MIND, BRAIN, AND EDUCATION

Are there Age-Related Differences in the Effects of Prior Knowledge on Learning? Insights Gained from the Memory Congruency Effect

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ABSTRACT— Humans accumulate knowledge throughout their entire lives. In what ways does this accumulation of knowledge influence learning of new information? Are there age-related differences in the way prior knowledge is leveraged for remembering new information? We review studies that have investigated these questions, focusing on those that have used the memory congruency effect, which provides a quantitative measure of memory advantage because of prior knowledge. Regarding the first question, evidence suggests that the accumulation of knowledge is a key factor promoting the development of memory across childhood and counteracting some of the decline in older age. Regarding the second question, evidence suggests that, if available knowledge is controlled for, age-related differences in the memory congruency effect largely disappear. These results point to an age-invariance in the way prior knowledge is leveraged for learning new information. Research on neural mechanisms and implications for application are discussed.

Memory performance improves substantially during the first two decades of life (Schneider, 2015). It has long been suggested that increases in the amount and structure of knowledge contribute to the observed memory improvements with age (Bjorklund, 1987; Chi, 1978). Research on individuals with expert knowledge in a particular domain has impressively demonstrated the benefits of prior knowledge for learning and memory. Seminal work by Chase and Simon (1973) has shown that chess experts greatly outperform novices when memorizing realistic chess positions, but that this advantage dwindles for random chess positions. Age-comparative studies have further underscored these findings. Children who are chess experts outperform adult novices and perform at a similar level as adult experts (Chi, 1978; Schneider, Gruber, Gold, & Opwis, 1993). These findings suggest that typical age-related improvements in memory are attenuated or might even disappear altogether when prior knowledge is equalized. Such an interpretation has important implications: It implies that prior knowledge determines learning to such an extent that it can overcome age-related limitations in other basic cognitive abilities (e.g., working memory; see Craik & Bialystok, 2006; Ofen & Shing, 2013).

In this article, we ask whether the effect of prior knowledge on memory changes with age or is stable across the lifespan. Looking at its lifespan development can give us insight into how prior knowledge and basic cognitive skills interact in bringing about successful learning of new information. Before proceeding, we want to make some notes on terminology. In the cognitive psychology tradition, researchers typically use the terms “semantic knowledge” and “episodic memory” instead of “prior knowledge” and “memory for new information.” We decided to use the more specific term “prior knowledge” to make clear that

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we are talking about the specific aspect of knowledge that is relevant for the memory task at hand (i.e., knowledge in that domain). However, as we explain in the section on availability vs. accessibility, this does not automatically imply that the knowledge is accessed and used. We decided to use the broader term "memory for new information" instead of "episodic memory" because many studies we reviewed did not use memory tests that clearly required learners to situate their memories in time and place. This is partly because of practical limitations in testing young subjects, and partly because of the use of more educationally relevant learning material (e.g., facts, definitions).

In the course of the review, we will pose two main questions: (1) In what ways does the accumulation of knowledge with age influence memory for new information? (2) Are there age-related differences in the way prior knowledge is leveraged for remembering new information? A lifespan perspective is pertinent because the amount of knowledge and learning of new information are known to have very different lifespan trajectories (Craik & Bialystok, 2006). Considering their relative growth and decline is necessary to have a comprehensive understanding of their interaction. As depicted in Figure 1, the amount and complexity of a learner's knowledge increases dramatically across childhood and continues to increase, at a slower pace, until old age (Carey, 1978; Gelman & Markman, 1987; Li et al., 2004; Schneider, 2015). In contrast, memory for new information also increases across childhood, but undergoes strong decrease in functioning in later adulthood, akin to other basic cognitive capacities (Craik & Bialystok, 2006; Li et al., 2004). There thus exists a mismatch between the two that needs to be explained.

Why should the growth in prior knowledge affect memory processes at all? Prior knowledge has been conceived of as an associative network of interconnected nodes that represent memory items (Anderson, 1983; Collins & Loftus, 1975). The accumulation of experiences with age then leads to an increase in the number of nodes as well as in the number and strength of links between them. Greater prior knowledge, that is, a larger and more connected associative network, is suggested to facilitate memory for new information because it provides a structure (also called *schema*) into which the new information can be integrated and that facilitates later retrieval (Bjorklund, 1987; Ceci & Howe, 1978; Chi, 1978; Elman et al., 1996). Conversely, it has been suggested that a larger and more connected associative network also leads to increasing memory search demands and increased competition, which makes some new information harder to remember (Ramscar, Hendrix, Shaoul, Milin, & Baayen, 2014; Ramscar, Sun, Hendrix, & Baayen, 2017). In summary, prior knowledge can both promote and hinder memory performance, but in either case has a major impact on memory processes (for a more detailed discussion, see Brod, 2021).

Quantifying the Effects of Prior Knowledge on Memory: The Memory Congruency Effect

A challenge for reviewing studies that have investigated the effects of prior knowledge on memory for new information, let alone across different developmental periods, is to find a good metric for the effect. This can again be exemplified by research on expertise. The quasi-experimental nature of these studies—comparing experts with novices—makes it difficult to pinpoint the memory benefit that is specifically because of prior knowledge, as opposed to potential additional group differences in other relevant factors such as cognitive capacities or motivation. Furthermore, ideally

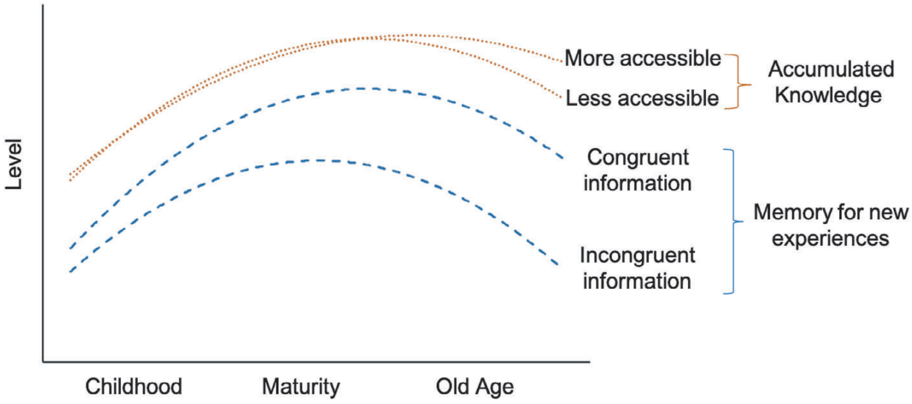

Fig. 1. Thematic depiction of the different lifespan trajectories of knowledge and memory for new information (based loosely on Craik & Bialystok, 2006; Li et al., 2004). Knowledge increases across development and is generally well maintained at old age, but some knowledge may become less accessible (lower dotted orange line). Memory for new information also increases across development, whereas its functioning decreases sharply in later adulthood (lower dashed blue line). However, some memory for new information can be formed more efficiently by children and better maintained in old age because of having a close relation or congruency to prior knowledge (upper dashed blue line).

we would be able to disentangle individual and contextual factors such as the type of memory test that might influence the magnitude of the effects of prior knowledge on memory, for which we need tasks in various knowledge domains that are suitable for learners of various ages. For the current article, we focus on studies that have leveraged the memory congruency effect, which we think is an approach that aptly quantifies the memory benefit of prior knowledge and the age differences therein.

The memory congruency effect is defined as a positive difference in memory performance between material encoded in a congruent vs. incongruent context. One of the first demonstrations of this effect was provided in the seminal work by Craik and Tulving (1975), who demonstrated that words that were embedded in a congruent sentence (e.g., "He moved the TABLE") were better remembered than words embedded in an incongruent sentence (e.g., "He moved the BUILDING"). The memory advantage because of knowledge congruency suggests that prior knowledge has supported memory performance, such as by making memory traces more elaborate (Bein et al., 2015; Craik & Tulving, 1975) and by facilitating memory search processes during retrieval (Moscovitch & Craik, 1976). The congruency effect, thus, allows researchers to investigate and compare factors that influence the magnitude of the effects of prior knowledge on memory.

A wealth of research has shown that there are several factors that determine the magnitude of the memory congruency effect. A prominent factor is the ratio between congruent and incongruent events. The memory congruency effect has been found to decrease if incongruent events are less frequent than congruent events (Stangor & McMillan, 1992; for an experimental manipulation, see Reggev, Sharoni, & Maril, 2018). These findings reveal an important point. If congruent and incongruent events strongly differ in frequency, it is unclear whether differences in memory performance between those events are because of congruency or because of frequency alone (e.g., pop-out effect). Therefore, in the following we only considered studies in which the number of congruent and incongruent events is comparable.

Of chief importance for the current review is the meta-analytic finding that the memory congruency effect increases both as a function of learners' prior knowledge and as a function of their age (Stangor & McMillan, 1992). Of course, learners' prior knowledge and age are typically confounded because there is a close coupling between the amount of knowledge and age for the first two decades of life (Li et al., 2004). Many studies that have found age-related increases in the memory congruency effect have used materials such as sentences (e.g., Geis & Hall, 1978; Ghatala, Carbonari, & Bobele, 1980), with verbal knowledge being particularly closely related with age (Li et al., 2004). Thus, it is unclear based on these studies to what extent there would be age-related increases in the memory congruency effect if available prior knowledge were controlled for.

Distinguishing Availability and Accessibility of Prior Knowledge

Having knowledge available is not sufficient—it needs to be accessed and activated to exert its influence on learning of new information (Brod, Werkle-Bergner, & Shing, 2013). Although at first glance this may sound trivial, the importance of this distinction becomes clear when looking at persons who are (temporarily) unable to access their knowledge. For example, older adults often have problems in naming known objects. This temporary inability to access their knowledge can be overcome by providing additional cues (Cohen & Burke, 1993). Furthermore, accessibility of prior knowledge can be manipulated experimentally as well. Bransford and Johnson (1972) used short, technical descriptions of highly familiar activities (e.g., doing laundry) and provided only some of the participants with the topic of the passage beforehand. Other participants were told about the topic afterwards or not at all. Even though the activities were highly familiar to all participants, recall of the text was much better in the group that received the topic beforehand and could, thus, use their prior knowledge while reading the text. These examples illustrate that knowledge can be available but not accessible. Importantly, to have an impact on memory, knowledge has to be both available and accessible.

In contrast to the lifelong increasing amount of available knowledge, the ability to access knowledge has been suggested to follow an inverted-U-shaped function across the lifespan, increasing across childhood and decreasing from middle adulthood toward old age (Craik & Bialystok, 2006). The ability to access knowledge is assumed to be closely coupled with the waxing and waning of cognitive control across the lifespan, which enables intentional processing of to-be-learned information (Craik & Bialystok, 2006). In sum, evidence from experimental and age-comparative studies suggest that availability and accessibility of prior knowledge can be distinguished.

These conjectures suggest that the key question of this article, whether the effects of prior knowledge on memory changes with age, needs to be unpacked further. In particular, they suggest that any observed age-related differences in memory performance could be a result of two factors: (1) differences in amount of available prior knowledge; or (2) differences in accessibility and use of prior knowledge, which are presumably linked to age-related differences in cognitive control abilities. Although there is strong evidence for the importance of the former factor, the latter factor has received considerably less attention. This is unfortunate because only effects that cannot be attributed to differences in available knowledge directly speak to whether the *effects of* prior knowledge on memory change with age. Equating for prior knowledge is therefore crucial for examining the hypothesis that differences in accessibility and use of prior knowledge play a role in age-related differences in the effect of prior knowledge on memory. Put differently, even if we find age-related differences in memory performance, we can only be sure that these differences are related to accessibility and use of prior knowledge if the amount of prior knowledge was comparable across age groups.

To conclude, in the majority of age-comparative studies, the potentially differing effects of availability and accessibility of prior knowledge were not considered. To separate these two aspects and thus allow a fair comparison of age-related differences in the effects of prior knowledge on memory, two conditions must be met: available prior knowledge needs to be equated between age groups, and the effect that this has on memory needs to be quantifiable. In the next section, we discuss how these conditions can be met.

Comparing the Size of the Memory Congruency Effect Between Different Age Groups

In the previous section, we argued that using the size of the memory congruency effect to study age-related differences in the effects of prior knowledge on memory requires control of available knowledge. When available knowledge is controlled for, any remaining age-related differences in the size of the memory congruency effect would suggest that the extent to which prior knowledge is leveraged for memory encoding or retrieval varies with age (i.e., a greater memory congruency effect implies a greater use of prior knowledge for memory encoding and/or retrieval). Researchers interested in age comparisons have attempted to control for available knowledge in two ways: by using stimuli that can be assumed to be highly familiar for all age groups, or by inducing new knowledge to a comparable degree that then serves as prior knowledge in the memory task. We will now discuss age comparison studies that have used either of the two approaches, starting with the former.

A study by Maril et al. (2011) used noun/color combinations that children (aged 8–11) and younger adults had to rate as possible or impossible in real life. In a later recognition memory test, words presented together with a possible color (i.e., congruent encoding condition) were better remembered than words presented together with an impossible color (i.e., incongruent encoding condition). This memory congruency effect did not differ significantly in size between the two age groups, although the effect was numerically bigger in adults.

A recent study corroborated this finding in a lifespan sample and using visual material that was highly familiar to all age groups (Brod & Shing, 2019). Children (aged 6–7), younger adults (aged 18–22), and older adults (aged 67–74) had to rate whether an object fits to a particular scene or not (e.g., tractor–farm). In an incidental recognition memory test, all groups demonstrated better memory for objects presented together with congruent scenes (see Figure 2). This memory congruency effect did not differ significantly between age groups and was almost identical numerically in all three groups. In sum, both studies have used stimuli that were highly familiar to all age groups and report congruency effects that are similar in size.

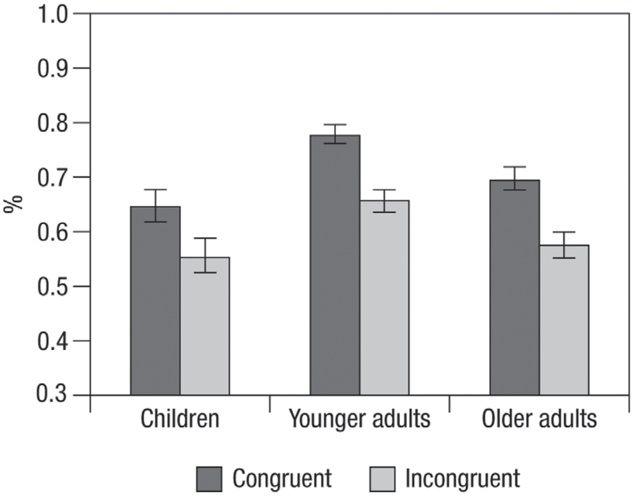

Fig. 2. Item Memory Performance in Brod and Shing (2019). Pr-Scores (Hits—False Alarms) indicated better memory for items encoded in a congruent context. There was a main effect of age, indicating better overall memory in younger adults than in children, but no congruency × age group interaction, indicating that the memory congruency effect was comparable across age groups.

Approaching the confound between age and prior knowledge by using experimentally induced prior knowledge is considerably more cumbersome than attempting to minimize the confound by using highly familiar stimuli. However, it allows for tight experimental control of prior knowledge among participants of different ages. In a study that adopted this approach (Brod, Lindenberger, & Shing, 2017), children (aged 8–12) and younger adults learned a hierarchy of novel objects via a trial-and-error learning task on day 1. It was ensured that, at the end of this session, all participants knew the hierarchy to a comparable degree. On day 2, participants performed a memory task in which they had to predict outcomes of competitions between pairs of learned objects. Half of the outcomes were congruent with the learned hierarchy, whereas the other half was incongruent with the learned hierarchy. In a later memory test, participants were better able to recall those outcomes of competitions that were congruent with the learned hierarchy than those that were incongruent with it. This memory congruency effect did not differ significantly between age groups and was almost identical numerically as well.

In sum, recent studies investigating age-related differences in the memory congruency effect have attempted to overcome the confound between age and prior knowledge by either using material that can be assumed to be similarly familiar to all age groups (e.g., pictures of common objects) or by inducing prior knowledge to a comparable degree in all age groups. These studies found no age-related differences in the size of the memory congruency effect, even up to old age. These findings stand in contrast to earlier studies that did not control for prior knowledge and found age-related increases in the memory congruency effect (e.g., Geis & Hall, 1978; Ghatala, Carbonari, & Bobele, 1980).

INTERIM CONCLUSIONS

To conclude, whether available knowledge is equated has a strong influence on the size of the memory congruency effect and the age differences therein. Studies that have not controlled for available knowledge have found that the memory congruency effect increases with age. In contrast, studies that have controlled for available knowledge have found that the size of the memory congruency effect is largely unrelated to learners' age. These results suggest that age-related differences in the size of the memory congruency effect are mainly because of age-related differences in prior knowledge, whereas age-related differences in accessibility and use of prior knowledge are negligible, at least in healthy individuals. The reviewed evidence thus points to an age-invariance in the way prior knowledge is leveraged for remembering new information. This conclusion does not necessarily imply, however, that the underlying mechanisms are invariant as well. Studies that have looked at age-related differences in neural mechanisms will be discussed in the next section.

CURRENT AND FUTURE DIRECTIONS

Distinguishing Prior Knowledge Effects on Memory Encoding and Retrieval: A Developmental Cognitive Neuroscience Perspective

Cognitive neuroscience research in recent years has shed light on the neural underpinnings of prior knowledge effects on memory. An important benefit of neuroimaging is that memory processing during encoding and retrieval can be studied directly and separately. Several lines of literature, including lesion (Ghosh, Moscovitch, Melo Colella, & Gilboa, 2014; Warren, Jones, Duff, & Tranel, 2014) and functional neuroimaging studies (e.g., van Kesteren, Fernandez, Norris, & Hermans, 2010) point toward the ventromedial prefrontal cortex (vmPFC), among other regions, for playing an important role in knowledge-mediated memory processing through its interaction with the hippocampus, both at encoding and retrieval. Notably though, not all studies that had investigated memory processing in the context of prior knowledge found an involvement of vmPFC (e.g., Sommer, 2017; Webb, Turney, & Dennis, 2016). In an attempt to clarify the role of the vmPFC, particularly for encoding, Brod and Shing (2018) showed that the vmPFC is not involved in memory formation in the context of prior knowledge per se, but that its contributions are modulated by the perceived congruency between prior knowledge and the new information. In general, when congruency is high, vmPFC detects the resonance, which may then initiate neural processing that integrates the new information into existing knowledge structures.

Turning to age-related differences in vmPFC and memory processing, a recent lifespan comparison study by Brod and Shing (2019) found similar levels of vmPFC activity in children, younger adults, and older adults for successful encoding of congruent scene–object pairs relative to incongruent pairs. This neural finding is in line with the behavioral finding, as depicted in Figure 2, that the memory congruency effect is similar across all age groups. In other words, for well-learned, consolidated knowledge, vmPFC activation underlying the memory congruency effect shows age-comparative magnitude. Notably, it was also found that the magnitude of vmPFC recruitment for encoding knowledge-congruent information correlated positively with knowledge-congruent memory errors conducted later on at retrieval. Children and, in particular, older adults showed heightened susceptibility to make such kind of memory errors. This finding exemplifies the double-edged role of knowledge for memory: on the one hand, the benefits of facilitating the encoding of congruent new information; on the other hand, the risk of endorsing lure information at retrieval that seems plausible but has in fact not been encountered.

When examining age-related differences in vmPFC at memory retrieval, in a study in which prior knowledge was experimentally induced in children and young adults (Brod, Lindenberger, & Shing, 2017), it was found that children showed less medial PFC activity than adults for successfully retrieved knowledge-congruent events. Within the children group, the level of activation was positively correlated with age. Moreover, for successfully retrieved knowledge-incongruent events, children showed stronger hippocampus activation but weaker connectivity between the striatum and dorsolateral PFC than adults. These results point to an age-related shift from a more hippocampus-bound processing to an increasing recruitment of prefrontal brain regions for memory retrieval (see also Ofen et al., 2019).

At a first glance, there seem to be inconsistent age patterns in vmPFC activation, with either no age difference or lower activation in children compared with adults. The latter seems also at odd with the age-invariance pattern in behavioral memory congruency effect, as discussed above. We offer two potential interpretations. The first interpretation is that encoding processes of knowledge-congruent information may be age invariant but retrieval processes still show age-related differences, despite knowledge availability being equated. In particular, children and older adults may have more difficulties at retrieval than younger adults in rejecting lure information that is congruent to knowledge. For example, in a series of studies, Amer et al. (2018, 2019) showed that the advantage of item–price congruency is comparable between younger and older adults when retrieval is speeded, but that it is reduced in younger adults for longer retrieval times. In contrast to older adults, younger adults seem to leverage longer retrieval times for engaging in controlled processes that help retrieval of incongruent item–price associations. The fMRI data (Amer et al., 2019) suggest that this deficiency in older adults is related to age-related reduced activation in brain areas engaged in controlled retrieval (e.g., dorsolateral PFC; cf. Atkins & Reuter-Lorenz, 2011; Dobbins, Foley, Schacter, & Wagner, 2002; Fandakova, Lindenberger, & Shing, 2014). At the other end of the lifespan, Brod, Lindenberger, and Shing (2017) did not find any age-related reductions in level of activation in the retrieval of knowledge-incongruent information in children. However, children showed weaker connectivity between the striatum and dorsolateral PFC than adults, also suggesting deficits in controlled retrieval.

Taken together, these findings suggest that, while the way knowledge is used for encoding new information is the same across age groups, differences in knowledge-unrelated retrieval processes can lead to behavioral age differences in the effects of knowledge on memory performance. In particular, control and monitoring processes supported by the lateral PFC are deficient in both children and older adults, resulting in poorer memory for knowledge-incongruent information. More generally, it has been found that knowledge supports the retrieval of episodic memory more through the neural network underlying familiarity—a more automatic form of memory retrieval without contextual details—than recollection—a more controlled form of memory retrieval accompanied by contextual details (Wang et al., 2018). Future studies should examine to what extent a strong reliance on familiarity signals, together with a lack of engagement in controlled processing supported by the lateral PFC, underlie lifespan age-related differences in (negative) knowledge effects on memory retrieval.

The second, non-mutually exclusive interpretation is that (newly) experimentally induced knowledge may differ from well-consolidated knowledge in the way it impacts on memory across age. Memory representations go through time-evolving reorganization over distributed brain regions, often with an increased involvement of the neocortex over time (e.g., Dudai, 2012). The speed at which this consolidation process takes place depends on several factors (Wang & Morris, 2010), conceivably with age being one of them. Experimentally induced knowledge (e.g., Brod, Lindenberger, & Shing, 2017) may not be as consolidated at the neocortical level in children compared with adults despite being learned at the same time, potentially leading to further age-related differences in the involvement of medial PFC for retrieving new, congruent information. Future studies that experimentally vary the extent of knowledge consolidation to track its effects on learning of new information will be of high importance to resolve this question.

Prior Knowledge and Memory at Infancy

Thus far, in our review, we have focused on prior knowledge and memory from middle childhood onwards. However, it is imperative to understand the interaction between prior knowledge and memory starting from early childhood (from infancy to toddlerhood), in order to fully map out the ontogenesis of these interactive processes. Memories of experienced events in the first years of life tend to be fragile and short-lived (see review by Bauer, 2007), as also illustrated by the characteristic phenomenon of infantile amnesia (the inability to remember experienced events in early childhood). Over time, there is gradual development in the ability to form, retain, and later retrieve memories of previous experiences. On the other hand, from early on, infants seem to be equipped with learning mechanisms that facilitate the detection of regularities (e.g., transitional probabilities in which occurrence of an event is dependent upon other) and structure from the environment (see review by Saffran & Kirkham, 2018). Together with core knowledge or a basic repertoire of expectations about the world, these capabilities allow infants to handle the insurmountable input from their environment. Subsequent learning is also facilitated with the backdrop of knowledge for regularities (Stahl & Feigenson, 2015). Taking a step further, one may postulate that memories for unique experiences are made possible to last when they can be built upon some form of structured knowledge. In other words, early forms of semantic memory may scaffold the laying down and keeping of memory for new experiences.

This postulation is in line with a functionalist approach to memory put forward by Keresztes, Ngo, Lindenberger, Werkle-Bergner, and Newcombe (2018), who suggest that during development, there is an emphasis on generalization over specificity of memory. That is, recognizing and forming stable representations of recurring episodes may be prioritized over remembering specific episodes. This may be driven by the maturational changes within the hippocampus, with the dentate gyrus region undergoing more protracted development than other subregions within the hippocampus (Keresztes et al., 2017). The dentate gyrus has been linked to the computation of pattern separation, which may underlie the formation of differentiated memory representations (Yassa & Stark, 2011). On the other hand, the CA3 (through its recurrent collaterals that project onto itself) and CA1 (through the monosynaptic pathway that receives input directly from the cortical input of entorhinal cortex) regions have been suggested to be functionally important for pattern completion. It is conceivable that pattern completion is implicated in knowledge-related new memories. Although human studies are scarce, a notable study by Yousuf, Packard, Fuentemilla, and Bunzeck (2021) showed converging evidence with enhanced activation of CA3 for successful encoding of items with semantically congruent cues. Importantly, in development, the earlier maturation of CA1 may underlie the bias toward generalization in early childhood. Together, these notions suggest that, during the first years of life, there is a shift from remembering mainly recurring episodes that are generalizable or predictive of future events to remembering the specifics of experiences. Generalizable memory, as a form of prior knowledge in early years, may scaffold the development of episodic memory, which emerges later in development.

Educational Implications

What practical implications does the discussed research on the memory congruency effect have for learning and instruction? First and foremost, it suggests that activating learners' prior knowledge that is congruent with the to-be-taught information will benefit their learning directly. This is because new information that is congruent is easy for learners to integrate into their knowledge structures. Teachers should thus attempt to first identify students' knowledge that is congruent with the to-be-taught information and then dovetail new concepts and facts with it (Shing & Brod, 2016). Effective methods to do so include providing students with analogies or examples based on their knowledge and experiences. Framing new concepts in the context of familiar, structurally similar ones has been repeatedly found to foster students' understanding (e.g., Gentner & Holyoak, 1997; Halpern, Hansen, & Riefer, 1990; Iding, 1997). Research on the memory congruency effect suggests that using those analogies should boost students' memory as well.

The ease of integration of congruent new information can further be leveraged to counteract some of the learning difficulties observed in children and older adults. For example, in a study in which older and younger adults had to learn grocery prices, older adults had a much harder time than younger adults to remember prices that were incongruent with their prior knowledge (i.e., unrealistic ones), but performed at the same level for prices that were congruent with their prior knowledge (Castel, 2005). These findings suggest that identifying and activating congruent prior knowledge is particularly helpful for people with generally poorer memory abilities (for an in-depth discussion of knowledge as a compensatory mechanism for older adults' memory, see Umanath & Marsh, 2014).

At the same time, presenting new information in a way that is most strikingly incongruent with learners' prior knowledge can be a viable instructional strategy as well. As discussed above, strong expectancy violations promote declarative learning in children as young as 3 years of age (Stahl & Feigenson, 2017). This could be because being surprised about a violation of expectations signals a need for learning (Reisenzein, Horstmann, & Schützwohl, 2019). But how can incongruent information be presented in a way that maximizes surprise and memory? A recent line of research has demonstrated that asking learners to generate predictions boosts surprise about incongruent information and, in turn, enhances its memorability (Brod, Hasselhorn, & Bunge, 2018; Theobald & Brod, 2021). Generating an incorrect prediction was shown to selectively enhance memory for incongruent information, which counteracted the otherwise observed memory advantage for congruent information. These findings suggest that teachers should probe their students for predictions, particularly when they know that new information will be incongruent with students' prior knowledge.

CONCLUSIONS

The infinite amount of information in the environment poses a critical challenge to the cognitive system of any learner; what should they learn or ignore from the environment in order to function adaptively? Converging lines of research suggests that prior knowledge plays a fundamental role here. Its strong effect on learning and memory is evident in the memory congruency effect, which denotes the memory advantage typically observed for knowledge-congruent information. Our review took a lifespan developmental perspective on the topic, which suggests that there is a tight coupling between prior knowledge and memory for new information that is already present in the early stages of development. The continuous increase in available knowledge is a key factor that supports the development of memory abilities and counteracts some of the decline in memory abilities observed in old age. Once the availability of knowledge is controlled for, there are no clear age-related differences in the memory benefit for knowledge-congruent over knowledge-incongruent information left.

For the current review, we have focused on studies using the memory congruency effect paradigm. Do findings of other paradigms match our conclusions? Although investigating the mechanisms of prior knowledge effects on memory has been and continues to be a diverse and productive research area (e.g., Bein, Trzewik, & Maril, 2019; Kole & Healy, 2007; Rawson & Van Overschelde, 2008; van Kesteren et al., 2013), age-comparative research is rare. An exception is research on false memory, particularly research on the false recognition of semantically related words (i.e., DRM paradigm; Deese, 1959; Roediger & McDermott, 1995). To some extent mirroring the findings regarding the memory congruency effect, the false alarm rate in the DRM paradigm, which is an indicator of prior knowledge effects, has been shown to increase from across middle childhood and up to old age when prior knowledge is not controlled (e.g., Dennis, Kim, & Cabeza, 2008; Metzger et al., 2008; Paz-Alonso, Ghetti, Donohue, Goodman, & Bunge, 2008). In contrast, studies that have used only highly typical category words that clearly fall within the vocabulary of the children or that have used child-friendly pictures have found high false alarm rates in children of all ages (Ghetti, Qin, & Goodman, 2002; Howe, 2006). These findings again underscore the double-edged roles of knowledge on memory for new information. Finally, although these findings suggest that our conclusions may hold in other paradigms as well, future research using a variety of paradigms is needed to draw generalized conclusion about age-related differences in the use of prior knowledge for learning and memory.

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Conflict of interest
We do not have a conflict of interest to disclose.

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