientist, 18*, 287–301.
- Wegner, D. M. (2003). The mind's best trick: How we experience conscious will. *Trends in Cognitive Sciences, 7*, 65–69.
- Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: The truth about false belief. *Child Development, 72*, 655–684.
- Wellman, H. M., & Liu, D. (2004). Scaling of theory-of-mind tasks. *Child Development, 75*, 523–541.