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Eight-Year-Olds' Attributions of the Origins of Self-Generated Knowledge

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An abstract of
A thesis submitted to the Faculty of the
James T. Laney School of Graduate Studies of Emory University
in partial fulfillment of the requirements for the degree of
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Abstract

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The present research was an investigation of eight-year-olds' memory for the context of their newly self-generated knowledge. Children were read pairs of story passages presenting novel facts that could be integrated to self-generate new factual knowledge. They also were read pairs of story passages in which the new factual knowledge was explicitly taught. Following a one-week delay, we asked them to identify where they learned each fact from a set of choices. In the Explicitly-Taught condition, children reliably selected the correct story as the source of their new knowledge. In the Self-Generation condition, selection of an internal versus an external source was at chance. Yet children who selected an external source as the origin of their new knowledge consistently selected the second story in each pair; the second story was the first opportunity to generate the new knowledge. The results indicate that children are generally uncertain as to the source of their self-generated knowledge but they may be aware, on some level, of the relations between the stories after learning the second fact in each story pair.

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People can often recall when and where they saw a film with relative ease, but recalling when and where they learned that sharks are fish is considerably more difficult. The information that sharks are fish is one of many pieces of knowledge stored in semantic memory. Semantic memory is remarkable in that it enables not only the storage and retrieval of information learned about the world but also the productive extension of that information to generate new knowledge. One way that knowledge can be extended is by self-generation through integration of separate but related episodes (Bauer & San Souci, 2010). Integration and self-generation are pervasive processes that occur even when the episodes are separated by time and place. It is reasonable to expect that the episodes during which knowledge is acquired are marked by contextual details of time and place, such as characterize episodic memories. Yet once information is incorporated into the knowledge base, it is thought to become timeless and placeless (Tulving, 1972). Indeed, Bauer and Jackson (2015) showed that among adults, newly self-derived information rapidly transitions from novel to known. This raises the question of whether information incorporated into the knowledge base through self-generation has a “history” of the episode that gave rise to it. Alternatively, does the information lack cues to its source? The major purpose of the present research was to address this question by testing children’s memory for the contextual details of newly self-generated knowledge. The work stands to inform the process by which information transitions from individual episodes to elements of the knowledge base.

There are many avenues for children to acquire knowledge, including parents, lessons at school, books, and educational television programs (see Gelman, 2009, for a review). The pieces of information that are acquired through such experiences are not static, discrete packages of knowledge. Rather, knowledge can be extended through the logical processes such as deduction, induction, and analogy (Goswami, 2011). For example, through deduction one applies a general rule to a specific example to create a new understanding. As an illustration, a child who knows that all cats purr can deduce that Mittens the cat purrs. In contrast, induction allows one to generalize from specific information. Each of these is a pervasive process that undergoes significant developmental change throughout childhood into adulthood.

It is also evident that knowledge extension occurs through integration of separate but related episodes (Bauer & Larkina, 2015; Bauer & San Souci, 2010; Bauer, King, Larkina, Varga, & White, 2012; Varga & Bauer, 2013). Bauer and San Souci (2010) first demonstrated that the ability to self-generate new knowledge through semantic integration develops in early childhood. In this study, 4- and 6-year-old children were read four story passages from a corpus of six total passages. The six short passages comprised three pairs of stories. Each story passage featured a protagonist who "learned" a novel stem fact in the course of an adventure and was complete with a beginning, middle, and end. Each pair of stories contained facts that were related to each other such that the novel stem facts they presented could be integrated to generate a novel integration fact. Children were read both passages from one pair of stories (Two-Stem condition) and one passage from each of the remaining two pairs (One-Stem condition). In an example pair of passages children were presented with "dolphins talk by clicking and squeaking" and "dolphins live in groups called pods." These facts could be integrated to self-generate the novel understanding that *pods talk by clicking and squeaking*.

After presentation of the story passages, children were tested for self-generation and stem fact recall. When asked in an open-ended format (e.g., How does a pod talk?), 4-year-old children successfully self-generated novel integration facts on 13% of trials in the Two-Stem condition. Six-year-olds self-generated on 67% of open-ended trials in the Two-Stem condition. To ensure that other processes were not responsible for children's generation of the novel integration fact, both 4- and 6-year-olds were asked open-ended integration questions for One-Stem condition passages. For these passages, they were not expected to generate the novel integration facts above chance levels. Four- and 6-year-olds generated the novel integration facts in 0% and 17% of One-Stem condition trials, respectively. Thus, it is clear that integration of the two related stem facts is required for self-generation.

The pattern of recall of the individual stem facts acquired in the text passages also suggested that retention of information from the separate episodes was necessary—though not sufficient—for generation of the novel integration facts. Overall, children who recalled or recognized both stem facts were able to self-generate new knowledge. More specifically, 10 out of 12 children who recalled both stem facts also generated the novel integration fact. In contrast, of the 18 children who did not generate the integration fact, 15 recalled one or no stem facts. This study paved the way for understanding the construction of a knowledge base in semantic memory. Bauer and Larkina (2015) expanded our understanding of this developmental progression by showing that 8-year-olds self-generate new knowledge at near ceiling levels when presented with both members of a stem-fact pair.

The retention of newly self-derived information indicates that self-generated knowledge becomes incorporated into one's knowledge base. Varga and Bauer (2013) investigated this by testing retention of newly self-generated knowledge following a one-week delay. They presented children with pairs of novel stem facts through story passages. As in Bauer and San Souci (2010), each pair of facts had a relational link that allowed the separate pieces of information to be integrated based on shared elements. Children were tested for self-generation of the novel integration facts in an open-ended format both immediately after the stories were read and in a second session one week later. During the first session, 6-year-olds generated 63% of the novel integration facts when prompted with open-ended questions (e.g., How does a pod talk?). One week later, they recalled 60% of the integration facts in the open-ended format. Thus, they retained the information over the delay. Indeed, there was little evidence of forgetting this new knowledge. Immediate and delayed performance did not differ statistically. For newly self-generated information to be cognitively meaningful and to aid in development of a knowledge base, it must be incorporated and subsequently retained over time.

Additional evidence that newly self-generated information becomes incorporated into the knowledge base comes from a study with adults, using event-related potentials (ERPs). ERPs are a noninvasive technique that allows recording of neural activity from the scalp. ERPs are unique in their ability to capture neural responses to events with a temporal resolution on the order of milliseconds. Using ERPs, Bauer and Jackson (2015) demonstrated that the brain responds similarly to newly self-derived information as it does well-known information after only two brief (400ms) presentations. In this study, undergraduate students read 120 sentences during an encoding phase. Eighty sentences were facts that should have been familiar information, typically learned in school by the time one has completed high school. An example of such a familiar fact is *Washington, D.C. is the capital of the United States*. The remaining 40 sentences comprised 20 pairs of novel facts that contained a relational link, such that facts could be integrated to form novel information. For example, participants read the separate facts *apple seeds contain pips* and *cyanide is found in pips*. These facts can be integrated to generate the new knowledge that apple seeds contain cyanide. During the test phase, participants read 80 facts that had not been previously presented during encoding. Twenty facts were well known, 40 were novel, and the remaining 20 facts were the novel integrations that could have been made with the 20 pairs of related facts during encoding. Each fact was presented twice, for 400ms each time. ERP data showed that, as expected, novel facts generated a significantly different neural response from the well-known facts. More importantly for present purposes, the neural response elicited by the integration facts changed across the two brief presentations. The first time the students saw the integration facts the response was intermediate to well-known and novel facts. Upon the second presentation, the neural response to integration facts resembled that of well-known information and was significantly different from the response to novel facts. This study thus suggests that information rapidly transitions from novel to known, becoming part of the knowledge base.

Results of prior research make clear that new knowledge becomes incorporated into the knowledge base. This implies that, like other contents of semantic memory, it is unmarked by details of time and place. Yet the new semantic information is derived from specific episodes that, at least initially, had rich contextual information. This raises the question of whether newly derived information is similarly marked by contextual details. We may presume that newly self-generated knowledge would not be marked by such details because it arises from knowledge extension rather than the experience of a distinct episode. However, it is equally reasonable to assume that participants may retain memories for the episodes from which the knowledge was derived. Similar questions apply to the status of the memories of the stem facts that are combined to generate the integration facts. We may expect that they are remembered as episodes with distinguishable contexts, as they were presented. Still, there stands the possibility that because the stem facts have been integrated with one another they have been removed from their episodic context.

To address questions of the status of newly self-derived knowledge—and the information from which it was derived—in the present research, we tested children's memory for the source of (a) the newly self-generated integration facts, and (b) the stem facts that gave rise to the integration facts. Memory for source information, such as the contextual details of when and where an episode occurred, improves in a similar timeframe as the development of self-generation abilities (e.g., Riggins, 2014). For example, in Riggins, Rollins, and Graham (2013), children between 5- and 6-years-old viewed 60 items in one of two different contexts. One week later, they viewed those same 60 items in addition to 30 distractor items. In a behavioral test of source memory, children were asked to report whether they had seen each item in the previous session. If they reported that the item was old, they were prompted to place it in its original context. Items were correctly identified as "old" on 87% of total trials. More importantly for present purposes, children identified the context for the items on 58% of trials that had been correctly identified as old.

Memory for the source of experiences continues to develop throughout the school years. Previous research has established that children between 7 and 11 years of age are relatively good at identifying source information about their knowledge (Cycowicz, Friedman, Snodgrass, & Duff, 2001; Riggins, 2014). For example, children between 7- and 9-years-old were shown 128 items on colored backgrounds. In a subsequent test for recognition of both previously viewed and novel items, children correctly identified 88% of items as familiar. More importantly for present purposes, children successfully provided the target source information, the color, of the familiar items 91% of the time (Cycowicz et al., 2001). This is substantially higher than the rate at which 5- and 6-years provide correct source information (Riggins et al., 2013). This provides evidence that the ability to recall and employ contextual details is fair at 5-6 years of age but quite good by 7-9 years of age. Because the present work requires reliably successful performance on source memory tasks, 8-year-olds were selected as participants.

In summary, in the present research, I addressed the questions of whether newly self-generated knowledge and the facts from which it is generated are marked by contextual details typically associated with episodes. I addressed the questions by asking 8-year-old children to make judgments about the source of their knowledge. Eight-year-olds were chosen due to their relatively reliable performance on source memory tasks (Cycowicz et al., 2001; Riggins, 2014) and high performance in previous self-generation work (Bauer & Larkina, 2015). Participants were read four pairs of story passages, two from a Self-Generation condition and two from an Explicitly-Taught condition. As in prior related research (e.g., Bauer & San Souci, 2010), pairs from the Self-Generation condition presented novel stem facts that share a relational link that allows the facts to be successfully integrated. The Explicitly-Taught condition served as a comparison for the Self-Generation condition as all stem and integration facts were presented in distinct episodes and did not require integration to be incorporated into the knowledge base. We reasoned that to the extent children remembered the specific sources of their experiences, they should correctly identify them in the Explicitly-Taught condition. Because each individual story passage presents one novel fact, either stem or integration, we characterize each story passage as an individual episode. We asked children to recall both integration and stem facts and then to trace each fact back to the episode in which they learned it. We hypothesized that 8-year-olds would judge their self-generated knowledge as being timeless and placeless as evidenced by an inability to report the episode during which such knowledge was learned.

Method

Participants

Participants were 17 8-year-old children (7 girls and 10 boys, *M* age = 8 years 6 months, *Range* = 8 years 2 months to 8 years 10 months). Children participated in two sessions spaced 1 week apart (*M* delay = 7.24 days; *Range* = 6-9 days). They were recruited from a volunteer pool of families who had expressed interest in participating in research. Based on parental report, 11 participants were Caucasian, 2 were African American, 1 was Asian, 2 were of mixed racial descent, and the parent of 1 participant did not report race. Two participants were identified as being of Hispanic descent. Two additional children participated but were excluded for not completing the second session (n = 1) and not completing the test of memory for source (n =1). These participants' data were not included in analyses. Written parental consent and the verbal assent of the children were obtained prior to the start of the first study session. The protocol and procedures were approved by the Emory University Institutional Review Board. At the end of each session, children received a small toy. Upon completion of the second session, parents received a $10 gift card to a local merchant.

Stimuli

Stimuli were four pairs of story passages used in previous research (Bauer et al., 2012; Bauer & Larkina, 2015; Bauer & San Souci, 2010; Varga & Bauer, 2013). Each pair of stories was about one topic (e.g., dolphins, kangaroos, plants, or volcanoes).

Each individual story passage featured hand-drawn, colored pictures depicting the main actions of the text that the experimenter read aloud. Passages were four pages in length with 13 to 27 words on each page, ranging from 82 to 89 total words. Further, each passage followed a similar structure in which a character (e.g., a lamb) goes to a location (e.g., the zoo) and learns something new (i.e., the target stem fact) in the course of her or his travels. Importantly, each individual story displayed a different main character to facilitate the distinction between the individual stories within a pair.

For each story pair, there were two forms of the stimuli. For the Self-Generation version of the stimuli, each story contained a novel fact (i.e., a stem fact) that could be integrated with its paired passage to generate a novel integration fact. For example, one story (A1) presented the stem fact *palm tree leaves are called fronds* whereas the other story (A2) in the pair presented the stem fact *palm tree leaves are used to make baskets*. This pair of story passages afforded the opportunity to self-generate the new knowledge that *fronds are used to make baskets* (integration fact). The novel stem fact first appeared on the second or third page of the story and was repeated on the final page. Importantly, the novel integration facts were not featured in the individual story passages in this version of the stimuli.

For the Explicitly-Taught version of the stimuli, there was a modification such that the integration fact was presented in the second story of the pair (A2). As in the self-generation version of the stimuli, Story one (A1) presented one stem fact (e.g., *palm tree leaves are called fronds).* The novel stem fact first appeared on the second or third page of the story and was repeated on the final page. The modified version of story two (A2) presented the integration fact (i.e., *fronds are used to make baskets)* on the second or third page. It was also repeated on the final page.

Procedure

Participants were tested individually by the same female experimenter (JAD) in a laboratory room equipped with a table, two chairs, and a small couch for parents. They were tested in two sessions, spaced one week apart.

Session 1. During the first visit, children were read four pairs of story passages. Two pairs of passages were presented in a Self-Generation condition and two in an Explicitly-Taught condition. In both conditions, each individual story was read once in a continuous manner and children were instructed to look at the pictures and listen to the stories. Between each pair of story passages, children completed unrelated buffer tasks as part of a larger study.

Following presentation of the first pair of story passages, children were asked open-ended questions that probed for self-generation of the novel integration fact (Self-

Generation condition: e.g., What are fronds used to make?) or recall of the integration fact (Explicitly-Taught condition). They were not given corrective feedback in order to prevent explicit learning (Self-Generation condition) or reinforcement of the information (Explicitly-Taught condition). Immediately after this assessment, participants engaged in approximately 5 minutes of unrelated filler activity. This process was repeated for each of the four story pairs. Presentation of the two conditions alternated such that half of the children experienced the Explicitly-Taught condition first and half experienced the Self-Generation condition first. Self-Generation and Explicitly-Taught versions of each story pair occur equally often across participants.

Session 2. Participants returned to the laboratory approximately one week after Session 1 (*M* = 7.22 days). Children completed an age-appropriate filler activity at the beginning of the second session to re-acclimate them to the laboratory setting prior to testing. Participants then were tested for recall of the integration facts, from both the Self-Generation and Explicitly-Taught conditions, using the open-ended questions from Session 1 (e.g., What are fronds used to make?). In a follow-up to each integration question, children were asked to provide the source of each integration fact they recalled. Forced-choice response options were (a) Story 1 from the respective pair, (b) Story 2 from the pair, (c) "I figured it out myself," (d) "I've always known that," and (e) "I don't know." Each of the response choices was paired with an appropriate graphic image representative of the choice (see Appendix). The first page of each story was chosen as the representative image for that story to avoid providing children with answers to subsequent questions. Images were shuffled prior to each open-ended integration question to prevent response bias. This process was repeated for all four story passage pairs.

Following the test for recall and source memory for the integration facts, children were asked to recall the stem facts from each story passage in open-ended format. For each stem fact recalled, children were asked to identify the source of the stem facts in the same manner as the integration facts. Following the open-ended recall and source questions, participants were asked forced-choice recognition questions for any integration facts that were not recalled and any stem fact questions that were answered incorrectly. In recognition testing, participants were provided with three answer choices and asked to select the "best one." Children were not asked to identify the source of their knowledge following the forced choice questions, as it was possible they could have answered the question correctly without spontaneously providing the correct information. Corrective feedback was never given to remain consistent with Session 1. At the end of the session, children completed unrelated tasks to ensure that they had a success experience in the session, regardless of their actual performance. There were four versions of test order based on counterbalancing story pairs with a Latin square. Each story pair occurred in each serial position an equal number of times across participants.

Scoring

Integration Facts. At Session 1, participants received an integration fact score based on their performance on the open-ended questions asked during Session 1. Children received a score of 1 for each correct answer. Children could receive a maximum score of 4 (max score of 2 in each condition). Similarly, at Session 2, participants received 1 point for each integration fact correctly recalled, for a possible total of 4 (max score of 2 in each condition). Also at Session 2, we calculated an integration total score by adding the open-ended and forced-choice recognition integration scores together. Forced-choice recognition questions were only asked as a follow-up to open-ended integration questions that children had answered incorrectly. Children could receive a maximum integration total score of 4 (2 per condition).

Stem Facts. At Session 2, participants were asked to recall the individual stem facts in an open-ended format. They received 1 point for each correct response. Each story passage pair read in the Self-Generation condition presented two stem facts. Pairs in the Explicitly-Taught condition presented only one stem fact each because the second stem fact had been modified to become the pair's integration fact. Because each participant was presented with two pairs from both the Self-Generation and Explicitly-Taught conditions, participants could receive a possible maximum of 6 (4 in the SG, 2 in the ET). A stem fact total score was calculated by summing the open-ended and forced-choice recognition scores for the stem facts. Forced-choice recognition questions were only asked as a follow-up to open-ended stem fact questions that participants had answered incorrectly. Participants could receive a maximum stem fact total score of 6 (4 in SG, 2 in ET). Because of the unequal number of stem facts across conditions (SG, ET) and types (stem 1, stem 2), participants were also given proportion scores. A stem fact recall proportion was calculated by dividing participants' stem fact recall score by the number of possible stem fact trials. Similarly, a stem fact total proportion was calculated by dividing participants' stem fact total score by the number of possible of stem fact trials. These proportion scores were calculated for each condition collapsing across type and for each type collapsing across each condition.

Source Categorization: Internal/External. Responses to source questions for both integration and stem facts were first categorized as being attributed to either an internal or an external source. The source choices of “I figured it out myself,” “I’ve always known that,” and “I don’t know” were categorized as internal because the child had attributed the information to her/himself. Source choices of either Story 1 or Story 2 were categorized as external. Participants could respond to a total of 2 source questions for each of the following types of facts: Self-Generation integration, Explicitly-Taught integration, Self-Generation stem 1, Self-Generation stem 2, and Explicitly-Taught stem 1.

Source Categorization: Story 1/Story 2. All responses to the sources questions that had been categorized as external were then sorted by which specific story, either Story 1 or Story 2, participants had reported as the source of their knowledge. This process was completed for the integration and stem facts in both the Self-Generation and Explicitly-Taught conditions. Participants’ responses were then tallied for each of the following types of facts: Self-Generation integration, Explicitly-Taught integration, Self-Generation stem 1, Self-Generation stem 2, and Explicitly-Taught stem 1.

Results

The results are presented in three parts: initial learning of the integration facts at Session 1, memory for the integration and stem facts at Session 2, and memory for the source of the integration and stem facts at Session 2. Initial learning of the integration facts was compared between conditions to ensure that there were no differences between the conditions at the outset. We then compared memory for the integration facts after the week delay to understand whether self-generated and explicitly taught integration facts are differentially retained and thus incorporated into the knowledge base. Descriptive statistics on participants' open-ended and total performance on the integration facts from Sessions 1 and 2 are provided in Table 1. Descriptive statistics on participants' open-ended and total performance for each type of stem fact are provided in Table 2. Descriptive statistics on participants' selection of external versus internal and Story 1 versus Story 2 as the source of their new knowledge are presented in Table 3 and Table 4, respectively.

Session 1 Performance

In the Self-Generation condition, children successfully self-generated a mean of 1.82 integration facts out of a possible total of 2. In the Explicitly-Taught condition, they recalled a mean of 1.94 integration facts out of a possible total of 2. Performance in the two conditions did not differ statistically, $t(16) = -1.461$, $p = 0.163$. Such a high level of performance was necessary for the question of interest as we could only ask children about the source of their knowledge if it was evident that the knowledge existed.

Session 2 Performance

Retention of Integration Facts. In response to open-ended questions, children recalled an average of 1.35 Self-Generated integration facts and 1.65 Explicitly-Taught integration facts. No difference was found between performance in these conditions $t(16) = -1.571$, $p = 0.136$. Children received an average integration total score (open-ended plus forced-choice) of 1.76 in the Self-Generation condition and 2 in the Explicitly-Taught condition. There was no difference in retention of integration facts between conditions, $t(16) = -1.725$, $p = 0.104$.

Stem Fact Recall and Recognition. Across conditions, in open-ended testing, participants correctly recalled a total of 70% of all stem facts. A repeated measures ANOVA across the three types of stem facts: (Self-Generation stem 1, Self-Generation stem 2, and Explicitly-Taught stem 1) fell just below the conventional level of significance, $F(2, 15) = 3.267$, $p = 0.051$. The failure to reach statistical significance likely was due to the small number of trials for each type of stem fact. Importantly, performance was highest for Self-Generation stem 2 (1.65), suggesting that stem 2 is privileged over stem 1 (1.35 and 1.18 in the Self-Generation and Explicitly-Taught conditions, respectively) and is likely a critical point in the process of self-generation.

Children remembered an additional 25 stem facts when asked in a forced-choice format. Thus, children remembered a total of 94% (96/102) of stem facts across the three types. Again, a repeated measures ANOVA reflected no significant differences between conditions, $F(2,15) = .414$, $p = 0.665$.

Memory for Source

Descriptive statistics on participants' selection of external and internal sources for the integration and stem facts are provided in Table 3. Descriptive statistics on participants' selection of Story 1 versus Story 2 for the integration and stem facts are provided in Table 4.

Integration Facts. Participants' source responses were first categorized as external or internal. Selection of Story 1 or Story 2 was categorized as an external source. "I've always known it," "I figured it out myself," and "I don't know/I'm just guessing" were categorized as internal. It is important to note that children first had to answer the open-ended integration question correctly before being asked the source question "How do you know that?". For the integration fact in the Self-Generation condition, participants selected internal and external sources equally often $t(14) = -1.388$, $p = 0.187$. In the Explicitly-Taught condition, participants chose external sources significantly more than internal sources $t(15) = -2.236$, $p = 0.041$.

For both the Self-Generation and Explicitly-Taught conditions, children who selected an external source for the integration fact overwhelmingly selected Story 2: $t(11) = -7.288$, $p < .001$ and $t(12) = -5.112$, $p < .001$, respectively. For the ET condition, selection of Story 2 reflected accurate memory for the source of the integration fact as it was always presented in Story 2. For the Self-Generation condition, consistent selection of Story 2 reflects a bias for the latter story, given that the integration facts were not actually presented in either story.

Stem Facts. In the SG condition children identified an external source for stem 1 significantly more than an internal source, $t(13) = -2.509$, $p = 0.026$. For the SG stem 2, this pattern of selecting an external source more than an internal source approached significance, $t(16) = -1.975$, $p = 0.066$. For the Explicitly-Taught stem 1, the pattern did not reach or approach significance, $t(13) = -0.806$, $p = 0.435$.

Accuracy of source performance was analyzed for children who selected an external source for the stem facts. Source responses initially categorized as internal were not included in the accuracy analysis because each stem fact originated from a specific story. For the SG condition, it was only for stem 2 that children accurately identified the specific source of stem 2 over stem 1, $t(13) = -4.192$, $p = 0.001$. For SG stem 1, children were not accurate at selecting the correct source $t(10) = -0.803$, p = 0.441, further demonstrating their bias toward stem 2. In the Explicitly-Taught condition, children did not accurately select the source of stem 1 above chance $t(9) = -1.616$, $p = 0.140$.

Discussion

The present experiment addressed the extent to which self-generated knowledge retains the contextual details of the episodes from which it arises. Eight-year-old children were excellent at self-generating new factual knowledge through integration and retaining their new knowledge over 1 week. Importantly, we found no difference in retention between the Self-Generation and Explicitly-Taught conditions. This finding reflects that both types of learning incorporate information into the knowledge base approximately equally well. This also allowed us to probe memory for source equally across the Self-Generation and Explicitly-Taught conditions. We found that children's self-generated knowledge had an unexpected context linked to the episodes from which it originated.

The data suggest that self-generated knowledge has a unique status when it comes to context. Overall, the 8-year-old children in the present study were uncertain as to the origin of their self-generated knowledge. However, when they recognized that their new knowledge came from an external source, they reliably reported that it came from the second story. This pattern of responses suggests that children recognized that they learned *pods talk by clicking and squeaking* at the first opportunity to integrate: presentation of the second stem fact.

In contrast to their consistent attribution of self-generated knowledge to Story 2, 8-year-old children only occasionally attributed self-generated knowledge to themselves. Notably, they never explicitly endorsed the option of "I figured it out myself." This may be related to a lack of metacognitive awareness that one can gain new knowledge by putting pieces of information together. When asked to identify the source of their self-generated knowledge, two children in this sample asked if they could select more than one of the five choices (only the first of which was included in analyses). Both of their explanations as to why they selected two or more choices revealed fusions of the two stories within a pair. For example, one participant who said, “Fronds are little pieces of palm tree and I thought pieces of a palm tree and remembered they were used to make baskets” also went on to say that he learned this from the story about the rabbit, the second story in the pair. Only one of the facts he described had truly come from that particular story. Not only were the stem facts integrated but so were the context details of the stories, suggesting that the representation of the individual stem facts had become less distinct.

In the ET condition, children correctly reported that they learned the integration fact from an external source significantly more than an internal source. Moreover, those who reported an external source accurately specified that the integration fact was learned from the second story in a pair. Importantly, Story 2 is the true source for the Explicitly-Taught integration fact. This demonstrates that when a target fact had a clear source, children were quite good at remembering that source. Notably, test order was randomized so that children would not be cued to the order in which they first heard the stories.

Interestingly, children’s memory for source of the stem facts further supports the privileged status of their self-generated knowledge. Participants correctly reported Story 2 as the source of stem 2 in the Self-Generation condition. Though it was just below statistical significance, participants also exhibited the strongest memory for stem 2 in the SG condition. Because it was presented second in a pair, the ET integration fact also functioned as stem 2, which participants also correctly identified as coming from Story 2. Children tended to report that stem 1 in the Self-Generation condition came from a story but they were not accurate at choosing the specific story. In the Explicitly-Taught condition, children were unable to identify reliably whether stem 1 came from a story or from themselves. Taken together, these data highlight stem 2 in the Self-Generation condition as unique.

Overall, children’s performance on our source task is consistent with the current literature on memory for source. In fact, prior research has employed paradigms that demand less specific knowledge of the contextual details for facts and pictures (Cycowicz et al., 2001; Drummey & Newcombe, 2002; Riggins, 2014). In Drummey & Newcombe (2002), children identified the source of ten facts but their source options were limited to experimenter and puppet. It is amazing that 8-year-olds can identify the specific character associated with eight individual stem facts. Children’s memory for contextual information may be better than previously shown.

More broadly, the current work raises the longstanding issue of the relation between episodic and semantic memories. Episodic and semantic memories have typically been considered separate stores with the former being relevant in autobiographical memory and the latter being one’s store of general knowledge. When taken with the current literatures on source monitoring and the development of episodic memory, our data suggest that the ability to monitor source continues to develop even after the relatively stable ability exhibited by 8-year-olds. Furthermore, semantic memories do not lose their episodic context immediately, suggesting that the distinct between semantic and episodic may apply only to information that has been stored in memory for the truly long term.

Limitations

A major limitation of the present research was the low number of total possible trials participants could complete. In prior research, participants in this paradigm had never before been exposed to more than 6 total stories. In order to have an equal number of trials possible in each condition while also avoiding inundating participants with facts and contextual details, we provided each participant with 2 opportunities to self-generate and 2 opportunities to explicitly learn the target integration facts. Furthermore, the design limited the number of source questions possible, as children first had to answer the open-ended fact questions correctly before they could answer the respective source questions. This created unequal numbers of trials for each fact type. Prior research on children's memory for source information has included distractor items during the source task. We did not include distractor items in this study in order to avoid overwhelming the children with a high number of questions. Because we did not include distractors, it is possible that participants learned we were interested in their memory for information about the stories. Even with a number of limitations, a strong pattern demonstrating children's bias toward stem 2 emerged from the data and as such, children's consistent selection of stem 2 as the source of their knowledge is that much more fascinating.

Future Research

Self-generated knowledge may have the unexpected context demonstrated in the present study because it arises through active manipulation of information instead of explicit teaching alone. Thus, future studies should compare memory for the source of information that requires manipulation with that which does not. Children's memory for the source of this newly self-derived knowledge can be compared to a pair of facts that allows but does not require integration and to a pair of facts that neither allows nor requires integration. Use of eye-tracking technology will allow us to understand if participants are attending differentially to the relational links across three conditions and may provide evidence linking children's metacognitive knowledge with their online processing of factual information.

Additionally, experiments that manipulate the strength of memory for the individual stem facts, such as requiring learning to criterion, will help us understand how the separate pieces of information change during the process of self-generation through integration. Such an experiment may help us understand whether the individual stem facts remain separate after integration.

Conclusions

Knowledge that is self-generated through integration of separate but related episodes has an unexpected context. It appears that self-generated knowledge retains the context from the first episode during which the opportunity to integrate presents itself. Though children did not explicitly state that they themselves had integrated stem facts in order to generate a new fact, they were "aware," at some level, that the integration happened at least on the level of context. Future studies should address the status of the stem facts following self-generation of new knowledge to elucidate how the representations of the stem facts may change.

References

Bauer, P. J., & Jackson, F. L. (2015). Semantic elaboration: ERPs reveal rapid transition from novel to known. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 41(1)*, 271-282.

Bauer, P. J., King, J. E., Larkina, M., Varga, N. L., & White, E. A. (2012). Characters and clues: Factors affecting children's extension of knowledge through integration of separate episodes. *Journal of Experimental Child Psychology, 111,* 681-694. (DOI:10.1016/j.jecp.2011.10.005)

Bauer, P. J., & Larkina, M. (in press). Realizing relevance: The influence of domain-specific information on generation of new knowledge through integration in 4- to 8-year-old children. *Child Development.*

Bauer, P. J., & San Souci, P. (2010). Going beyond the facts: Young children extend knowledge by integrating episodes. *Journal of Experimental Child Psychology*, 107, 452-465.

Cycowicz, Y. M., Friedman, D., Snodgrass, J. G., & Duff, M. (2001). Recognition and source memory for pictures in children and adults. *Neuropsychologia*, *39*(3), 255–267. doi:10.1016/S0028-3932(00)00108-1

Drummey, A. B., & Newcombe, N. S. (2002). Developmental changes in source memory. *Developmental Science, 5*(4), 502-513.

Gelman, S. A. (2009). Learning from others: Children's construction of concepts. *Annual Review of Psychology, 60*, 115-140.

Goswami, U. (2011). Inductive and deductive reasoning. In U. Goswami (Ed.), *Childhood cognitive development* (pp. 399–419). Oxford, UK: Wiley–Blackwell.

Riggins, T. (2014). Longitudinal investigation of source memory reveals qualitative differences between item memory and binding. *Developmental Psychology, 50(2)*, 449–459.

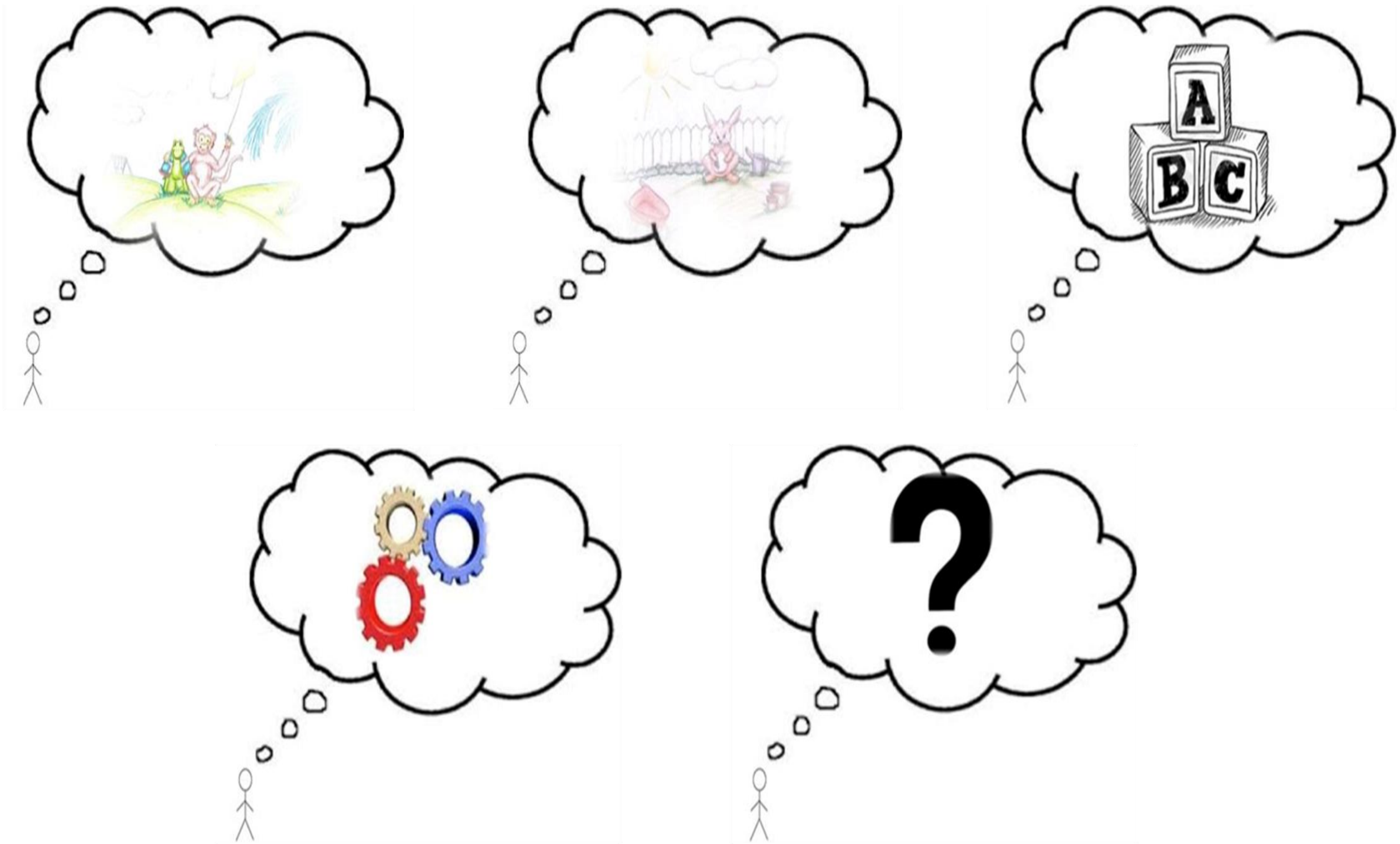
Riggins, T., Rollins, L., & Graham, M. (2013). Electrophysiological investigation of source memory in early childhood. *Developmental Neuropsychology*, *38*(3), 180–196. doi:10.1080/87565641.2012.762001

Tulving, E. (1972). Episodic and semantic memory. In E. Tulving and W. Donaldson (Eds.), *Organization of Memory* (pp. 381–402). New York: Academic Press.

Varga, N. L., & Bauer, P. J. (2013). Effects of delay on 6-year-old children's self-generation and retention of knowledge through integration. *Journal of Experimental Child Psychology*, 115, 326-341. (DOI: 10.1016/j.jecp.2013.01.008)

Appendix

Source choices presented to children representing Story 1, Story 2, "I figured it out myself," "I've always known that," and "I don't know."



Tables

Table 1

Sessions 1 and 2 Integration Performance

	Session 1 Open-Ended	Session 2 Open-Ended	Session 2 Total
Condition	*M (SD)*	*M (SD)*	*M (SD)*
Self-Generation	1.82 (.39)	1.35 (.70)	1.76 (.56)
Explicitly-Taught	1.94 (.24)	1.65 (.61)	2.00 (0)

Table 2

Memory for Stem Facts

	Open-Ended	Total
Fact Type	*M (SD)*	*M (SD)*
SG Stem 1	1.35 (.79)	1.82 (.53)
SG Stem 2	1.65 (.49)	1.94 (.24)
ET Stem 1	1.18 (.73)	1.88 (.33)

Table 3

Selection of External vs. Internal Sources

Panel A. Integration Facts

	n	External *M (SD)*	Internal *M (SD)*
Self-Generation	15	1.00 (.65)	.77 (.26)
Explicitly-Taught	16	1.25 (.77)*	.88 (.22)
Panel B: Stem Facts			
SG Stem 1	14	1.29 (.83)*	.82 (.25)
SG Stem 2	17	1.12 (.70)	.82 (.25)
ET Stem 1	14	.86 (.66)	.71 (.26)

Note: **p* <.05, *n* = number of trials. Tests compared selection of external versus internal sources for each fact type.

Table 4

Selection of Story 1 vs. Story 2 Sources

Panel A. Integration Facts		Story 1	Story 2
	n	*M (SD)*	*M (SD)*
Self-Generation	12	.63 (.23)	1.17 (.39)**
Explicitly-Taught	13	.77 (.26)	1.31 (.48)**
Panel B. Stem Facts			
SG Stem 1	11	1.00 (.77)	.82 (.25)
SG Stem 2	14	.68 (.25)	1.14 (.53)**
ET Stem 1	10	.90 (.57)	.60 (.21)

Note: ***p* <.001, *n* = number of trials. Tests compared selection of Story 1 versus Story 2 for each fact type