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Promoting future-oriented thought in an academic context

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ABSTRACT

Although positive effects of future thinking have been demonstrated, the effects of future thinking on children's academic achievement are less known. We examined the effects of three forms of thinking about the future or alternative outcomes on math performance in 9- to 12-year-olds ($N = 127$). After a math pre-assessment, participants were asked to think about math success according to a between-subjects condition: episodic prospection (episodically simulating a personal future event), semantic prospection (thinking about the future in a non-personal, general sense), or episodic counterfactual thinking (episodically simulating an alternative past event). Results show that semantic prospection promoted gains in mean math accuracy and a greater proportion of 3rd-person visual perspective. A 3rd-person visual perspective also related to gains in mean math accuracy across conditions. Semantic prospection may be a more beneficial form of future thinking in some contexts, perhaps because it supports greater psychological distancing. Academic achievement interventions may benefit from targeting specific forms of future thinking.

Individuals spend considerable effort trying to predict or plan for what the future might bring. While engaged with their immediate environment, their thoughts wander to what is yet to come: a difficult exam scheduled for the following week, a charity run later in the month, or an annual family reunion. This ability to envision personal future events is thought to be adaptive because it allows individuals to predict and plan for possible eventualities (Schacter et al., 2017; Suddendorf & Corballis, 2007; Wilkins & Clayton, 2019). Recent research has begun to test this functional hypothesis by examining whether inducing individuals to envision the future leads to positive, future-oriented action. Findings indicate that inducing this mental activity in adults leads to reduced delay discounting (Peters & Buchel, 2010), cigarette smoking (Daniel et al., 2016), and caloric intake in obese individuals (Dassen, Jansen, Nederkoorn, & Houben, 2016). Positive effects have also been observed earlier in life, with envisioning one's personal future associated with reduced unhealthy snacking in obese 9- to 14-year-olds (Daniel et al., 2016) and less impulsive decision-making in 12- to 16-year-olds (Bromberg, Wiehler, & Peters, 2015).

The reviewed findings indicate that envisioning one's future may encourage actions (e.g., reduce cigarette smoking) associated with better outcomes (e.g., lower risk of lung cancer). However, these findings are from studies of prudent choices in which participants were asked to envision their future immediately prior to making choices (normally between a small reward now versus a larger, later reward). Using an Estonian folktale, Tulving (2005) illustrated how envisioning the future should extend to behaviors beyond

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prudent choices. In this folktale, a child dreams of a party with delicious chocolate pudding which she cannot enjoy because she failed to bring a spoon. The following night, before going to sleep, the young girl puts a spoon under her bed so that she can enjoy the pudding next time. This example aligns with the general theoretical perspective that envisioning the future should not only support prudent choices, but also a range of actions aimed at achieving positive future outcomes (Prabhakar, Coughlin, & Ghetti, 2016; Schacter et al., 2017; Suddendorf & Corballis, 2007; Wilkins & Clayton, 2019). Nascent work supports this proposition by showing that conversations about children's future selves improve their future-oriented decisions and prospective memory (Chernyak, Leech, & Rowe, 2017; Leech, Leimgruber, Warneken, & Rowe, 2019). Here, we extend this work by examining whether future thinking can also support children's academic achievement during late childhood, a time of increasing independence. We elected to focus on math performance as a target behavior given that early math skills are the most significant predictor of subsequent achievement (Duncan & Magnuson, 2011). Persistent difficulty completing math problems during grade school has been associated with a 13% decrease in graduating from high school and a 34% decrease in attending college (Duncan & Magnuson, 2011). Numeracy skills are also important for later professional achievement (Foley, Borgonovi, Guerriero, Levine, & Beilock, 2017).

Critical to our investigation is evidence that math interventions do not need to target math skills to be effective. Mounting data suggest that social factors, including beliefs about math abilities, also affect math performance (Blackwell, Trzesniewski, & Dweck, 2007; DeBellis & Goldin, 2006; De Corte, Op 't Eynde, & Verschaffel, 2002). This evidence suggests that children's math performance may also be sensitive to socio-cognitive interventions that do not operate on strengthening children's math skills (which can require substantial time and resources), but rather on how they face math challenges (i.e., their attitudes, beliefs, and motivation). We therefore questioned whether future-oriented thought might be leveraged to help children overcome math difficulties. Specifically, can children's prior math difficulties be attenuated by encouraging them to think about future situations in which they have the opportunity to overcome past challenges?

1. Varieties in future-oriented thought and mental simulation

One can think about the future in a number of different ways. For this study, we considered different types of future-oriented thought that might support academic achievement and that also seemed within the realm of how a parent or teacher might speak to a child within an academic context. The first type of thinking we considered was episodic prospection, which has been the focus of the majority of studies showing benefits of future-oriented thought (Bromberg et al., 2015; Daniel et al., 2016; Peters & Buchel, 2010). Episodic prospection is the ability to envision a future event that is personal, specific, and rich in contextual detail (Tulving, 1985). In contrast to general knowledge of what a future event might entail (e.g., studying harder will result in a better grade), episodic prospection allows an individual to simulate or pre-live a personal, possible future event in their mind (e.g., seeing oneself studying harder – carefully reading through the textbook and working through all of the practice problems – and feeling proud upon receiving a good grade). Thus, having to episodically simulate a future academic experience might encourage children to walk through the *processes* they should take with considerable *visual clarity*, ultimately affording a more compelling and effective form of mental practice than types of future-oriented thought that do not encourage a similar subjective experience. This possibility aligns with evidence that implementation intentions (if-then plans that specify when, where, and how a person will respond to potential obstacles) facilitate the attainment of future goals (Gollwitzer & Sheeran, 2006). Implementation intentions paired with mental contrasting (i.e., contrasting a desired future academic outcome with potential obstacles) resulted in better grades, attendance, and conduct in economically disadvantaged 11-year-olds than merely thinking positively about future academic achievement (Duckworth, Kirby, Gollwitzer, & Oettingen, 2013). Visualization, and particularly process-focused visualization, also had a positive effect on college students' academic performance (Pham & Taylor, 1999). Indeed, a malleable view of one's intelligence relates to better educational outcomes than a fixed view in children (Dweck, 2007), perhaps because a malleable view increases consideration of the processes required for positive change (Dweck & Master, 2008).

This previous research motivates the prediction that episodic prospection may support academic achievement via enhanced visual clarity and greater consideration of processes. However, this prediction is tempered by evidence that episodic prospection is slow to develop (Abram, Picard, Navarro, & Piolino, 2014; Ferretti et al., 2018; Ghetti & Coughlin, 2018; Prabhakar & Ghetti, 2020; Wang et al., 2014). While the ability to engage in future-oriented behavior suggestive of episodic prospection emerges during the preschool years (see Atance & O'Neill, 2005 and Hudson, Mayhew, & Prabhakar, 2011 for reviews), studies suggest it continues to improve until possibly adolescence (Abram et al., 2014; Coughlin, Lyons, & Ghetti, 2014; Coughlin, Robins, & Ghetti, 2019; Gott & Lah, 2014; Wang et al., 2014). We therefore considered two additional forms of thinking about the future or alternative outcomes, namely semantic prospection and episodic counterfactual thinking, and tested the alternative hypothesis that these forms of thinking might be more beneficial in children. Both semantic prospection and episodic counterfactual thinking have been associated with positive behavioral regulation in adults (Nasco & Marsh, 1999; Palombo, Keane, & Verfaellie, 2016).

Semantic prospection refers to general knowledge, facts, and concepts about the future that are nonpersonal and devoid of episodic detail (Atance & O'Neill, 2001; Klein, Loftus, & Kihlstrom, 2002). This type of thinking shares a future orientation with episodic prospection, but does not involve episodic simulation (i.e., envisioning oneself in the future with high visual clarity). Since children are thought to gain semantic abilities prior to episodic abilities (Nelson, 2001; Coughlin *et al.* 2014), we reasoned that semantic prospection may benefit children who cannot fully engage in episodic prospection. We also considered the possibility that semantic prospection may promote advantageous *psychological distancing* (La Corte & Piolino, 2016). Psychological distancing is a cognitive operation shown to increase self-control in children and adults by shifting attention from emotional distractors toward the bigger picture (Carlson & Zelazo, 2008; Fujita, Trope, Liberman, & Levin-Sagi, 2006; White et al., 2017). Research has shown that taking a self-distanced or 3rd-person visual perspective when remembering a past event allows the individual to reflect on the event with less intense emotion than taking an immersive, egocentric approach (Kross et al., 2005). Benefits of psychological distance have also been observed in the realm of future thinking, with young children demonstrating more accurate future-oriented decisions and predicted preferences for others than for themselves (Lee & Atance, 2016; Russell, Alexis, & Clayton, 2010). Given the non-personal, script-like nature of semantic prospection, we reasoned this form of thinking may promote greater psychological distancing than episodic prospection. This increased psychological distancing may be especially helpful when thinking about future math performance given the high proportion of individuals who experience math-related tension, worry, and anxiety (Luttenberger, Wimmer, & Paechter, 2018).

The final form of thinking we considered was episodic counterfactual thinking, which involves episodically simulating a plausible alternative outcome to a personal past event (De Brigard & Giovanello, 2012). Similar to episodic prospection, episodic counterfactual thinking involves the episodic simulation of a personal event, but it is oriented toward the past. A child engaging in episodic counterfactual thinking might envision what it would have been like to have taken alternative actions during a past academic experience in order to have obtained a better outcome (e.g., envision having studied harder for the last exam and subsequently getting a better grade). By envisioning alternative actions within the context of an existing memory, he or she would obtain mental practice without the demands of having to construct a novel future event. Episodic counterfactual thinking might therefore confer the benefits of episodic simulation with fewer cognitive demands. However, it may also be more constrained and (when anchored to a past failure such as poor math performance) less motivating than episodic prospection. Though there is a lack of consensus surrounding the developmental trajectory of counterfactual thinking, it's been argued that even young children are competent with counterfactuals (Weisberg and Gopnik, 2013). Other work suggests the ability develops until at least middle childhood (Beck, 2020) or even early adolescence (Rafetseder, Schwitalla, & Perner, 2013). Discrepant findings likely reflect the use of tasks that vary along dimensions including whether they are episodic or semantic in nature (Nyhout & Ganea, 2019; Beck, 2020). Here, we are interested in episodic counterfactuals that are anchored to a personal past experience that the individual participated in (and not merely observed). While developmental work on this specific type of counterfactual is very limited, a study on regret found that children as young as five years could engage in this type of thinking (Weisberg & Beck, 2010). We speculate that the developmental trajectory of episodic counterfactual thinking likely overlaps with that of episodic prospection given similarities in their underlying neural systems (Schacter, Benoit, De Brigard, & Szpunar, 2015), but that episodic counterfactual thinking may be less demanding and possibly mature faster than episodic prospection given that it's anchored to a fixed past instead of an uncertain future.

2. The present study

The goal of the present study is to examine whether the unique properties of episodic prospection, semantic prospection, and episodic counterfactual thinking support academic achievement during late childhood through various mechanisms. We therefore compared the influence of these three forms of thinking about the future and alternative outcomes on math performance in 9- to 12-year-olds. We focused on older children given that gains in autonomy and episodic prospection occur during these ages (Prabhakar, Coughlin, & Ghetti, 2016). Math performance was examined within the context of a novel challenge for several reasons. First, we sought to provide a context that was not biased toward a particular form of mentalization. Episodic simulation involves generating a novel and perceptually rich event representation, while semantic prospection involves accessing general knowledge, facts, and scripts about an event. We therefore designed a task that was novel and perceptually rich (providing possible episodic content), and yet still contained elements about which participants possessed general knowledge, facts, and scripts (providing possible semantic content) (see Atance & Metcalf, 2013 for episodic prospection task considerations). Second, we wanted to avoid a task for which older children may have more direct experience and relevant semantic knowledge than younger children. And third, embedding the math task within the context of a novel challenge provided motivation for doing math within the laboratory setting.

In our novel task, the *Picture Discovery Challenge*, participants were asked to solve math problems and for each problem they solved correctly, they received the opportunity to uncover one piece of a puzzle for a subsequent picture discovery game. We ensured that participants would fail to solve the number of math problems required to complete the picture puzzle due to an insufficient time limit (see full task description in Methods section for additional details). This design feature allowed us to create a past experience of math failure that was matched across participants. It also ensured that participants could not rely on memories of past success when asked to think of succeeding at the task later on. After experiencing this failure, and over the course of approximately two weeks, participants completed two Skype interviews during which they were asked to think about a future or alternative situation in which they succeeded at the Picture Discovery Challenge. Of importance, they were instructed to think of the future or alternative situation according to random assignment to one of three between-subjects mentalizing conditions: episodic prospection, semantic prospection, or episodic counterfactual thinking. During each Skype interview, participants described what they were mentalizing and also rated their mentalization experience for visual clarity and adopted visual perspective. Participants' descriptions of their mentalizations were later transcribed and coded for the amount of process-based strategies (i.e., references to the processes or steps needed to do better at any phase of the task) and outcome-based strategies (i.e., references to a positive task outcome, but not the steps required to achieve it) they contained. Participants then returned to the lab to complete the same Picture Discovery Challenge as before, only with new math problems, a different picture puzzle to solve, and no imposed time limit. We assessed math gains by comparing mean math accuracy before versus after the Skype interviews.

Our experimental design allowed us to compare the influence of different forms of thinking about the future or alternative outcomes on children's math performance while also interrogating possible mechanisms through which these types of mentalization may exert an effect. We specifically examined whether there was an effect of mentalizing condition on the *visual perspective*, *visual clarity*, and reported *process-* vs. *outcome-based* strategies reported during Skype interviews, as well as the extent to which these mentalization features related to gains in mean math accuracy following the Skype interviews. If semantic prospection benefits children because it promotes advantageous psychological distancing, then this condition may result in a higher proportion of 3rd-person visual perspective compared to the other two conditions. And, if episodic prospection and episodic counterfactual thinking benefit children because they lead to the simulation of personal events in rich contextual detail, then these conditions may result in higher visual clarity and a greater consideration of process-based strategies. These predictions are predicated on the ability to engage in each form of mentalization, an ability which—especially with respect to the episodic simulation conditions—may not mature until adolescence (e.g., Coughlin et al., 2014; Rafetseder et al., 2013).

3. Method

3.1. Participants

Our sample included 139 participants who were between the ages of 9 and 12 years. Twelve of these participants were excluded from final analyses due to failure to complete all experimental sessions ($n = 6$), failure to respond to interview questions ($n = 1$), IQ below 70 ($n = 1$), neurodevelopmental disorder disclosed after enrollment ($n = 2$), and experimenter error ($n = 2$). The remaining 127 participants were divided into two age groups: 67 younger children ($M = 9.54$ years, $SD = 6.57$ months, range = 8.92–10.92 years, 33 female) and 60 older children ($M = 11.47$ years, $SD = 7.79$ months, range = 11.00–13.00 years, 30 female). Participants were divided into these groups to examine potential age effects given evidence that episodic prospection and forms of counterfactual thinking may exhibit protracted developmental trajectories (e.g., Beck, 2020; Coughlin et al., 2014; Rafetseder et al., 2013; Wang et al., 2014). The final sample was approximately 76% White, 10% Asian American, 10% multiracial, 3% Native American or Alaska Native, and 1% Black. The majority of participants had a family income of $60,000 or greater (85%) and at least one parent with a bachelor's degree (87%). This demographic breakdown reflects families who volunteered to participate in developmental research through community events in a California town.

All participants were fluent in English, without a history of developmental or psychological disorders, and compensated $40 in appreciation of their time. Since an a priori power analysis was not conducted before beginning data collection, a post hoc analysis was conducted with typical parameters (power =0.80, alpha =0.05) to determine how small an effect size could be detected with our sample size. Results indicated we could detect an effect size of $f = 0.15$ for improvement from pre- to post-assessment, and an effect size of $f = 0.16$ for the interaction between improvement from pre- to post-assessment and experimental condition. The study was approved by the Institutional Review Board of the local university. Parents provided written informed consent for all participants.

3.2. Materials and procedure

The experiment occurred across five sessions, each spaced approximately one week apart (see Fig. 1 for a schematic of the design). Participants were randomized to experimental condition at consent, with the only consideration being an (approximately) equal representation of age groups and sex within each condition.

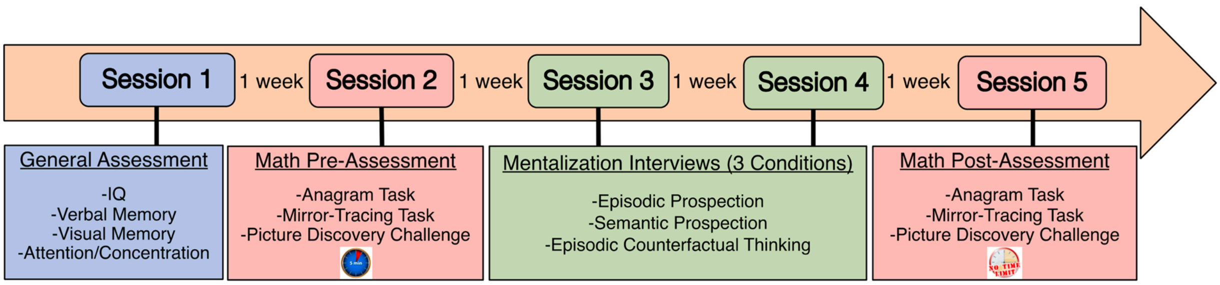

Fig. 1. Schematic of experimental design. Participants completed five sessions spaced approximately one week apart from each other. During session 1, they completed an IQ test (Wechsler, 2011) followed by verbal memory, visual memory, and attention/concentration tests (Sheslow & Adams, 2003) to assess general cognitive function. During session 2, they completed a general persistence battery consisting of an Anagram Task (Eisenberger & Leonard, 1980) in which they attempted to solve difficult word anagrams, and a Mirror-Tracing Task (Matthews & Stoney, 1988) in which they traced the outline of a geometric figure visible only through a mirror. After completing these tasks (see later section for additional details surrounding their selection), participants completed the Picture Discovery Challenge in which they attempted to solve as many of 20 math problems as they could within five minutes in order to complete a picture puzzle. Sessions 3 and 4 consisted of Skype interviews during which they were asked to think about succeeding at The Picture Discovery Challenge according to random assignment to one of three between-subjects mentalization conditions: episodic prospection, semantic prospection, or episodic counterfactual thinking. During session 5, they again completed the general persistence battery and the Picture Discovery Challenge using new anagram and math problem sets along with a new picture puzzle to complete. No time limit was imposed for The Picture Discovery Challenge during this session so that participants had as much time as they wanted to solve the 20 math problems in order to complete the picture puzzle, and could also choose to quit at any time.

3.3. General assessment (Session 1)

During an initial lab visit, participants were administered IQ and memory measures to confirm comparable cognitive function across experimental groups. IQ was assessed using the vocabulary and matrix reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 2011). Memory was assessed using the verbal memory, visual memory, and attention/concentration indices of the Wide Range Assessment of Memory and Learning-2 (WRAML-2; Sheslow & Adams, 2003).

3.4. Story reading for visual perspective scale

We also used this general session to provide an experience that could later be used to acquire visual perspective ratings. During this experience, the experimenter read a short story titled The Story of John and Mary to the participant while sitting across from them. Unbeknownst to the participant, we would later use two pictures of the same setup (only with actors) to illustrate the difference between a 1st- versus 3rd-person visual perspective during Sessions 3 and 4 (when collecting these ratings for the mentalization interviews described later). Specifically—a picture taken from the perspective of the participant's view (i.e., seeing the experimenter display the title page directly in front of them) would be used to illustrate a 1st-person perspective, and a picture taken from the view of an observer (i.e., seeing the scene play out as if one was watching it from the outside, with both the experimenter and participant visible) would be used to illustrate a 3rd-person perspective. Participants were not notified of this hidden purpose at the time of the story reading.

3.5. Math pre-assessment (session 2)

Approximately one week after completing their first visit, participants returned to the lab to complete their math pre-assessment session. At the beginning of this session, they completed two general persistence measures: the Anagram Task (Eisenberger & Leonard, 1980) and the Mirror-Tracing Task (Matthews and Stoney, 1988). We administered these tasks at the beginning of the session to confirm that experimental groups did not differ in general persistence prior to completing the math task. In the Anagram Task, participants attempted to solve eight extremely difficult word anagrams (e.g., the probe DUAYL could be solved with the rare word YAULD). In the Mirror-Tracing Task, they attempted to trace the outline of a geometric figure that they could only see though a mirror. Persistence was computed as time spent per problem on the Anagram Task, and overall time spent on the Mirror-Tracing Task. While motor coordination contributes to performance on the Mirror-Tracing Task, we reasoned that participants who were persistent in doing the tracing well, without going out of the lines often, would also spend more time completing the task compared to others.

Once general persistence had been measured, participants completed the main experimental task, the math assessment, within the context of the Picture Discovery Challenge. Participants were told that their goal was to solve as many of 20 math problems as possible in order to complete a picture puzzle. Math problems alternated between word problems (obtained or adapted from Van Garderen & Montague, 2003) and Raven's matrices (Raven, Raven, & Court, 1998). These problems were selected to be challenging, but not impossible for participants' mathematical skill level (i.e., required a basic understanding of addition, subtraction, multiplication, and division) (California Department of Education, 2013). An example word problem is: "*In a swimming race, Mark is 11 yards behind John, and Annie is 5 yards ahead of Mark. How far ahead of Annie is John?*" (answer: 6 yards). In addition to being displayed on the screen, word problems were read out loud via audio recordings. Raven's matrices problems showed a series of pictures depicting a geometric pattern. For each problem, the participant had to choose which of several geometric shapes completed the pattern. All problems were presented one at a time on a touchscreen tablet. Participants first attempted to solve each problem using a workbook. After circling their answer in their workbook, they advanced to a new screen in which they had to choose an answer from eight response options. The correct response was then highlighted, and participants pressed the "next button" to advance to the next problem. The math task was thus entirely self-paced and designed to contain content that would lend itself to both semantic and episodic mentalization. Since math is a core academic subject, all participants should possess rich semantic knowledge surrounding math and its practices. Episodically, the math task included novel features (e.g., circling answers in a workbook, multiple phases to completing each problem on the touchscreen computer), as well as word and matrix problems that required the ability to consider multiple figures and the relations between them. Research indicates that visualization may help children solve word problems (Foster, 2007) and is used by many people when solving matrix problems (DeShon, Chan, & Weissbein, 1995).

Critically, participants were told they would only have five minutes to complete as many math problems as possible. Once the five minutes had elapsed, they were required to stop the math task and to attempt to complete the picture puzzle by uncovering puzzle pieces hidden in a bin filled with colorful rice. Participants were allowed to take one dig in the box for each math problem they had solved correctly. A participant who solved six math problems was therefore twice as likely to uncover puzzle pieces than a participant who solved three math problems because they had earned double the digs. There was a total of twelve hidden puzzle pieces which together depicted a pleasant line drawing (selected from Cycowicz, Friedman, Rothstein, & Snodgrass, 1997). Participants typically found at least one puzzle piece every other dig, and needed on average half of the puzzle pieces to successfully guess the picture. While there was inherent variability in the number of digs required to uncover all of the puzzle pieces, the five-minute time limit imposed on the math task ensured that no participant earned enough digs to complete the picture puzzle. Thus, everyone was guaranteed a common starting point (i.e., failure to solve enough math problems) for later mentalization.

3.6. Mentalization interviews (sessions 3 and 4)

The experimental manipulation was delivered over the following few weeks. Across two identical Skype interviews spaced approximately a week apart, participants were asked to think about succeeding at the Picture Discovery Challenge according to random assignment to either the episodic prospection, semantic prospection, or episodic counterfactual thinking condition. Two interviews were administered to strengthen the effect of the manipulation. Each interview was conducted by a different research assistant, neither of whom completed the math pre-assessment with the participant. Thus, participants were always interviewed by someone naive to their math pre-assessment experience.

During each interview, the experimenter first confirmed that the participant remembered the original pre-assessment session. After confirming this was the case, they then asked the participant to think about succeeding at the Picture Discovery Challenge according to their assigned mentalization condition (see Table 1 for mentalization script by condition). Those within the episodic prospection condition were prompted to form a contextually-rich, episodic mentalization of themselves succeeding at the Picture Discovery Challenge at a specific time in their personal future. Those within the episodic counterfactual thinking condition were also prompted to form a contextually-rich, episodic mentalization of themselves succeeding at the Picture Discovery Challenge, but one anchored to their personal past, such that they envisioned a different way they could have done things. Those within the semantic prospection condition were prompted to think about someone succeeding at the Picture Discovery Challenge sometime in the future; there was no emphasis on the event being contextually-rich, specific in time, or personal within this condition. All participants were then asked to report the steps needed to succeed at the Picture Discovery Challenge within the context of their mentalization. They were prompted to share as much information as possible, and also received three follow-up questions. These follow-up questions prompted them to consider actions needed to get more digs (intended to draw their attention to math problem strategies) as well as actions to take upon

Table 1
Mentalization interview script for those assigned to the episodic prospection (EP), semantic prospection (SP), and episodic counterfactual thinking (ECT) conditions. Significant wording differences between conditions are in bold.

	Mentalizing Condition	
EP	SP	ECT
Main Instructions		
Think about **one specific time in the upcoming weeks** when **you will play** the Picture Discovery Challenge again in this lab and **will do really well** at it. Try to **get a really clear picture** in your head.	Think about **sometime in the upcoming weeks** when **someone will play** the Picture Discovery Challenge in this lab and **will do really well** at it. **Think** about it.	Think about that **specific time in the last few weeks** when **you played** the Picture Discovery Challenge in this lab and a **different way things could have happened** so that you **would have done really well** at it. Try to **get a really clear picture** in your head.
Have you worked as hard as you can to **have a clear picture of one specific time in the upcoming weeks when you will play** the Picture Discovery Challenge again in this lab and **will do really well** at it?"*(wait for "yes" response)*	Have you worked as hard as you can to **think about sometime in the upcoming weeks when someone will play** the Picture Discovery Challenge in this lab and **will do really well** at it?" *(wait for "yes" response)*	Have you worked as hard as you can to **have a clear picture of that specific time in the last few weeks when you played** the Picture Discovery Challenge in this lab and a **different way things could have** happened so that you **would have done really well** at it?" *(wait for "yes" response)*
Okay, now tell me, in this **specific future time, what you see yourself doing** to succeed at the Picture Discovery Challenge in this lab. When you're ready, please start by saying: "To **do really well** at the Picture Discovery Challenge, **I will** _____." *(prompt until they can think of nothing else)*	Okay, now tell me, in this **future time, what one should do** to succeed at the Picture Discovery Challenge in this lab. When you're ready, please start by saying: "To **do really well** at the Picture Discovery Challenge, **someone should** _____." *(prompt until they can think of nothing else)*	Okay, now tell me, in this **different past, what you see yourself doing** to succeed at the Picture Discovery Challenge in this lab. When you're ready, please start by saying: "To **have done really well** at the Picture Discovery Challenge, **I could have** _____." *(prompt until they can think of nothing else)*
Follow-Up Questions		
• Tell me more about what **you see you will do** to get more digs. • Tell me more about what **you see you will do** when you get a dig. • Anything else you'd like to add about this **one specific time in the upcoming weeks** when **you will play** the Picture Discovery Challenge **again** in this lab and **will do really well** at it?	• Tell me more about what **one should do** to get more digs. • Tell me more about what **one should do** when they get a dig. • Anything else you'd like to add about **sometime in the upcoming weeks** when **someone will play** the Picture Discovery Challenge in this lab and **will do really well** at it?	• Tell me more about what **you see you could have done** to have gotten more digs • Tell me more about what **you see you could have done** when you got a dig. • Anything else you'd like to add about that **specific time in the last few weeks** when **you played** the Picture Discovery Challenge in this lab and a **different way things could have happened so that you would have done really well** at it?

earning digs (intended to draw their attention to solving the picture puzzle). Although our interest was in the influence of mentalization on math performance specifically, we did not want to bias mentalization content by only prompting the consideration of one part of the event. Of importance, follow-up questions were also worded to be more episodic or semantic in nature depending on the participant's mentalization condition. At the end of each interview, participants were asked to rate the visual perspective (1st-person perspective '0' versus 3rd-person perspective '1') and clarity (ranging from very unclear '0' to perfectly clear '5') of their mentalization. A visual scale including two pictures from the *Story Time Experience* that occurred during Session 1—one taken from a 1st-person perspective and the other from a 3rd-person perspective—was used to facilitate the collection of visual perspective ratings. A visual scale that included six pictures of a face and thought bubble—with the contents of the thought bubble transitioning from a blank picture to a very clear and vibrant picture—was used to facilitate the collection of clarity ratings (Ghetti & Alexander, 2004). Prior work has shown that children as young as five years can easily provide ratings with the use of these scales (Coughlin et al., 2014).

Table 2

Examples of reported strategies by age group. Strategies are followed by abbreviations indicating the participant's assigned mentalizing condition (EP: episodic prospection, SP: semantic prospection, and ECT: episodic counterfactual thinking) and the strategy type they represent (proc: process-based, out: outcome-based). Each example may include more than one strategy.

Age Group	Strategy
9-10 Years	
• I'll probably try to think it out step by step to try to think of what it's actually asking me. [EP-proc]	
• I will try to look at the, like read them more carefully—the problems—more carefully, that way I don't have to go back and read them again. [EP-proc]	
• I will remember all the math lessons that I've ever been taught. [EP-proc]	
• I could have numbered the problems, and umm draw(n) out some of the problems to help me figure it out. [ECT-proc]	
• I could have checked over my answers. [ECT-proc]	
• They can try different ways to try to answer. And if they get different answers each time, they should try a new way and then if they get the different—and then if they get the same answer for the problems they got, they should say that's the answer. [SP-proc]	
• They should maybe break apart the problems and then put them together and then it might help them figure out the problems. [SP-proc]	
• Well something that I think I did too much was think about how-how other people did on it…instead of focusing on what I should have done. [SP-proc]	
• I would be very prepared because I know what to expect; I'll know to concentrate. [EP-proc]	
• I'll dig deep but not far, that way I don't make too big of a dig, and so that I can get more of the deep puzzle pieces. [EP-proc]	
• If I get more than one dig, I will try to dig in different places, not in one place because there's less of a chance of two being close together. [EP-proc]	
• I could've gotten more puzzle pieces. [ECT-out]	
• Hmm… I could've looked at it in different angles instead of just being one angle. [ECT-proc]	
• When they get a dig, they should get piece…they should get the piece. [SP-out]	
11-12 Years	
• I will have to look at them for a few minutes before I can solve them. [EP-proc]	
• I will check my answers before I tap the screen. [EP-proc]	
• I will get the math problems right. [EP-out]	
• I will try my hardest [EP-proc]	
• I could have, um, taken more care to write down the problem better than just kind of scribbling it down, because it was too messy and I had to start over. [ECT-proc]	
• I could have maybe studied it harder, like look at it more and try to understand it. [ECT-proc]	
• I could have just decided to be a bit more… not as, well… not as stressed about trying to get as many as I can and just taking it by my own time. [ECT-proc]	
• Someone should (…) like draw pictures to help them better understand. [SP-proc]	
• Someone should work faster on the math problems. [SP-proc]	
• They should also be very cautious and make sure they don't get like anything messed up, look over their work. [SP-proc]	
• Someone should uh try their hardest and not to give up. [SP-proc]	
• I see myself putting the pictures together to see what could be possible. [EP-proc]	
• So when I got a dig, I got two puzzle pieces. And at one point I even saw the other puzzle piece, and I was going for it, but my shovel was already full. I think I should have concentrated more on the actual puzzle piece that I saw instead of actually going for the puzzle piece that I didn't see. [ECT-proc]	
• And then when they get (the pieces), they want to try every um angle that they could for the picture to find out what it looks like. [SP-proc]	
• And then you could put them together if you get more pieces. And do the same thing, see if you can connect—Let's say there's two lines, maybe if you could try to like, connect the lines, so they make one connecting line. [SP-proc]	

3.7. Math post-assessment (session 5)

Approximately one week after their final interview, participants returned to the lab to complete a surprise math post-assessment session. Participants were first asked to complete the Anagram (Eisenberger & Leonard, 1980) and Mirror-Tracing Tasks (Matthews & Stoney, 1988). Administering these general persistence measures again ensured that the math pre- and post-assessment sessions were directly comparable. After completing the Anagram and Mirror Tracing Tasks, participants again completed the main experimental task, the math assessment, within the context of the Picture Discovery Challenge.

The setup of the math post-assessment session was identical to that of the math pre-assessment, including the identity of the research assistant working with the participant, except for two critical differences. First, there was no time limit imposed on the Picture Discovery Challenge; participants could spend as much time on the math problems as they wanted and could also choose to quit the task at any time. This timing change created a post-assessment context that was not simply a "re-casted" past event. In the real world, children are unlikely to mentalize about exact future events (which typically involve some degree of uncertainty or novelty). We therefore thought it important to create a post-assessment context that contained many of the past event features, but that was not identical to it. Eliminating the time limit also provided an opportunity for participants to succeed at the math problems through their own actions. Second, two sets of anagram problems, math problems, and puzzle pieces were used and counterbalanced across the pre- and post-assessment sessions so that participants were always tested using novel stimuli. For example, participants who were administered math problem set "a" during their pre-assessment session were administered math problem set "b" during their post-assessment session, and vice-versa. This change further allowed us to measure the effect of mentalization on math performance within the context of an experience that shared features of the past event but that was still novel. The primary outcome measure was gain in *mean math accuracy* (i.e., the number of correctly solved problems divided by the total number of problems completed) from pre- to post-assessment.

3.8. Strategy coding

Skype interviews were video recorded and transcribed. Two independent raters then counted the number of process- and outcome-based strategies reported within each interview for each participant. A process-based strategy was defined as a strategy that referenced the processes or steps needed to do better on the Picture Discovery Challenge. These strategies described taking concrete actions, engaging in specific cognitive processes, engaging in behavioral or emotional self-regulation, increasing effort, or working on academic skills. An outcome-based strategy was defined as a strategy that referenced achieving a specific outcome, but not the steps required to achieve it. In rare instances, participants reported strategies that involved changes to a feature of the event that was outside their control (e.g., "*If I had more time, I could've done better.*"). We lumped these strategies into the outcome-based category given that they seemed to indicate a failure to take action or responsibility for achieving a more positive outcome. See Table 2 for examples of reported strategies.

Since participant reports tended to vary by mentalizing condition (e.g., referencing the future if assigned to the episodic prospection condition and the past if assigned to the episodic counterfactual thinking condition), it was impossible to maintain true blindness to experimental condition. However, raters were never told participants' assigned experimental condition and age, nor the predicted effects of the experimental manipulation. An inter-rater reliability analysis conducted on approximately 95% of the transcripts revealed high reliability for both strategy types (Cronbach's standardized $\alpha > 0.86$). Discrepancies between raters were resolved via discussion, with all final scores reflecting agreement between raters.

3.9. Text analysis

A text analysis of the transcribed Skype interviews was also completed to substantiate our use of visual perspective and clarity visual scales. For this analysis, all words spoken by the experimenter during the mentalization interviews were removed from each transcript. Edited transcripts were then run through the Linguistic Inquiry and Word Count software (LIWC2015; Pennebaker, Booth, Boyd, & Francis, 2015). This software quantifies content by comparing each word in a text against specified dictionaries. LIWC2015 includes many built-in dictionaries for parts of speech. For example, there is a broad "pronouns" dictionary which encompasses more specific pronoun dictionaries such as "I" and "You" dictionaries. We collapsed across several specific pronoun dictionaries to quantify text reflecting a 1st- versus 3rd-person visual perspective. The "I" and "We" dictionaries were added together to create a *1st-person visual perspective* dictionary (see Chernyak et al., 2017 for a similar, non-automated approach). The "You", "She/He", and "They" dictionaries were added together—in addition to a custom-built dictionary that included references to "Someone" and "Somebody"—to create a *3rd-person visual perspective* dictionary. The built-in "adjectives" dictionary was used as a *clarity* dictionary, with the reasoning being that more clear mentalizations may be associated with more descriptive language. LIWC2015 then used these dictionaries to quantify the percentage of words within each transcript (i.e., the total number of category words divided by the total number of words in the text) that reflected a 1st-person visual perspective, a 3rd-person visual perspective, and clarity. The percentage of 1st- and 3rd-person pronouns thus did not sum to 100% because percentages were out of all words included in the mentalization description (i.e., nouns, adjectives, articles, other pronouns, etc.).

4. Results

4.1. Preliminary analyses

4.1.1. Pre-assessment and baseline performance

Preliminary analyses first examined whether experimental groups differed in performance on the pre-assessment math and persistence measures, as well as the baseline cognitive function measures (Table 3). A one-way ANOVA revealed no significant effect of mentalizing condition on pre-assessment math performance (measured as mean accuracy; $F(2,124) = 2.79$, $p = .065$, $\eta_p^2 = .043$). Despite not meeting the threshold for statistical significance, we consider the fact that this significance value was low in subsequent analyses. Importantly, there were also no significant effects of mentalizing condition on the pre-assessment Anagram Task ($F(2,122) = 0.88$, $p = .416$, $\eta_p^2 = .01$), pre-assessment Mirror-Tracing Task ($F(2,121) = 0.22$, $p = .806$, $\eta_p^2 < .01$), IQ ($F(2,124) = 0.06$, $p = .940$, $\eta_p^2 = .01$), verbal memory ($F(2,123) = 2.19$, $p = .116$, $\eta_p^2 = .03$), visual memory ($F(2,123) = 0.22$, $p = .805$, $\eta_p^2 < .01$), and attention/concentration measures ($F(2,124) = 0.92$, $p = .400$, $\eta_p^2 = .02$). We additionally found no effect of mentalizing condition on *change* in persistence from pre- to post-assessment on the Anagram ($F(2,121) = 0.33$, $p = 0.721$, $\eta_p^2 = .01$) and Mirror-Tracing Tasks ($F(2,121) = 0.38$, $p = 0.687$, $\eta_p^2 = .01$). Together, these findings indicate that experimental groups were highly similar in their persistence and cognitive function.

4.1.2. Correspondence between visual scale ratings and mentalization descriptions

Preliminary analyses next examined whether the visual perspective and clarity ratings participants reported were reflected in how they described their mentalization experience during the Skype interviews. Specifically, we correlated participants' mean visual perspective and clarity ratings (averaged across both interviews) with the percentage of their mentalization descriptions that reflected each respective category (outputted from LIWC2015 and collapsed across both interviews). We found that 3rd-person visual perspective ratings were associated with the percentage of 1st-person ($r(122) = -0.20$, $p = .025$) and 3rd-person ($r(122) = 0.20$, $p = .028$) pronouns participants included in their mentalization descriptions. Participants who reported a 3rd-person visual perspective included a smaller proportion of 1st-person pronouns and a greater proportion of 3rd-person pronouns in their mentalization descriptions. The correlation between participants' mean clarity rating and the percentage of adjectives in their mentalization descriptions was not significant ($r(122) = 0.17$, $p = .056$), but did follow the expected pattern, such that individuals with higher clarity ratings tended to include a greater proportion of adjectives in their descriptions. These results suggest that the visual perspective and clarity ratings tracked actual features of participants' mentalizations and substantiate the use of these visual scale ratings in subsequent analyses.

4.2. Analyses of experimental manipulation

4.2.1. Math performance

We next examined the effect of our experimental manipulation on math performance gains by entering mean math accuracy (i.e., number of math problems correctly solved divided by total number of math problems completed) into a 3 (mentalizing condition: episodic prospection, semantic prospection, episodic counterfactual thinking) x 2 (assessment time: pre vs. post) x 2 (age: younger children vs. older children) mixed-effects ANOVA. Results revealed main effects of age ($F(1,121) = 7.80$, $p = .006$, $\eta_p^2 = .06$) and

Table 3
Performance on baseline, pre-assessment, and post-assessment measures across episodic prospection (EP), semantic prospection (SP), and episodic counterfactual thinking (ECT) conditions.

Measure	Mentalizing Condition			p-value
	EP (n = 43–44)	SP (n = 41–42)	ECT (n = 40–41)	
Baseline Session				
IQ	116.52 (113.06–119.98)	116.26 (111.87–120.65)	115.61 (112.13–119.09)	0.940
Verbal Memory	106.2 (101.93–110.48)	101.00 (96.68–105.32)	100.90 (96.97–104.84)	0.116
Visual Memory	95.41 (91.32–99.49)	97.00 (93.42–100.58)	95.46 (91.51–99.41)	0.805
Attention / Concentration	111.43 (107.63–115.24)	107.45 (102.90–112.00)	108.78 (104.24–113.32)	0.400
Pre-Assessment Session				
Anagram Task (m:s)	1:09 (0:51–1:27)	1:25 (1:12–1:37)	1:14 (0:53–1:35)	0.416
Mirror-Tracing Task (m:s)	4:50 (3:18–6:21)	4:33 (3:04–6:02)	5:15 (3:44–6:46)	0.806
Mean Math Accuracy	0.47 (0.38–0.55)	0.32 (0.22–0.42)	0.43 (0.35–0.51)	0.065
Post-Assessment Session				
Anagram Task (m:s)	0:34 (0:28–0:40)	0:43 (0:35–0:52)	0:40 (0:28–0:51)	0.258
Mirror-Tracing Task (m:s)	2:36 (1:57–3:15)	2:15 (1:54–2:37)	2:19 (1:45–2:53)	0.632
Mean Math Accuracy	0.50 (0.45–0.55)	0.50 (0.44–0.55)	0.46 (0.40–0.53)	0.575

Note: Mean math accuracy was computed as the total number of word and matrix reasoning problems answered correctly divided by the total number of problems completed (chance performance = 0.125). Scores for some measures were not obtained for one participant per experimental group. 95% confidence intervals in parentheses. P-value indicates the effect of mentalizing condition.

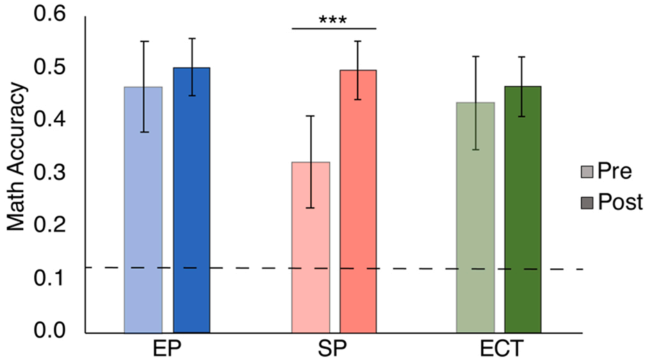

Fig. 2. Mean math accuracy from pre- to post-assessment by mentalizing condition. EP: episodic prospection, SP: semantic prospection, ECT: episodic counterfactual thinking. Dashed line shows chance performance. Bars represent 95% confidence intervals. ***$p = .001$.

assessment time ($F(1,121) = 9.36$, $p = .003$, $\eta_p^2 = .07$) on mean math accuracy. Overall, older children (M =0.50, 95% CIs [.45,.55]) were more accurate than younger children, (M =0.40, 95% CIs [.36,.45]), and accuracy was greater in the post-assessment (M =0.49, 95% CIs [.46,.52]) than in the pre-assessment (M =0.41, 95% CIs [.36,.46]). The main effect of assessment time was further qualified by an assessment time x mentalizing condition interaction ($F(2,121) = 3.35$, $p = .039$, $\eta_p^2 = .05$) (Fig. 2). Simple effects analyses revealed that participants within the semantic prospection condition experienced a significant gain in accuracy from pre- to post-assessment ($t(1,41) = 3.67$, $p = .001$); this was not true for participants within the episodic prospection ($t(1,43) = 0.85$, $p = .398$) and episodic counterfactual thinking ($t(1,40) = 0.72$, $p = .474$) conditions. The assessment time x mentalizing condition x age interaction was not significant ($F(2,121) = 0.07$, $p = .931$, $\eta_p^2 = .001$), indicating that the effect of our experimental manipulation on math performance did not differ between younger and older children. Though gains in mean math accuracy was our primary outcome measure, see Supplemental Information for an exploratory analysis showing no effect of our manipulation on the number of math problems completed.

4.2.2. Post-hoc analysis: examination of pre-assessment mean math accuracy

Preliminary analyses indicated that there was not a significant effect of experimental condition on pre-assessment math performance. However, given that the effect approached statistical significance ($p = .065$), and that pre-assessment performance was lowest in the semantic prospection condition, we probed the effect of our experimental manipulation on math gains when pre-assessment performance was better equated across the three conditions. Taking a subsampling approach, we randomly removed participants in the semantic group with a pre-assessment score of 0% until the effect of experimental condition on pre-assessment math performance was above a trend level (p-value > 0.10). Random removal of two participants within the semantic prospection group achieved this increased p-value. We then re-ran our main analysis of the experimental manipulation, a 3 (mentalizing condition: episodic prospection, semantic prospection, episodic counterfactual thinking) x 2 (assessment time: pre vs. post) x 2 (age: younger children vs. older children) mixed-effects ANOVA on math performance in the reduced sample ($N = 125$). Although the assessment time x mentalizing condition interaction fell short of conventional levels of statistical significance ($F(2,119) = 2.92$, $p = .058$, $\eta_p^2 = .05$), the gain from pre- to post-assessment in the semantic condition remained significant ($t(1,39) = 3.43$, $p = .001$) even after removing these

Table 4
Performance on mentalization measures by mentalizing condition—episodic prospection (EP), semantic prospection (SP), and episodic counterfactual thinking (ECT)—and age.

Measure	Age Group	Mentalizing Condition		
		EP ($n = 43$–44)	SP ($n = 42$)	ECT ($n = 41$)
Visual Perspective	9–10 Years	0.35 (0.17–0.54)	0.64 (0.48–0.80)	0.30 (0.13–0.46)
	11–12 Years	0.45 (0.25–0.65)	0.50 (0.32–0.68)	0.39 (0.21–0.58)
Clarity	9–10 Years	3.68 (3.39–3.97)	3.93 (3.59–4.27)	3.63 (3.34–3.91)
	11–12 Years	3.65 (3.30–4.00)	3.55 (3.10–4.00)	3.89 (3.62–4.17)
Process-Based Strategies	9–10 Years	5.65 (4.08–7.22)	7.17 (6.07–8.26)	5.20 (4.28–6.13)
	11–12 Years	7.30 (6.37–8.23)	6.07 (4.88–7.26)	7.00 (5.92–8.08)
Outcome-Based Strategies	9–10 Years	0.93 (0.61–1.26)	1.17 (0.79–1.54)	0.80 (0.32–1.27)
	11–12 Years	0.73 (0.32–1.13)	1.21 (0.65–1.78)	1.13 (0.64–1.63)

Note: Visual perspective (1st-person perspective coded as '0' and 3rd-person perspective coded as '1') and clarity (coded on a 6-point Likert scale ranging from unclear '0' to perfectly clear '5') reflect mean rating across the two skype interviews. Srategy data is missing for one participant assigned to the episodic prospection condition. 95% confidence intervals in parentheses.

participants. That our experimental groups were largely comparable on the persistence and other cognitive function measures provides additional confidence in the specificity of this effect. However, additional work that replicates this pattern of results using similar experimental designs is important moving forward.

4.3. Mentalization experience

Our results provide some support for an effect of our experimental manipulation on mean math accuracy, but do not indicate whether the manipulation affected the intended aspects of the mentalization experience. To address this question, we examined whether there was an effect of mentalizing condition on participants' visual perspective and clarity ratings, as well the number and type of strategies reported during mentalization (see Table 4 for means by age and condition).

4.3.1. Visual perspective and clarity ratings

Separate 3 (mentalizing condition: episodic prospection, semantic prospection, episodic counterfactual thinking) x 2 (interview: first vs. second) x 2 (age: younger children vs. older children) mixed-effects ANOVAs assessed the effect of mentalizing condition on visual perspective and clarity ratings. Interview number was included in these analyses because we administered two interviews in an attempt to strengthen the experimental manipulation. We reasoned that condition differences may be stronger in the second versus first interview.

Results revealed a main effect of mentalizing condition on visual perspective rating ($F(2,121) = 3.70$, $p = .027$, $\eta_p^2 = .06$) (Fig. 3a). This effect was due to a greater proportion of 3rd-person visual perspective ratings within the semantic prospection condition compared to both the episodic counterfactual thinking ($t(81) = 2.78$, $p = .007$) and episodic prospection ($t(84) = 2.00$, $p = .048$) conditions (which did not differ from each other, $p = .522$). Participants within the semantic prospection condition were therefore more apt to adopt a visual perspective associated with psychological self-distancing (Kross et al., 2005).

Results also revealed a mentalizing condition x interview x age interaction on clarity ratings ($F(2,121) = 6.24$, $p = .003$, $\eta_p^2 = .09$). Simple-effects analyses revealed differences by mentalizing condition during the first interview only for both age groups (Fig. 4a). During this interview, younger children provided higher clarity ratings in the semantic condition compared to the episodic prospection condition, $t(43) = 2.10$, $p = .041$ (all other comparisons in younger children: $ps > 0.064$). A different pattern was observed in older children who provided higher clarity ratings in the episodic counterfactual thinking condition compared to the semantic prospection condition, $t(38) = 2.82$, $p = .008$ (all other comparisons in older children: $ps > 0.078$). This pattern of results was complemented by a significant age-related decrease in clarity within the semantic prospection condition ($t(40) = -2.26$, $p = .029$) and a significant age-related increase in clarity within the episodic counterfactual thinking condition ($t(39) = 2.67$, $p = .011$) (effect of age within episodic prospection condition: $p = .225$). Thus, while younger children reported greatest clarity in the semantic prospection condition, there was a shift with age such that older children's mentalizations were most clear when engaging in a form of episodic simulation.

4.3.2. Reported strategies

We next examined whether the number and type of reported strategies differed by mentalizing condition via a 2 (strategy type: process-based vs. outcome-based) x 3 (mentalizing condition: episodic prospection, semantic prospection, episodic counterfactual thinking) x 2 (interview: first vs. second) x 2 (age: younger children vs. older children) mixed-effects ANOVA. Five participants were excluded from this analysis due to missing data from either one ($n = 4$) or both ($n = 1$) Skype interviews. Results revealed a main effect of strategy type ($F(1,116) = 479.94$, $p < .001$, $\eta_p^2 = .81$) such that participants reported more process-based strategies ($M = 6.35$, 95% CIs [5.87, 6.82]) than outcome-based strategies ($M = 0.95$, 95% CIs [0.78, 1.12]) per Skype interview. There was also a mentalizing

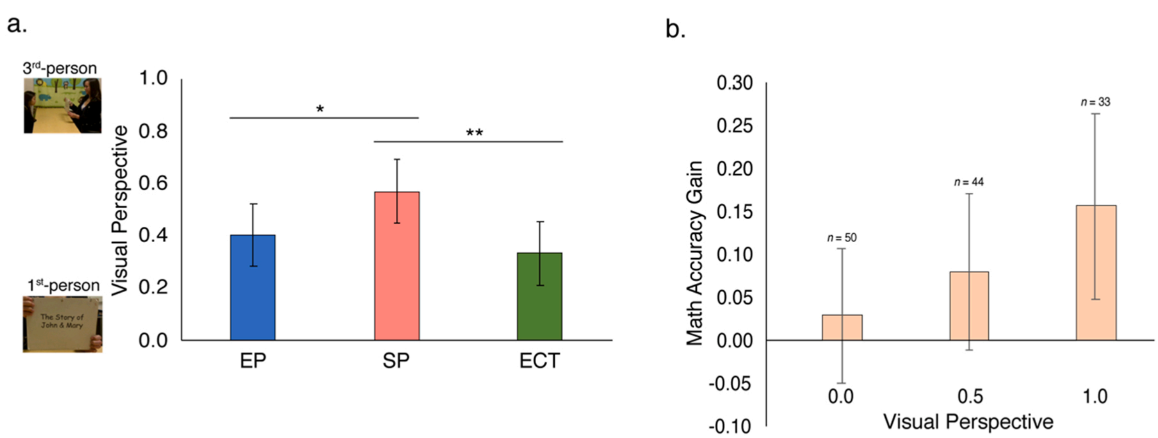

Fig. 3. (a) Mean visual perspective rating by mentalizing condition and (b) mean math accuracy gain by visual perspective rating. EP: episodic prospection, SP: semantic prospection, ECT: episodic counterfactual thinking. For part (b), visual perspective ratings were binned by response type for visualization purposes only (0.0 = 1st-person perspective, 0.5 = mixed perspective, 1.0 = 3rd-person perspective). Bars represent 95% confidence intervals. $^{**}p < .01$; $^{*}p < .05$.

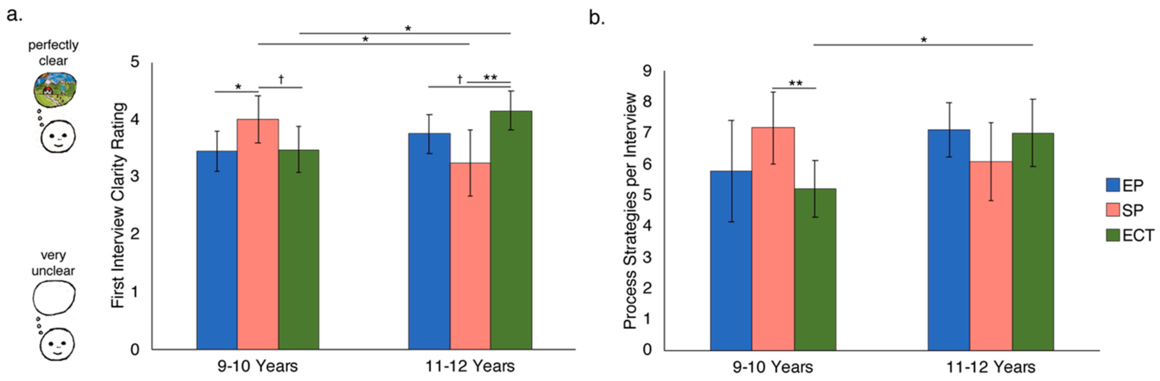

Fig. 4. (a) First interview clarity rating and (b) process strategies reported (per interview) by mentalizing condition and age. EP: episodic prospection, SP: semantic prospection, ECT: episodic counterfactual thinking. Bars represent 95% confidence intervals. $^{**}p < .01$; $^{*}p < .05$; $^{\dagger}p < .10$.

condition x age interaction ($F(2,116) = 3.406$, $p = .037$, $\eta_p^2 = .06$) that was subsumed by a strategy type x mentalizing condition x age interaction ($F(2,116) = 3.234$, $p = .043$, $\eta_p^2 = .05$). This result was driven by a mentalizing condition x age interaction on process-based strategies ($F(2,116) = 3.63$, $p = .030$, $\eta_p^2 = .06$) (Fig. 4b) but not on outcome-based strategies ($F(2,116) = 1.04$, $p = .355$, $\eta_p^2 = .02$). Simple effect analyses showed that younger children reported more process-based strategies in the semantic prospection condition compared to the episodic counterfactual thinking condition, $t(40) = 2.81$, $p = .008$ (all other comparisons in younger children: $.158 < ps < .531$). In contrast, the number of process-based strategies reported by older children did not differ between mentalizing conditions ($.173 < ps < .875$). However, there was an age-related increase in the number of process-based strategies reported in the episodic counterfactual thinking condition ($t(39) = 2.66$, $p = .011$) that was not evident in the other mentalizing conditions ($.160 < ps < .185$). Thus, while younger children reported more process-based strategies within the semantic prospection condition, this was not the case for older children.

4.3.3. Relation between mentalization and math performance

The effect of our manipulation on both mentalization and math performance raises the question of whether the two are related within individuals. We therefore used a multiple regression analysis to examine whether aspects of the mentalization experience predicted gains in mean math accuracy across the entire sample. Predictors included mean visual perspective rating, mean clarity rating, and mean reported process-based strategies. Age (in months) and pre-assessment math accuracy were added to the model to control for general cognitive development and math ability. The overall regression model was significant, $F(5,120) = 6.95$, $p < .001$, adjusted $R^2 = .19$. In addition to age ($\beta = 0.20$, $p = .022$) and pre-assessment math accuracy ($\beta = 0.25$, $p = .004$), mean visual perspective rating ($\beta = 0.26$, $p = .002$) significantly predicted post-assessment math accuracy. Across all participants, taking a 3rd-person visual perspective during mentalization predicted greater post-assessment accuracy controlling for pre-assessment performance (Fig. 3b). This effect cannot be attributed to a higher proportion of 3rd-person visual perspective ratings within the semantic prospection condition alone, since it remained even when the semantic prospection condition was excluded from the analysis ($\beta = 0.25$, $p = .016$). Neither mean process-based strategies ($\beta = 0.03$, $p = .698$) nor mean clarity rating ($\beta = 0.10$, $p = .231$) predicted post-assessment math accuracy in this individual difference analysis. Multicollinearity analyses revealed tolerance values > .89 for all predictors.

5. Discussion

This study examined the effects of episodic prospection, semantic prospection, and episodic counterfactual thinking on math performance in 9- to 12-year-olds. Though each type of mentalization has been associated with positive behavioral effects in adults (Nasco & Marsh, 1999; Palombo et al., 2016; Peters & Buchel, 2010), we are unaware of any study that has contrasted their effects within a single paradigm at any point in development. Results therefore provide valuable insight into the function of these three abilities, as well as additional knowledge surrounding cognitive processes that may be targeted to support academic achievement in children.

Engaging in semantic prospection resulted in significant math gains from pre- to post-assessment. Semantic prospection involves thinking about the future in a non-personal, general manner. This type of future-oriented thought might help children view a future challenge with greater objectivity. Indeed, prior research has shown that children who pretend to be Batman perform better on executive function tasks, likely because pretending creates an experience of psychological distance (White et al., 2016). Children are also more accurate when doing future-oriented reasoning for others (e.g., an unfamiliar peer) than for themselves (Lee & Atance, 2016). Of note, Liberman and Trope (2014) have suggested there is a continuum of psychological distance within various domains. Within the social domain, members of an outgroup may be perceived as more distant from the self than people viewed as similar or familiar to one’s self. Encouraging children to reason about “someone” within the semantic prospection condition (versus a more familiar individual, such as a classmate) may have therefore been particularly effective at enhancing psychological distance.

While psychological distance likely benefits most challenges, it may have been especially beneficial within the context of the Picture Discovery Challenge. Though this task was game-like in nature, it required that children solve math problems online with an adult researcher observing their performance. Research suggests that anxiety surrounding math is unrestricted to testing (Hembree, 1990) and may result in an avoidance of math-related situations (Suarez-Pellicioni et al., 2016). Psychological distancing may have therefore not only increased objectivity, but also attenuated math-related anxiety. Such anxiety would likely be even greater in traditional school contexts. Future work that tests the generalizability of our findings to these and other contexts while also incorporating objective measures of state-based anxiety could provide additional insight.

The greater proportion of 3rd-person visual perspective taking in the semantic prospection condition is consistent with the hypothesis that the benefits of this form of mentalization stemmed from psychological distancing. Research has shown that a 3rd-person visual perspective relates to a greater focus on the objective features of an event, whereas a 1st-person visual perspective results in richer accounts of emotion, physical sensations, and psychological states associated with the event (McIsaac & Eich, 2002). Taking a 3rd-person perspective may also encourage a greater perception of events as challenges rather than threats (Kross et al., 2014), perhaps leading to an adaptive shift in understanding (Wallace-Hadrill & Kamboj, 2016). Of importance, a 3rd-person perspective was positively associated with math gains across all conditions. This convergence of results between the experimental manipulation and the individual difference analysis underscores that a greater proportion of 3rd-person visual perspective within the semantic prospection condition was not epiphenomenal, and instead speaks to a potential mechanism underlying the observed benefit of this form of future thinking.

Our results also complement prior education research showing benefits of metacognitive instruction and expansive framing, both of which may have been more inherent to the semantic prospection condition. When examining the association between teacher instructional talk and growth in math concepts, Zepeda and colleagues found that teachers' support of metacognition via statements (e.g., "*think about that for a minute*" and "*what should we do now*") related to greater growth in math concepts (Zepeda, Hlutkowsky, Partika, & Nokes-Malach, 2019). Similar instructional statements in the semantic prospection condition (e.g., "*think about it*" and consider "*what one should do*") may have promoted greater consideration of metacognitive strategies known to have educational benefits (Dignath & Büttner, 2008; Hattie, Biggs, & Purdie, 1996). Mahy and colleagues have also suggested that auxiliary verbs such as "*should*" may prime more rational responding via psychological distancing than auxiliary verbs such as "*want*" (Mahy et al., 2020). While an auxiliary verb manipulation did not influence delay choices in their study with younger children (Mahy et al., 2020), it is possible that the older children in our study were sensitive to the use of "*should*" in the semantic prospection condition. It is also possible that encouraging participants to think about the future more broadly in terms of the agent (i.e., someone) and temporal period (i.e., sometime in the future) in the semantic prospection condition may have resulted in greater transfer to the post-assessment session. Indeed, students are more likely to transfer learning when they are asked to contribute to conversations that extend across time, places, and people (Engle et al., 2012). While these connections to existing literature are speculative, they introduce ideas whose pursuit may provide insight into the underlying mechanisms and potential application of semantic prospection in educational settings.

Contrary to research showing an adaptive advantage of episodic prospection (Bromberg et al., 2015; Peters & Buchel, 2010), we did not observe an influence of this type of mentalization on math performance. This discrepancy may be partly due to differences between samples. The majority of developmental work showing positive effects of episodic prospection on delayed discounting has been done with adolescents (Bromberg, Lobatcheva, & Peters, 2017; McCue, McCormack, McElnay, Alto, & Feeney, 2019). A recent study with 7- to 11-year-olds found only weak support for an effect controlling for age and IQ (Burns, O'Connor & McCormack, 2021), while a study with preschoolers found no effect controlling for age and receptive vocabulary (Atance & Jackson, 2009). It is possible that the propensity to benefit from episodic prospection depends on its developmental state, with benefits more likely in individuals with more sophisticated capabilities.

The mentalization interview data align with potential improvements in episodic simulation across our targeted age range. Younger children provided higher clarity ratings in the semantic prospection condition compared to the episodic prospection condition, despite the fact that episodic prospection should be associated with a richer subjective experience. They also reported more process-based strategies in the semantic condition compared to the episodic counterfactual thinking condition. In contrast, older children provided higher clarity ratings in the episodic counterfactual thinking condition compared to the semantic prospection condition. There was also a significant age-related increase in the number of process-based strategies reported in the episodic counterfactual thinking condition. Together, these data suggest that younger children may have encountered greater difficulty describing situations episodically compared to semantically. This possibility aligns with the view that children gain semantic abilities prior to episodic abilities (Nelson, 2001), as well as work suggesting semantic representations may be an important driver of episodic prospection (Grysman, Prabhakar, Anglin, & Hudson, 2015; Martin-Ordas, Atance, & Caza, 2014). However, it does not explain why there was an age-related increase in process strategies in only one of the episodic simulation conditions—the episodic counterfactual thinking condition. It is possible that this pattern was absent within the episodic prospection condition due to continued developmental limitations in that ability. Another possibility is that the disparity reflects functional differences between the two processes. Episodic counterfactual thinking entails causal implications (e.g., "*If I had double-checked my work, I would have gotten more problems right*") that may be particularly effective at eliciting corresponding behavioral intentions (Epstude & Roese, 2008). Once this ability is mature, the activation of these intentions may lead to a greater consideration of process strategies.

Despite evidence that younger children may have experienced difficulties with episodic simulation, older children still failed to show a unique benefit of either episodic simulation condition on math performance. It is also noteworthy that the features we theoretically associated with episodic simulation—heightened visual clarity and reported process-based strategies—did not relate to math gains. While the experimental manipulation may have diminished the variability required to observe effects within our individual differences analysis, it is also possible that these features failed to promote math gains. Such failure could be due to difficulty translating the insight gained from mentalization into future practice. This possibility suggests a communality with literature on strategy deficiencies, in which children may at times use appropriate strategies but fail to benefit from them (Bjorklund, Coyle, & Gaultney, 1992; Miller & Seier, 1994). Another possibility is that the structure of our mentalization interviews led to the generation of process-based strategies that were less influential than those generated in studies from related traditions. For example, studies showing benefits of mental contrasting with implementation intentions have asked participants to think of actions they could take that would help them overcome a specific obstacle standing in the way of their goal (e.g., Duckworth et al., 2013). In our study, participants were asked to think more generally about the actions needed to "*do really well*" at the Picture Discovery Challenge, which may have resulted in the generation of strategies that were more general and thus less impactful. A final possibility is that heightened visual clarity and more process-based strategies do not always benefit the targeted future behaviors. For example, heightened visual clarity may be particularly beneficial for reducing maladaptive behavior; clearly envisioning the negative mental and physical consequences of cigarette smoking might make it easier to refrain from engaging in that behavior. In contrast, heightened visual clarity may not be as beneficial when the goal is to increase adaptive behavior within a future context that may be anxiety provoking. In such cases, and perhaps particularly within an academic setting, taking a self-distanced and objective view may be most effective.

We also note that aspects of our experimental design may have reduced the effectiveness of the episodic simulation conditions at promoting math gains. Research has shown that the repeated simulation of an upward, downward, or neutral episodic counterfactual relates to decreased plausibility ratings (De Brigard, Szpunar, & Schacter, 2013). Thus, while episodic counterfactual thinking might have afforded mental practice, it might also have reduced the perceived plausibility of a positive outcome. This effect may have prevented the mental practice from yielding stronger benefits. In addition, although there was not a significant effect of experimental condition on pre-assessment math performance, performance was highest within the episodic simulation conditions. Future work that replicates our pattern of results is therefore important moving forward. This future work could benefit from incorporating additional features. For example, coding mentalization content for episodic versus semantic content could provide additional insight into children's ability to engage the targeted processes. Additionally, it would be valuable to compare the consequences of engaging in mentalization to that of not engaging in mentalization in general. Here, our goal was to compare three forms of mentalization for which a potential positive influence on behavior has received some theoretical (Epstude, & Roese, 2008; Schacter, Benoit, & Szpunar, 2017; Suddendorf & Corballis, 2007) and empirical (Peters & Buchel, 2010; Nasco & Marsh, 1999; Palombo et al., 2016) support. We did not include a no-contact control condition because we thought it unlikely that schools and parents engage in nothing at all in order to promote academic achievement, and also because of work suggesting that interventions should be compared across conditions for which similar expectations of improvement exist (Boot et al., 2013). Nonetheless, the extent to which the three forms of mentalization influence behavior compared to no form of mentalization should be considered and would be a valuable topic to explore in future work.

Finally, results from this study may inform a body of work demonstrating improved school achievement outcomes via "possible-selves" interventions (Oyserman, Bybee, & Terry, 2006). Possible selves encompass an individual's ideas about what he or she might become or would like to become (Markus & Nurius, 1986). Possible-selves interventions are thought to encourage the formation of concepts about a future self, which in turn promote the regulation of current behavior in order to achieve the desired future self (Oyserman et al., 2006). Results from this study suggest that these interventions may be most effective when they leverage developmentally appropriate types of future-oriented thought. For example, younger children may benefit most from the interventions when they attempt to think about the future semantically as opposed to episodically, or when they attempt a more semantic-episodic hybrid approach that involves "representing general states of the world that are autobiographical in nature (e.g., imagining that one will attain one's career aspirations in the future)" (Szpunar, Spreng, & Schacter, 2016, p.3). This may shift later in development, with older adolescents benefiting more from episodic future thought. We speculate that targeting specific types of future-oriented thought at different developmental stages may enhance the effectiveness of these interventions. We also note that this study was conducted on a sample of children that were largely White and of middle to high socioeconomic status, limiting the generalizability of our findings. Future studies targeting diverse groups could therefore provide additional insight into whether there are sociocultural differences—in addition to potential developmental differences—in the effectiveness of different forms of future-oriented thought.

The overarching goal of this study was to examine how different forms of future thinking may influence children's academic achievement. Our results suggest that encouraging children to engage in semantic prospection when thinking about their future math performance may promote greater objectivity and less emotional intensity via psychological distancing. Typical math interventions focus on conveying math knowledge and skills. However, Foley and colleagues (Foley *et al.* 2017) have suggested that math interventions could benefit from psychological techniques that stress self-regulation and the reappraisal of threat responses. Our data provide preliminary support for this suggestion, suggesting that *how* children think about their future may influence their later academic achievement.

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Declaration of Competing Interest

None.

Data availability

The data on which the manuscripts' analyses were based is available at the following URL: https://osf.io/2vwq5/?view_only=d97ad3c4e1c0446abb3875cb1307fa51.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.cogdev.2022.101183.

References

Abram, M., Picard, L., Navarro, B., & Piolino, P. (2014). Mechanisms of remembering the past and imagining the future—New data from autobiographical memory tasks in a lifespan approach. *Consciousness and Cognition: An International Journal, 29*, 76–89. https://doi.org/10.1016/j.concog.2014.07.011

Atance, C. M., & Jackson, L. K. (2009). The development and coherence of future-oriented behaviors during the preschool years. *Journal of Experimental Child Psychology, 102*, 379–391. https://doi.org/10.1016/j.jecp.2009.01.001

Atance, C.M., & Metcalf, J.L. (2013). Future thinking in young children. In M. Taylor (Ed.), The Oxford handbook of the development of imagination (pp. 305–324). Oxford University Press.

Atance, C. M., & O'Neill, D. K. (2001). Episodic future thinking. *Trends in Cognitive Sciences, 5*, 533–539. https://doi.org/10.1016/s1364-6613(00)01804-0

Atance, C. M., & O'Neill, D. K. (2005). The emergence of episodic future thinking in humans. *Learning and Motivation, 36*, 126–144. https://doi.org/10.1016/j.lmot.2005.02.003

Beck, S. R. (2020). The subject of children's counterfactual thoughts. *Psychology of Consciousness: Theory, Research, and Practice, 7*, 340–350. https://doi.org/10.1037/cns0000235

Bjorklund, D. F., Coyle, T. R., & Gaultney, J. F. (1992). Developmental differences in the acquisition and maintenance of an organizational strategy: Evidence for the utilization deficiency hypothesis. *Journal of Experimental Child Psychology, 54*, 434–448. https://doi.org/10.1016/0022-0965(92)90029-6

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across adolescent transition: A longitudinal study and an intervention. *Child Development, 78*, 246–263. https://doi.org/10.1111/j.1467-8624.2007.00995.x

Bromberg, U., Wiehler, A., & Peters, J. (2015). Episodic future thinking is related to impulsive decision making in healthy adolescents. *Child Development, 86*, 1458–1468. https://doi.org/10.1111/cdev.12390

Bromberg, U., Lobatcheva, M., & Peters, J. (2017) Episodic future thinking reduces temporal discounting in healthy adolescents. PLoS ONE 12: e0188079. doi: 10.1371/journal.pone.0188079.

Burns, O'Connor, Atance, & McCormack. (2021). More later: Delay of gratification and thought about the future in children. *Child Development, 92*, 1554–1573. doi.org/10.1111/cdev.13521.

Carlson, S. M., & Zelazo, P. D. (2008). Symbolic thought. In M. M. Haith, & J. B. Benson (Eds.), *Encyclopedia of infant and early childhood* (pp. 288–297). Boston, MA: Elsevier/Academic Press.

California Department of Education. (2013). *T*he California Common Core State Standards: Mathematics. Retrieved from http://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf.

Chernyak, N., Leech, K. A., & Rowe, M. L. (2017). Training preschoolers' prospective abilities through conversation about the extended self. *Developmental Psychology, 53*, 652–661.

Coughlin, C., Lyons, K., & Ghetti, S. (2014). Remembering the past to envision the future in middle childhood: Developmental linkages between prospection and episodic memory. *Cognitive Development, 30*, 96–110. https://doi.org/10.1016/j.cogdev.2014.02.001

Coughlin, C., Robins, R. W., & Ghetti, S. (2019). Development of episodic prospection: Factors underlying improvements in middle and late childhood. *Child Development, 90*, 1109–1122. https://doi.org/10.1111/cdev.13001

Cycowicz, Y. M., Friedman, D., Rothstein, M., & Snodgrass, J. G. (1997). Picture naming by young children: Norms for name agreement, familiarity, and visual complexity. *Journal of Experimental Child Psychology, 65*, 171–237. https://doi.org/10.1006/jecp.1996.2356

Daniel, T. O., Said, M., Stanton, C. M., & Epstein, L. H. (2016). Episodic future thinking reduces delay discounting and energy intake in children. *Eating Behaviors, 18*, 20–24. https://doi.org/10.1016/j.eatbeh.2015.03.006

Dassen, F. C. M., Jansen, A., Nederkoorn, C., & Houben, K. (2016). Focus on the future: Episodic future thinking reduces discount rate and snacking. *Appetite, 96*, 327–332. https://doi.org/10.1016/j.appet.2015.09.032

DeBellis, V. A., & Goldin, G. A. (2006). Affect and meta-affect in mathematical problem solving: a representational perspective. *Educational Studies in Mathematics, 63*, 131–147. https://doi.org/10.1007/s10649-006-9026-4

De Brigard, F., & Giovanello, K. S. (2012). Influence of outcome valence in the subjective experience of episodic past, future, and counterfactual thinking. *Consciousness and Cognition, 21*, 1085–1096. https://doi.org/10.1016/j.concog.2012.06.007

De Brigard, F., Szpunar, K. K., & Schacter, D. L. (2013). Coming to grips with the past: effect of repeated simulation on the perceived plausibility of episodic counterfactual thoughts. *Psychological Science, 7*, 1329–1334. https://doi.org/10.1177/0956797612468163

De Corte, E., Op t Eynde, P., & Verschaffel, L. (2002). "Knowing what to believe": The relevance of students' mathematical beliefs for mathematics education. In B. K. Hofer & P. R. Pintrich (Eds.), Personal epistemology: The psychology of beliefs about knowledge and knowing (p. 297–320). Lawrence Erlbaum Associates Publishers.

DeShon, R. P., Chan, D., & Weissbein, D. A. (1995). Verbal overshadowing effects on Raven's advanced progressive matrices: Evidence for multidimensional performance determinants. *Intelligence, 21*, 135–155. https://doi.org/10.1016/0160-2896(95)90023-3

Dignath, C., & Büttner, G. (2008). Components of fostering self-regulated learning among students. A meta-analysis on intervention studies at primary and secondary school level. *Metacognition and Learning, 3*, 231–264. https://doi.org/10.1007/s11409-008-9029-x

Duncan, G.J., & Magnuson, K. (2011). The nature and impact of early achievement skills, attention skills, and behavior problems. In G. J. Duncan and R. J. Murnane (Eds.), Whither opportunity? Rising inequality, schools, and children's life chances (pp. 47–69). New York, NY: Russell Sage.

Duckworth, A. L., Kirby, T. A., Gollwitzer, A., & Oettingen, G. (2013). From fantasy to action: Mental Contrasting with Implementation Intentions (MCII) improves academic performance in children. *Social Psychological and Personality Science, 4*, 745–753. https://doi.org/10.1177/1948550613476307

Dweck, C. S. (2007). The secret to raising smart kids. *Scientific American: Mind. December/January*, 36–43.
Dweck, C.S. & Master, A. (2008). Self-theories motivate self-regulated learning. In D. H. Schunk and B. J. Zimmerman (Eds.), Motivation and self-regulated learning: Theory, research, and applications (pp. 31–51). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.
Eisenberger, R., & Leonard, J. M. (1980). Effects of conceptual task difficulty on generalized persistence. *The American Journal of Psychology, 93*, 285–298. https://doi.org/10.2307/1422233
Engle, R. A., Lam, D. P., Meyer, X. S., & Nix, S. E. (2012). How does expansive framing promote transfer? Several proposed explanations and a research agenda for investigating them. *Educational Psychologist, 47*, 215–231. https://doi.org/10.1080/00461520.2012.695678
Epstude, K., & Roese, N. J. (2008). The functional theory of counterfactual thinking. *Personality and social psychology review: an official journal of the Society for Personality and Social Psychology, Inc, 12*, 168–192, 0.1177/1088868308316091.
Ferretti, F., Chiera, A., Nicchiarelli, S., Adornetti, I., Magni,, R., Vicari, S., … Marini, A. (2018). The development of episodic future thinking in middle childhood. *Cognitive Processing, 19*, 87–94. https://doi.org/10.1007/s10339-017-0842-5
Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current Directions in Psychological Science, 26*, 52–58. https://doi.org/10.1177/0963721416672463
Foster, S. (2007). The Day Math and Reading Got Hitched. *Teaching children mathematics, 14*, 196–201.
Fujita, K., Trope, Y., Liberman, N., & Levin-Sagi, M. (2006). Construal levels and self-control. *Journal of Personality and Social Psychology, 90*, 351–367. https://doi.org/10.1037/0022-3514.90.3.351
Ghetti, S., & Alexander, K. W. (2004). "If it happened, I would remember it": strategic use of event memorability in the rejection of false autobiographical events. *Child Development, 75*, 542–561. https://doi.org/10.1111/j.1467-8624.2004.00692.x
Ghetti, S., & Coughlin, C. (2018). Stuck in the present? Constraints on children's episodic prospection. *Trends in Cognitive Science, 22*, 846–850. https://doi.org/10.1016/j.tics.2018.07.013
Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. *Advances in Experimental Social Psychology, 38*, 69–119. https://doi.org/10.1016/S0065–2601(06)38002–1
Gott, C., & Lah, S. (2014). Episodic future thinking in children compared to adolescents. *Child Neuropsychology, 20*, 625–640. https://doi.org/10.1080/09297049.2013.840362
Grysman, A., Prabhakar, J., Anglin, S. M., & Hudson, J. A. (2015). Self-enhancement and the life script in future thinking across the lifespan. *Memory, 23*, 774–785. https://doi.org/10.1080/09658211.2014.927505
Hattie, J., Biggs, J., & Purdie, N. (1996). Effects of learning skills interventions on student learning: A meta-analysis. *Review of Educational Research, 66*, 99–136. https://doi.org/10.3102/00346543066002099
Hudson, J. A., Mayhew, E. M., & Prabhakar, J. (2011). The development of episodic foresight: Emerging concepts and methods. *Advances in Child Development and Behavior, 40*, 95–137. https://doi.org/10.1016/b978-0-12-386491-8.00003-7
Klein, S. B., Loftus, J., & Kihlstrom, J. F. (2002). Memory and temporal experience: The effects of episodic memory loss on an amnesic patient's ability to remember the past and imagine the future. *Social Cognition, 20*, 353–379. https://doi.org/10.1521/soco.20.5.353.21125
Kross, E., Bruehlman-Senecal, E., Park, J., Burson, A., Dougherty, A., Shablack, H., & Ayduk, O. (2014). Self-talk as a regulatory mechanism: how you do it matters. *Journal of Personality and Social Psychology, 106*, 304–324. doi:10.1037/a0035173.
La Corte, V., & Piolino, P. (2016). On the role of personal semantic memory and temporal distance in episodic future thinking: The TEDIFT model. *Frontiers in Human Neuroscience, 10*, 385. https://doi.org/10.3389/fnhum.2016.00385
Lee, W. S., & Atance, C. M. (2016). The effect of psychological distance on children's reasoning about future preferences. *PLoS One, 11*, 1–18. https://doi.org/10.1371/journal.pone.0164382
Leech, K. A., Leimgruber, K., Warneken, F., & Rowe, M. L. (2019). Conversation about the future self improves preschoolers' prospection abilities. *Journal of Experimental Child Psychology, 181*, 110–120. https://doi.org/10.1016/j.jecp.2018.12.008
Liberman, N., & Trope, Y. (2014). Traversing psychological distance. *Trends in Cognitive Sciences, 18*, 364–369. https://doi.org/10.1016/j.tics.2014.03.001
Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management, 11*, 311–322. https://doi.org/10.2147/PRBM.S141421
Mahy, C. E. V., Moses, L. J., O'Brien, B., Castro, A. W., Kopp, L., & Atance, C. M. (2020). The roles of perspective and language in children's ability to delay gratification. *Journal of Experimental Child Psychology, 192*. https://doi.org/10.1016/j.jecp.2019.104767
Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist, 41*, 954–969. https://doi.org/10.1037/0003-066X.41.9.954
Martin-Ordas, G., Atance, C. M., & Caza, J. S. (2014). How do episodic and semantic memory contribute to episodic foresight in young children? *Frontiers in Psychology, 5*, 732. https://doi.org/10.3389/fpsyg.2014.00732
Matthews, K.A., & Stoney, C.M. (1988). Influences of sex and age on cardiovascular responses during stress. Psychosomatic Medicine, 50, 46–56. Retrieved from http://search.proquest.com/docview/617512276?accountid=14505.
McCue, R., McCormack, T., McElnay, J., Alto, A., & Feeney, A. (2019). The future and me: Imagining the future and the future self in adolescent decision making. *Cognitive Development, 50*, 142–156, 0.1016/j.cogdev.2019.04.001.
Mcisaac, H.K., & Eich, E. Vantage point in episodic memory. Psychonomic Bulletin & Review, 9, 146–150. doi:10.3758/BF03196271.
Miller, P. H., & Seier, W. L. (1994). Strategy utilization deficiencies in children: when, where, and why. *Advances in Child Development and Behavior, 25*, 107–156. https://doi.org/10.1016/s0065-2407(08)60051-8
Nasco, S. A., & Marsh, K. L. (1999). Gaining control through counterfactual thinking. *Personality and Social Psychology Bulletin, 25*, 556–568. https://doi.org/10.1177/0146167299025005002
Nelson, K. (2001). Language and the Self: From the "Experiencing I" to the "Continuing Me". In The Self in Time (pp. 23–42). Psychology Press.
Nyhout, A., & Ganea, P. A. (2019). The development of the counterfactual imagination. *Child Development Perspectives, 13*, 254–259. https://doi.org/10.1111/cdep.12348
Oyserman, D., Bybee, D., & Terry, K. (2006). Possible selves and academic outcomes: How and when possible selves impel action. *Journal of Personality and Social Psychology, 91*, 188–204. https://doi.org/10.1037/0022-3514.91.1.188
Palombo, D. J., Keane, M. M., & Verfaellie, M. (2016). Using future thinking to reduce temporal discounting: Under what circumstances are the medial temporal lobes critical? *Neuropsychologia, 89*, 437–444. https://doi.org/10.1016/j.neuropsychologia.2016.07.002
Pennebaker, J.W., Booth, R.J., Boyd, R.L., & Francis, M.E. (2015). Linguistic Inquiry and Word Count: LIWC2015. Austin, TX: Pennebaker Conglomerates (www.LIWC.net).
Peters, J., & Buchel, C. Episodic future thinking reduces reward delay discounting through an enhancement of prefrontal-mediotemporal interactions. Neuron, 66, 138–148. doi:10.1016/j.neuron.2010.03.026.
Pham, L. B., & Taylor, S. E. (1999). From thought to action: Effects of process-versus outcome- based mental simulations on performance. *Personality and Social Psychology Bulletin, 25*, 250–260. https://doi.org/10.1177/0146167299025002010
Prabhakar, J., Coughlin, C., & Ghetti, S. (2016). The neurocognitive development of future-oriented behavior and its implications for academic achievement. *Mind, Brain, and Education, 10*, 196–206. https://doi.org/10.1111/mbe.12124
Prabhakar, J., & Ghetti, S. (2020). Connecting the dots between past and future: Constraints in episodic future thinking in early childhood. *Child Development, 91*, e315–e330. https://doi.org/10.1111/cdev.13212
Rafetseder, E., Schwitalla, M., & Perner, J. (2013). Counterfactual reasoning: from childhood to adulthood. *Journal of Experimental Child Psychology, 114*, 389–404. https://doi.org/10.1016/j.jecp.2012.10.010
Raven, J., Raven, J.C., & Court, J.H. (1998). Manual for Raven's progressive matrices and vocabulary scales. San Antonio, TX: Pearson.
Russell, J., Alexis, D., & Clayton, N. (2010). Episodic future thinking in 3- to 5-year-old children: The ability to think of what will be needed from a different point of view. *Cognition, 114*, 56–71. https://doi.org/10.1016/j.cognition.2009.08.013

Schacter, D. L., Benoit, R. G., & Szpunar, K. K. (2017). Episodic future thinking: mechanisms and functions. *Current Opinion in Behavioral Sciences, 17*, 41–50.

Schacter, D. L., Benoit, R. G., De Brigard, F., & Szpunar, K. K. (2015). Episodic future thinking and episodic counterfactual thinking: intersections between memory and decisions. *Neurobiology of Learning and Memory, 117*, 14–21. https://doi.org/10.1016/j.nlm.2013.12.008

Sheslow, D., & Adams, W. (2003). Wide Range Assessment of Memory and Learning (2nd ed.). Wilmington, DE: Wide Range.

Suddendorf, T., & Corballis, M. C. (2007). The evolution of foresight: What is mental time travel, and is it unique to humans? *Behavioral Brain Sciences, 30*, 299–351. https://doi.org/10.1017/S0140525X07001975

Szpunar, K.K., Spreng, R.N., & Schacter, D.L. (2016). Toward a taxonomy of future thinking. In K. Michaelian, S. B. Klein, & K. K. Szpunar (Eds.), Seeing the future: Theoretical perspectives on future-oriented mental time travel (pp. 21–35). Oxford University Press. doi:10.1093/acprof:oso/9780190241537.003.0002.

Tulving, E. (1985). Memory and consciousness. *Canadian Psychology, 26*, 1–12. https://doi.org/10.1037/h0080017

Tulving, E. (2005). Episodic memory and autonoesis: uniquely human. In H. Terrace, & J. Metcalfe (Eds.), *The missing link in cognition* (pp. 4–56). Oxford University Press.

Van Garderen, D., & Montague, M. (2003). Visual-spatial representation, mathematical problem solving, and students of varying abilities. *Learning Disabilities Research and Practice, 18*, 246–254. https://doi.org/10.1111/1540-5826.00079

Wallace-Hadrill, S. M. A., & Kamboj, S. K. (2016). The impact of perspective change as a cognitive reappraisal strategy on affect: A systematic review. *Frontiers in Psychology*, *7*. https://doi.org/10.3389/fpsyg.2016.01715

Wang, Q., Capous, D., Koh, J. B. K., & Hou, Y. (2014). Past and future episodic thinking in middle childhood. *Journal of Cognition and Development, 15*, 625–643. https://doi.org/10.1080/15248372.2013.784977

Wechsler, D. (2011). Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-II). San Antonio, TX: NCS Pearson.

Weisberg, D. P., & Beck, S. R. (2010). Children's thinking about their own and others' regret and relief. *Journal of Experimental Child Psychology, 106*, 184–191. https://doi.org/10.1016/j.jecp.2010.02.005

Weisberg, D. S., & Gopnik, A. (2013). Pretense, counterfactuals, and Bayesian causal models: Why what is not real really matters. *Cognitive Science, 37*, 1368–1381. https://doi.org/10.1111/cogs.12069

White, R. E., Prager, E. O., Schaefer, C., Kross, E., Duckworth, A. L., & Carlson, S. M. (2016). The "Batman effect": Improving perseverance in young children. *Child Development, 88*, 1563–1571. https://doi.org/10.1111/cdev.12695

Wilkins, C. & Clayton, N. (2019). Reflections on the spoon test. Neuropsychologia, 134:107221. doi:10.1016/j.neuropsychologia.2019.107221.

Zepeda, C. D., Hlutkowsky, C. O., Partika, A. C., & Nokes-Malach, T. J. (2019). Identifying teachers' supports of metacognition through classroom talk and its relation to growth in conceptual learning. *Journal of Educational Psychology, 111*(3), 522–541. https://doi.org/10.1037/edu0000300