The Counterintuitive Course of False Memory Development During Childhood

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Chapter for:

M. L. Courage and N. Cowan (Eds.),
The Development of Memory in Infancy and Childhood (2nd Edition)
New York: Psychology Press

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Over the past couple of centuries of research on the nature of children's memory abilities, much has been learned about how memory develops across childhood, particularly how accurate memory for events are formed, stored, and subsequently retrieved (e.g., see the compendium of chapters in both volumes of Bauer & Fivush, 2014; Howe, 2015). Considerable scientific evidence also attests to the different variables that influence how accurately children can remember emotional events, including ones that are stressful and traumatic (e.g., Goodman, Goldfarb, Quas, Narr, Milojevich, & Cordon, 2016). Because the knowledge accrued in these areas of the scientific study of children's memory have been well documented in the recent literature, the focus of this chapter is on the slightly less well documented topic of how children's memories can be altered or changed as a consequence of implicit and often automatic influences that arise endogenously (internal influences) and exogenously (external influences). As it turns out, these so-called false or illusory memories can be far less common in children than initially expected. Ironically, research has shown that depending on the source of influence, children can be both less and more susceptible to memory illusions. Before reviewing this literature, we begin with an explanation of what is meant by the term "false memories" and delineate the various sources from which they can arise.

What Are False Memories?

False memories are ones where the events or details of that memory were not actually experienced, or not experienced in the manner in which they are being remembered (Loftus, 2005). These illusions occur as a natural consequence of the adaptive nature of memory. Specifically, because memory involves (re)constructive processes during encoding,

storage, and retrieval, errors in what is being remembered can occur as a natural consequence of the remembering process itself (e.g., Howe, 2011a, 2011b; Schacter, Guerin, & St. Jacques, 2011). That is, because memory is not like a videorecorder or verbatim storage device, what gets into memory is a construction based on a personalized interpretation of the actual experience, one that is filtered through the lens of personal knowledge and experience. Moreover, memory, even in childhood, is not so much about remembering the past as it is about extracting meaning from prior experiences to enable accurate interpretations of the present and anticipation of the future (e.g., Atance & O'Neill, 2005; Howe & Otgaar, 2013).

For now, we return to delineating the different types of false memories that have been studied in the memory literature. In general, there are two main types of false memories: Suggestion-induced (exogenous) and spontaneous (endogenous) false memories (e.g., Mazzoni, 2002). *Suggestion-induced false memories* are normally elicited by means of external suggestive pressure (Frenda, Nichols, & Loftus, 2011). The misinformation paradigm is the quintessential method used to study the formation of suggestion-induced false memories. Here, participants can either view a video of an event (e.g., a filmed version of the theft of a purse in a classroom) or are actually involved in the event (e.g., witness the theft of a purse in their classroom). Following this, participants are presented with misinformation in the form of, for example, another eyewitness' statement or a series of suggestive questions. Generally speaking, the misinformation contains false details that were not present during the encoding phase (e.g., that the purse thief carried a gun during the robbery while no gun was actually present). Next, participants receive a memory test that includes both presented and misinformed details. The canonical finding is that a non-

trivial percentage of participants report the misinformation as having been actually presented during the encoding phase – the classic misinformation effect.

Alternatively, *spontaneous false memories* are evoked solely by means of internal memory mechanisms such as spreading activation between related nodes in one's memory network (Gallo, 2010). The elicitation of spontaneous false memories is mostly done by relying on the Deese/Roediger-McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm. Here, participants study word (or picture) lists containing items that are associatively linked to each other (e.g., *weep, baby, yell, sorrow, tears*). During subsequent memory tests (recall, recognition), many participants falsely remember a non-presented, but related, item called the critical lure (i.e., *cry*). In fact, the rate at which false memories are recollected can be as high as those rates for true memories (Roediger & McDermott, 1995).

Of course, there are any number of variations on these basic paradigms. For example, suggestion-based false memories are not restricted to providing misleading information about the details of an event, but can involve the implantation of entire false events. For example, Ceci, Huffman, Smith, and Loftus (1994) presented preschoolers with fictitious events where children came to falsely remember and believe that they had got their hand stuck in a mousetrap (a negative event) or went up in a hot air balloon ride (a positive event). About 33% of children came to believe that these events actually happened to them and formed memories for these events. Interestingly, researchers have shown that it may be just as easy to form false memories for negative events, including falling off a tricycle and receiving stitches (Ceci, Loftus, Leichtman, & Bruck, 1994) or being abducted by a UFO (Otgaar, Candel, Merckelbach, & Wade, 2009), than it is to form them for positive events (e.g., a hot-air balloon ride) and perhaps even easier than forming false memories for

neutral events (see Otgaar, Candel, & Merckelbach, 2008). (For a more complete exegesis of different methods used to elicit false memories, see Otgaar, Houben, & Howe, 2019.)

Historical Perspectives on Children's False Memory Development

Interestingly, the very early research on children's memory revolved around issues not simply about the accuracy of their recollections but also on the malleability of children's memories (Davis, 1998). Many have suggested that the Salem witch trials of 1692 (Boyer & Nissenbaum, 1974) was the first time children's memory reliability was at issue (e.g., Ceci & Bruck, 1995). At this time, children's memories were not questioned and people believed their allegations. During the 18th and 19th centuries, there was a considerable focus on the extent to which children's memories were subject to suggestibility. For example, in 1784, the government of France summoned a commission to investigate the work of Mesmer, who was purported to be curing children's (and adults') physical ailments using magical rituals (e.g., see Hull, 1933). As it turned out, Mesmer was actually using what would now be called hypnosis, something that was discovered after several informal experiments by the French commission (see Ellenberger, 1970; Goldstein, 1987; Hull, 1933). These experiments can be considered among the very first on children's (and adults') suggestibility, and showed that people of all ages can be cured of a malady simply upon the suggestion of an adult.

Subsequently, work during the 1800s on hypnosis continued, with various physicians using it to ease pain, alleviate bedwetting and nail biting, cure disease, instill good morals, and change "untruthfulness" in childhood (see Coffin, 1941; Hull, 1933; Janet, 1919/1925). Interestingly, educational psychologists in the late 19th century began using nonhypnotic versions of suggestion to influence children's responses to perceptual stimuli (e.g., Small,

1896). Indeed, using these techniques, children would say they perceived stimuli that were only suggested by an adult but that were not actually there, an early form of perceptual illusion (similar effects were also found for adults – Gilbert, 1894; Seashore, 1895).

In addition, during the 19th century, some physicians began to speculate about a link between children's suggestibility and the truthfulness of their allegations of being abused. Indeed, some physicians even claimed that children were lying about their child sexual abuse (see Masson, 1984). These false allegations were said to arise due to mothers mistaking common childhood conditions as evidence of sexual abuse and questioning their children in a suggestive manner about possible abuse.

Of course, there was no scientific evidence to back up these claims and it was not until Bernheim (1888/1964) provided empirical tests of children's resistance to suggestion, that such assumptions about children's suggestibility were challenged. However, as in modern day research, it is not clear that Bernheim's experiments provided an adequate test of these assumptions as he did not examine a parent's suggestive questioning about sexual abuse. Rather, using a single subject design, Bernheim questioned children about conversations he knew they had overheard and tried to convince them that they had not heard such conversations; a procedure that is more line with work on omissions errors in children (e.g., Otgaar et al., 2010). The children resisted his suggestion and continued to maintain that they had in fact heard these conversations.

Interestingly, Bernheim (1888/1964) also examined adults' suggestibility about events they had not experienced and many of them later reported that these events had actually occurred. He referred to this phenomenon as a "retroactive hallucination," something very similar to today's term "implanted (or false) memory." Although Bernheim thought that children could accurately report about events they had experienced, he also

could not rule out that given intensive and suggestive questioning, even children could succumb to "retroactive hallucinations." These hallucinations, he would write, are not due to deliberate lying but are the result of memory confusion that arises from social pressure.

Theoretical Perspectives on Children's False Memory Development

Of course, with continuing concerns about the reliability of children's memory in the courtroom (and elsewhere), research on children's memory and suggestibility continued to blossom in the 20th century. Although we will discuss more about children's suggestibility throughout this chapter, especially as it relates to the topic of false memory development, more complete reviews of the full range of studies done in this area can be found in numerous recent sources. These include Ceci and Bruck's (1993) review, which also includes an exegesis of work conducted in the early 20th century, and a more recent review by Klemfuss and Olaguez (2020) which provides an overview of more recent research on children's suggestibility.

Shifting gears, a number of theories of memory development have been constructed, ones that also include explanations for the emergence of false memories. For example, Fuzzy-trace Theory (FTT; Brainerd, Reyna, & Ceci, 2008) says that when experiencing an event, people store two independent memory traces, a verbatim trace and a gist trace. Verbatim traces are involved in the processing of item-specific information including the exact surface characteristics of an experience. Gist traces are ones that are extracted based on the underlying meaning (associative and semantic structure) of an event. Because verbatim traces fade more rapidly than gist traces, FTT postulates that over time, it becomes increasingly difficult to retrieve the exact details of an event. When this happens, people will rely on the retrieval of gist traces which can foment the production of

false memories (i.e., information related to the meaning of the event but was not actually experienced as part of the event). Developmentally, as children get older, the ability to create and retrieve gist traces get easier. What this means is that older children and adults are more likely to create false memories than younger children. This phenomenon has been dubbed a *developmental reversal* (Brainerd et al., 2008; Otgaar, Howe, Merckelbach, & Muris, 2018).

An alternative theory, Associative-activation Theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009; Otgaar, Howe, Muris, & Merckelbach, 2019), uses the notion of spreading activation to explain the formation of false memories. According to AAT, the experience of an event leads to the encoding of a representation of that event in memory and the activation of this representation spreads throughout an interrelated memory network containing nodes (i.e., concepts) that are related to that experience. In adults, this associative activation is rapid and automatic leading to the activation of neighboring nodes that were not experienced. When such nodes are activated, false memories are formed. With development, as well as through experience and (in)formal learning, associative links between nodes becomes stronger and denser, enabling faster and more automatic associative activation. Given these (and other) developmental changes, AAT, like FTT, predicts that older children and adults will be more susceptible to false memory formation than younger children (Howe et al., 2009).

The Counterintuitive Nature of False Memory Development

With these fundamentals about false memory as background, we now proceed to the main topic of this chapter, namely, what age-related patterns exist in the development of memory illusions across childhood? Are young children more (as some believed in the

early 20th century – e.g., Varendonck, 1911) or less (as many believed during the Salem witch trials) susceptible to these illusions than older children and adults? The answer, as it turns out, is both – children can be both more and less susceptible to false memories, depending on how these memories come to be evoked (Otgaar, Howe, Brackmann, & Smeets, 2016; Otgaar et al., 2018). In the remainder of this chapter, we will detail these contingencies and show how this memory malleability is actually quite predictable.

Children's Memories Are More Prone to Memory Illusions

We begin by examining the familiar refrain that *children are more susceptible to false memories than adults*. This long-held belief has its recent origins in research pioneered in large part by Ceci and his colleagues (e.g., Ceci, Ross, & Toglia, 1987). In this research, children (3- to 12-year-olds) were read a story about a girl on her first day at school. Importantly, they were told that the girl had a stomach ache but a day later, some of the children received misinformation suggesting that the girl had a headache. Two days later when all of the children received a recognition test about the story, the youngest of the children (3- to 4-year-olds) who were told she had a headache, were more likely to accept this suggestion than older children. This pattern of age differences in suggestibility has been replicated numerous times (e.g., Calado, Otgaar, & Muris, 2018; Kulkofsky & Klemfuss, 2008; Otgaar, Candel, Smeets, & Merckelbach, 2010).

Similar findings have also been obtained using different procedures than the standard misinformation paradigm. For example, using a memory implantation procedure where entire events are manipulated not just details of an event, Otgaar et al. (2009) suggested to 7- to 12-year-old children that they had been abducted by a UFO. False memory rates for such an abduction were higher for the younger 7- to 8-year-olds than the older 11- to 12-year-olds. A similar pattern emerged in other studies where it was

suggested to children that they received a rectal enema or got their fingers stuck in a mousetrap (Otgaar, Candel, Scoboria, & Merckelbach, 2010).

The idea that younger children are more susceptible to suggestion and implantation than older children and adults is well encapsulated in Figure 1. Here, we provide a summary of studies in which false suggestive information was presented to children of different ages and the direction (if any) of the age differences in susceptibility to accepting this information. As is clear from this figure, the majority of studies found that younger children were more susceptible to misinformation and suggestibility than older children.

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Insert Figure 1 about here

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However, as we will see shortly, this is not the whole story. In order to anticipate this *developmental reversal* in false memory effects, recall that one of the essential ingredients of false memory is a sufficiently well-developed knowledge base in which these memory illusions can foment. Specifically, in order for a false memory to emerge, the person must have the necessary knowledge in order to generate that false memory. For example, if one does not know that guns are often used in robberies, then if a gun is not present in the scene, one will not develop a false memory for a gun. Similarly, if a child does not know that whales, bats, dogs, monkeys, shrews, cats, and seals are all mammals, then presenting these items on a word list will not lead inexorably lead to the development of the false memory, "mammal." Thus, to a large extent, having a false memory depends on what is in memory already.

To put a finer point on this argument, it is not just whether children do or do not know a particular relationship or categorization scheme, but also children of different ages

may have different associative networks. That is, children may organize concepts differently as a function of age, experience, and (in)formal learning. To see how this might be the case, consider a study by Ceci, Papierno, and Kulkofsky (2007). Here, children (4- and 9-year-olds) were given 257 sets each consisting of three pictures. Their task was to determine which of the three pictures did not belong with the others in the set. The outcome of this similarity-rating task was a multidimensional map of children's associations among the items being rated, with different maps emerging for 4-year-olds than 9-year-olds. These maps could then be used to predict age differences in children's proneness to suggestion.

To do this, one to three months later, Ceci et al. (2007) had these same children, as well as other children of these same ages, listen to a story that was illustrated using the pictures from the earlier similarity-rating task (e.g., a boy and a girl saw an *eagle* when visiting the zoo). After two days, some of the children heard misleading information about the story (e.g., the boy and the girl saw a *robin* when visiting the zoo). Finally, five to seven days later, children received a memory test that included pictures that had either been presented or served as the misleading stimuli. The critical result was that when the stimuli were highly associated, the misinformation was more likely to be falsely remembered than when the stimuli were not associated. Importantly, this effect was found regardless of age when age-relevant similarity ratings were used to determine which stimuli were actually presented and which were used as the misleading item. That is, older children were just as susceptible to misinformation effects when items came from their similarity-rating maps as younger children were when similarity ratings were drawn from their associative maps. Thus, it would appear that susceptibility to misinformation is directly related not only to what is in memory, but how that information is associatively organized.

So, from this line of research we can see that younger children are not always more susceptible to misinformation-induced memory illusions than older children. It may be then that susceptibility to memory illusions has more to do with what information is in memory, and how it is interwoven in an associative network, than it has to do with age. That is, the relationship between age and susceptibility to memory illusions may actually be an artifact of the correlation between age and the structure and content of children's knowledge base. If this is true, then we should be able to demonstrate not only that younger and older children are equally susceptible to false memories but also that younger children can sometimes be less susceptible to memory illusions than older children.

Children's Memories Are Less Prone to Memory Illusions

Next, we consider this alternative hypothesis, namely, that *children are less susceptible to false memories than adults*. This is exactly what researchers have found using the Deese/Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). In this paradigm, participants are presented with a list of concepts (usually in the form of written or spoken words) that are all associatively related to each other, to a greater or lesser extent (e.g., *baker, dough, knife, flour*), and are also related to an unpresented concept known as the critical lure (i.e., *bread*). Following presentation, participants are given a memory test (recall or recognition) with the result that many participants will falsely remember the critical lure as having been presented on the list. Indeed, this false memory rate is often commensurate with true memory rates (Roediger & McDermott, 1995).

When studied developmentally, younger children produce fewer false memories than older children and adults (e.g., Brainerd et al., 2008; Howe, 2005; Howe et al., 2009). This finding is consistent with the idea that younger children's knowledge base is not as well developed as older children's and adults' and hence some of these associations are either

absent in memory or the links among related concepts are weaker for these children. As children's knowledge base develops, and these links come into existence, strengthen, and can be activated relatively automatically, these spontaneous and endogenous false memories tend to increase with age. These developmental trends occur not just with word lists, but also with picture lists (Howe, 2008), pictures of integrated scenes (Howe, 2008; Lyons, Ghetti, & Cornoldi, 2010), across languages in bilingual individuals (Howe, Gagnon, & Thouas, 2008), as well as stories where DRM word lists have been embedded (Howe & Wilkinson, 2011).

Finally, developmental reversals occur even when child-relevant materials are used (e.g., Carneiro, Albuquerque, Fernandez, & Esteves, 2007; Metzger, Warren, Shelton, Price, Reed, & Williams, 2008). Like Ceci et al. (2007), these researchers constructed age-appropriate DRM lists and predicted that even very young children (3- to 4-year-olds) should produce as many false memories to their age-relevant lists as older children and adults did to their age-appropriate lists. Although controlling knowledge base in this way did result in increasing the false memory rates for even the youngest of these children, developmental trends were still present. That is, using age-appropriate materials attenuated the usual developmental reversal but it did not entirely eliminate it. As mentioned earlier when discussing AAT, although developmental differences in false memory rates may be due primarily to correlated age differences in knowledge base, there are also differences in the automaticity with which activation spreads in a younger versus an older child's knowledge base (e.g., Howe, 2005). More specifically, even though the relevant knowledge structures are in place, access to these structures and the activation of the links contained within them, may be slower and less automatic for younger than older children. It is this residual difference that may be the source of the remaining developmental difference in false

memory rates even when participants receive age-appropriate materials relevant to their knowledge base. (Of course, there may also have been differences among these various studies in their relative success at equating knowledge base materials across age.)

It is not just word and picture lists where developmental reversals have been obtained. Similar effects have appeared when more integrated materials (e.g., thematic scenes, videos) have been studied. In fact, researchers have also found that children are less susceptible to memory illusions using a slightly different misinformation procedure known as the memory conformity paradigm (Gabbert, Memon, & Allen, 2003). For example, in a study involving the presentation of pictures containing associatively related details (e.g., a desk with books and a laptop), we found that children (7- to 8-year-olds and 11- to 12-year-olds) were less susceptible to suggestion than adults (Otgaar, Howe, Brackmann, & van Helvoort, 2017). Pairs of participants viewed the pictures individually believing they were seeing the same pictures. However, each picture included a critical item that was associatively related to the scene but was absent in the paired picture (see Figure 2 for an example). Following picture presentation, participants had to discuss their pictures and retrieve all of the details in the picture they could recall. The key point here is that participants would mention (suggest) an associatively related item that was present in their picture but not in the picture for the other participant. The critical question was whether participants would falsely remember the other-mentioned (suggested) but absent item in a follow-up memory test. When participants had to individually remember everything they could from their picture, children were no more susceptible to suggestion than adults. Moreover, when correcting for response bias, it turned out that adults were more susceptible to suggestion that either of the child groups (see also Kim et al., 2017).

Insert Figure 2 about here

Finally, in a recent series of four experiments with 4- to 6-year-olds, 7- to 9-year-olds, 10- to 12-year-olds, and adults we used video presentations (e.g., of a bank robbery) that contained associatively related information (e.g., robber, vault) (Otgaar et al., 2016). Following this presentation, participants were given an eyewitness account of the event that contained misinformation (e.g., falsely stating that there was a gun during the robbery) (Experiments 1 and 2). In the other experiments (Experiments 3 and 4), participants received the same misinformation in the context of an interview rather than an eyewitness account. When participants were given a recognition test, we found evidence for our predicted developmental reversal in all four experiments. Specifically, we routinely found that regardless of whether misinformation was delivered by an interviewer or another eyewitness, older children and adults produced more false memories than younger children.

What these results show is that even very young children (4-year-olds) can exhibit fewer false memories than older children and adults when the information being remembered is consistent with one's knowledge base (associative networks). That this age group showed fewer false memories than older children is especially important because 4- to 5-year-olds have been shown to be particularly susceptible to external suggestion as they are thought to be more compliant and accepting of information presented by authority figures (see Leichtman & Ceci, 1995). Our findings show that when misinformation is directly related to one's knowledge base, even 4-year-olds can resist the suggestions of others.

Importantly, such developmental reversal effects have not only been detected in paradigms using some form of suggestion (e.g., misinformation, memory conformity), they have also been found in related applied memory paradigms. The point here is that theories such as AAT predict that developmental reversals will appear as long as the encoded stimuli are associatively related to each other and that older children have a more elaborate knowledge base concerning these stimuli than younger children. For example, Brackmann, Sauerland, and Otgaar (2019) tested developmental trends in eyewitness identification. Specifically, young children (7- to 10-year-olds), older children (11- to 13-year-olds), adolescents (14- to 16-year-olds), and adults viewed a wallet-theft video and subsequently had to identify the thief in different lineups (culprit-present, culprit-absent). The thief-absent lineup contained a bystander who was previously seen near the thief in the video. Bystander misidentification was assumed to occur because of inferential memory errors suggesting that the bystander was incorrectly linked as being the thief. Interestingly, and in line with the tenets of AAT, adolescents were more susceptible to this inferential memory error (bystander misidentified as the thief) than the older and younger children (but not the adults). This finding is quite similar to developmental reversal effects with other procedures and has been obtained by other researchers as well (see also Ross et al., 2006).

This pattern of results once again illustrates that the relationship between age and susceptibility to memory illusions is not as straightforward as once believed. That is, when we take into account the content and associative structure of a person's memory network, adults are just as susceptible, and sometimes more susceptible, to suggestion and misinformation than children. Of course, we are not the only researchers to have found these developmental reversals, with others having demonstrated that adults can be more

susceptible to memory illusions than young children (e.g., 4- to 7-year-olds) (see Kim et al., 2017; McGuire, London, & Wright, 2015).

Factors Contributing to the Development of Children's False Memories

False memories have traditionally been viewed as potentially harmful. Nowhere is this more apparent than in legal cases in which memory often serves as the only evidence (see Howe, 2013; Howe & Knott, 2015; Howe, Knott, & Conway, 2018). Here, it is often difficult to determine the degree to which a complainant's statement is based on events that actually happened or details and perhaps even entire events that are only thought to have happened. Because most events that children and adults' eyewitness tend to be well-integrated conceptually, the simple activation of these associative structures may lead to additional unwitnessed details and events being misremembered as actually having occurred. This is as true today as it was in the days of the Salem witch trials.

We do not intend to settle this matter here but simply want to point out that when it comes to children's ability to testify about what happened (versus what they may believe happened but did not), there is not a single blanket statement that can encapsulate the variability in developmental trends in eyewitness reliability. Indeed, as we have shown, children are sometimes the better eyewitness but at other time adults can be the better eyewitness. Some of this depends on how the event being witnessed maps onto a person's world knowledge and some of it depends on how facile one is when it comes to accessing and retrieving information from this knowledge base.

However, there are some other factors that play a role. These include source monitoring, event plausibility, knowledge base, and emotion. In this section, we discuss each of these factors in turn.

Source Monitoring

Source monitoring refers to a person's ability to identify the origins of a memory (Johnson, Hashtroudi, & Lindsay, 1993). That is, source memory refers to information about the circumstances under which a memory was formed including perceptual information (e.g., the color, size, and location of objects encountered during an experience), the temporal sequence of events within the experience, emotional information, and any other information that may uniquely identify the experience. These visual, spatial, auditory, temporal, and affective aspects of an experience are not necessarily encoded deliberately but rather, may be part of the features that are automatically stored and bound together with the memory for the event. Indeed, this is thought to be one of the hallmarks of memories for actual events. Specifically, unlike events that were only imagined, memories for real events are thought to contain these source-related features, ones that become embedded in the representation of that experience.

Although these aspects of an event may be encoded incidentally for real experiences, they tend to fade relatively rapidly from memory. When they do, identifying the source of one's memory may become difficult. It is at this point, when people can become confused as to whether the memories they are retrieving are ones that represent actual experiences from the past or are memories of things they did not directly experience but maybe only imagined, read about in a newspaper, or heard about from a friend. This is when false memories can occur as people can incorrectly attribute something they only thought about, heard about, or even dreamt about to memories for things that actually happened to them.

Finally, what does source monitoring have to say about developmental trends in false memories? Developmentally, because source monitoring improves with age in

childhood (Lindsay, Johnson, & Kwon, 1991), source monitoring correctly predicts decreases in false memories with age, as with exogenously evoked false memories (e.g., using suggestive questioning techniques). However, it fails to predict the well-established developmental increases in endogenously-evoked false memories (e.g., ones based on the development of a child's knowledge base). Thus, although source information is important when considering a person's ability to distinguish memories for things that actually happened (true memories) from things that may only have been imagined (false memories), it is not clear that it correctly predicts the opposing trends in children's false memory development.

Event Plausibility

As we have already stressed, for most false memories, the rememberer has to have a sufficiently developed knowledge base within which the memory illusion can foment. An important addition to this, particularly for suggested and implanted memories, is that the rememberer must also believe that the event is plausible. Furthermore, the person must believe that it is something that could have happened to them (Pezdek, Finger, & Hodge, 1997).

An initial experiment on the importance of plausibility when implanting a suggested event was carried out by Pezdek and Hodge (1999). Here, they presented 5- to 7-year-olds and 9- to 12-year-olds with a plausible event (lost in a shopping mall) and an implausible event (receiving an enema). The plausible event was much more likely to give rise to a false memory than the implausible event for all of the children regardless of age.

Of course, plausibility is often said to be inexorably tied to one's knowledge base. However, this relationship is neither fixed nor immutable (see Scoboria, Mazzoni, Kirsch, & Relyea, 2004). Moreover, event plausibility can be experimentally manipulated, something

that was demonstrated by Otgaar et al. (2009) with children. Here, the authors first conducted a pilot study to examine the a priori plausibility of, and children's knowledge about, certain events. Based on this initial study, they selected two events that differed in initial plausibility but were equivalent in both valence and script knowledge – almost choked on a candy (plausible) and abducted by a UFO (implausible). A new group of children (7- to 8-year-olds and 11- to 12-year-olds) were falsely told that they had been abducted by aliens in a UFO (implausible event) or almost choked on a candy (plausible event) when they were 4 years old. The critical manipulation concerning the plausibility of each of these events was whether or not children had first seen fake newspaper articles suggesting that UFO abduction or almost choking on a candy happened quite frequently where they lived when they were 4 years old.

The results showed that event plausibility did not interact with age. Importantly, regardless of age, children who had first read the newspaper article about UFOs or about almost choking on a candy were more likely to falsely remember these events happening to them than children who did not read these articles. Finally, having read these newspaper articles, children were equally likely to produce false memories for the plausible and implausible events. Thus, plausibility is malleable and can lead even children to produce false memories for events that are, on the face of it, implausible. These effects are exceedingly robust, with similar findings using child participants having been obtained in other labs (e.g., see Strange, Sutherland, & Garry, 2006).

Although age may not always interact with plausibility, as noted at the outset of this section, what is viewed as plausible is intertwined with what is in a person's knowledge base. If one does not know about particular events, plausibility cannot be assessed (or it will simply be viewed as implausible). Thus, to the extent that plausibility and knowledge

base are linked, in order to understand the development of false memories in children, we need to examine parallel developments in children's knowledge.

Knowledge Base

As we have already pointed out, what is already in memory (a person's knowledge base), serves as the basis for developing false memories. Changes in what is in memory across childhood as well as how it is organized plays a critical role in the emergence of memory illusions. These changes typically result from formal as well as informal learning opportunities, both within and outside of traditional school environments. As this covers a vast literature, we will focus solely on these changes as they have been studied in relation to the development of false memories.

One line of research that has investigated changes in knowledge base has already been discussed (Ceci et al., 2007). Other studies have looked at presenting connected-meaning stimuli in the form of word lists (i.e., DRM; e.g., Howe et al., 2009), stories (e.g., Howe & Wilkinson, 2011), scenes (e.g., Howe, 2008; Lyons et al., 2010), and videos (e.g., Otgaar, Howe, Peters, Sauerland, & Raymaekers, 2013). For example, Otgaar et al. (2013) examined younger (6- to 8-year-olds) and older (10- to 12-year-olds) children's and adults' spontaneous false memories using DRM lists and several meaning-connected video presentations. That is, we presented participants with DRM lists and videos where the information was associatively related and there were elements (critical lures) that were not presented. For example, one of the videos was about a street fight and a related but unpresented item was a policeman on a motorcycle. When participants received a recognition test about the DRM lists and the videos, these missing items were on the test. What we found was that for the DRM lists, there was the typical developmental trend where younger children produced lower levels of false memories than older children and

adults. However, for the better integrated (i.e., more highly associated) videos that were consistent with children's (as well as adults') knowledge base, spontaneous false memories were more evident in children than adults. That is, the additional context provided by the video presentation aided children's spread of activation through the associative network, increasing the likelihood of forming a false memory.

This result is akin to other findings where additional contextual information increases children's false memory rates. For example, Dewhurst, Pursglove, and Lewis (2007) presented children (5, 8, and 11 years of age) with standard DRM lists or DRM lists embedded in a story context. Like videos, stories provide a clearer depiction of the underlying theme of the associated information, something that may help children access the underlying associative network in memory. Dewhurst et al. (2007) found that stories increased younger children's false memory rates, something that was also found in a study by Howe and Wilkinson (2011).

Finally, as already mentioned, these effects are also robust when associative stimuli are presented in the context of a scene. For example, Otgaar, Howe, Peters, Smeets, and Moritz (2014) presented children and adults with visual scenes (e.g., beach, funeral) in which critical items were absent (i.e., beach ball, priest). Across three experiments, we were able once again to reverse the developmental reversal effect. That is, on a recognition test, we found that children produced more false memories than adults.

What these results show is that contextually-enhanced presentations (stories, scenes, videos) of content-related materials (associative lists) enhances younger children's ability to access the necessary information (thematic nodes) in memory. This in turn, enhances the spread of activation within that network and this can lead to increased false memory rates. For older children and adults, such contextual embedding is redundant

because their knowledge base is already sufficiently well developed and integrated in relation to these stimuli that they accrue no additional advantage.

Emotion, Trauma, and False Memory

False memories, like true memories, are rarely devoid of emotion. In fact, in the courtroom, complainants' and eyewitness' memories are frequently laced with emotion. Especially relevant for children's eyewitness memory are studies that have examined the effect of maltreatment and emotion on false memory formation. Interestingly, there is only limited work in this area and the work that has been done has almost exclusively focused on spontaneous false memories (e.g., Howe, 2007; Howe, Candel, Otgaar, Malone, & Wimmer, 2010). What research exists on the consequences of real-life experiences shows that people with a trauma history can be more vulnerable to the creation of spontaneous false memories than people without such a history, but only when they were presented with emotionally-negative material (word lists, scenes) (Baugerud, Howe, Magnussen, & Melinder, 2016; Otgaar, Muris, Howe, & Merckelbach, 2017). However, not all children who have been maltreated are more susceptible than non-maltreated children to forming false memories for emotional word lists (Howe, Toth, & Cichetti, 2011). When maltreated and non-maltreated children learned pairs of emotionally-charged DRM lists and were asked to suppress their memory for the first emotional list, no memory differences were found as a function of maltreatment. Perhaps the key difference among these studies that may have contributed to these different outcomes is the type and degree of maltreatment experienced by the participants. It may be that children who experienced more severe or extensive maltreatment (Baugerud et al., 2016; Otgaar et al., 2017) may be more susceptible to forming false memories than children whose maltreatment was less severe or frequent (Howe et al., 2011). Of course, other differences may have also played a role,

including parent-child attachment and the impact maltreatment had on the child's life (e.g., Goodman, Goldfarb, Quas, Narr, Milojevich, & Cordon, 2016; Goodman, Quas, Goldfarb, Gonzalves, & Gonzalez, 2019).

Like research using associative word lists and scenes, research that has focused on trauma and suggestion-induced false memories with children and has shown mixed results. That is, some studies find no statistical differences in acceptance of suggestion as a function of trauma (e.g., Chae, Goodman, Eisen, & Qin, 2011) while we have found suggestion-induced false memories to be lower in maltreated than non-maltreated children (Otgaar, Howe, & Muris, 2017). Concerning the impact of emotional material on false memory formation more generally, research seems to indicate that emotionally-negative material foments the production of false memories (Bookbinder & Brainerd, 2016). This appears to be true both for spontaneous and suggestion-induced false memories (Bookbinder & Brainerd, 2016; Otgaar et al., 2008).

Theoretically, both FTT and AAT predict these outcomes. For FTT, it is claimed that the retrieval of gist traces is easier for emotionally negative stimuli than for neutral stimuli (Bookbinder & Brainerd, 2016). For AAT, it is known that emotionally-negative memories are more densely interrelated than neutral ones (Howe et al., 2010). This, in turn, makes trace access and spreading activation easier than in less densely packed networks (e.g., positive and neutral networks).

Concluding Comments

In this chapter, we have outlined how it is that children can be both more and less susceptible to memory illusions. By way of synopsis we have demonstrated that false memory rates are directly related to the content and structure of children's knowledge

base. This is true for both exogenous (e.g., suggestibility) and endogenous (e.g., spontaneous) forms of false memories. Along the way, we have elucidated the role of event plausibility, context-enhanced modes of presentation, source monitoring, and emotion. We have demonstrated that negative information, plausible or implausible, can be implanted into children's memories. But perhaps most importantly, we have shown that the default assumption that children, particularly younger ones, are more susceptible to memory illusions than older children and adults is itself false. Indeed, as in many conclusions based on psychological science, whether children are more or less susceptible to false memories depends on the circumstances in which these memory illusions arise.

Although we have enumerated many of these circumstances in this chapter, there are surely more that remain to be discovered. These include the maturation of children's metacognitive skills (e.g., Ghetti & Alexander, 2004), the ability to bind information into cohesive and holistic memory traces (e.g., Ngo, Horner, Newcombe, & Olson, 2019), as well as a host of related neurobiological changes that are correlated with the maturation of memory (e.g., Ghetti & Fandakova, 2020). Regardless of the outcome of these additional research efforts, the take home message is clear: Age is not a valid index of the reliability of eyewitness testimony. That is, simply because an eyewitness is a child does not mean we can assume they are more or less susceptible to false memories. Indeed, as in many areas of science, there are a plethora of individual differences in memory that influence the reliability of what is being remembered, none perhaps more important than the knowledge an individual already possesses.

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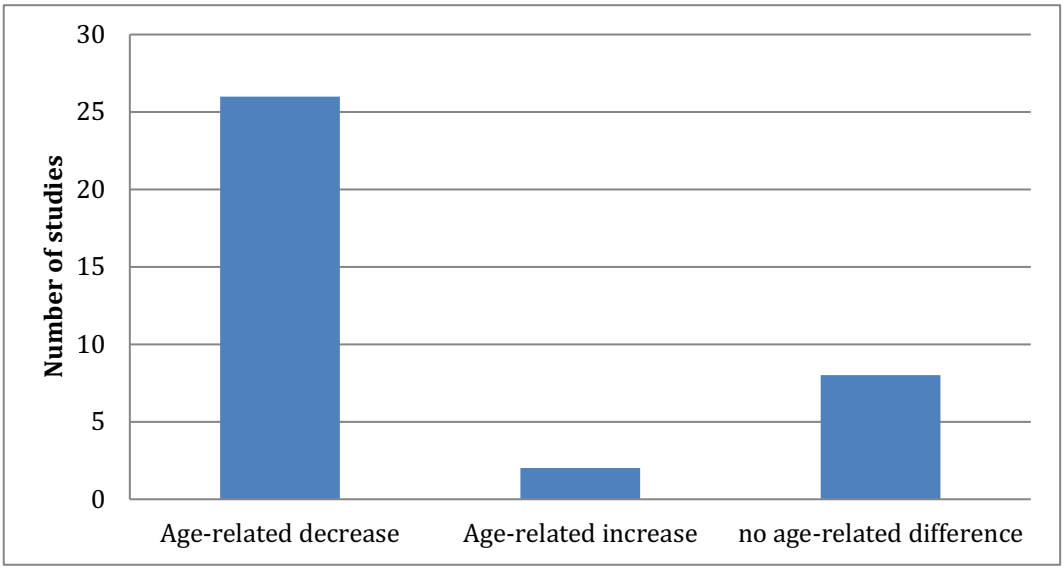

Figure 1. Number of developmental studies on the misinformation effect that show age-related decreases (younger children are more suggestible than older children), age-related increases (older children are more susceptible than younger children), and no age-related differences. For information about the studies that were included, see material posted on the Open Science Framerwork (https://osf.io/cd2qg/). (Reprinted from Otgaar, Howe, Merckelbach, & Muris, 2018, with permission.)

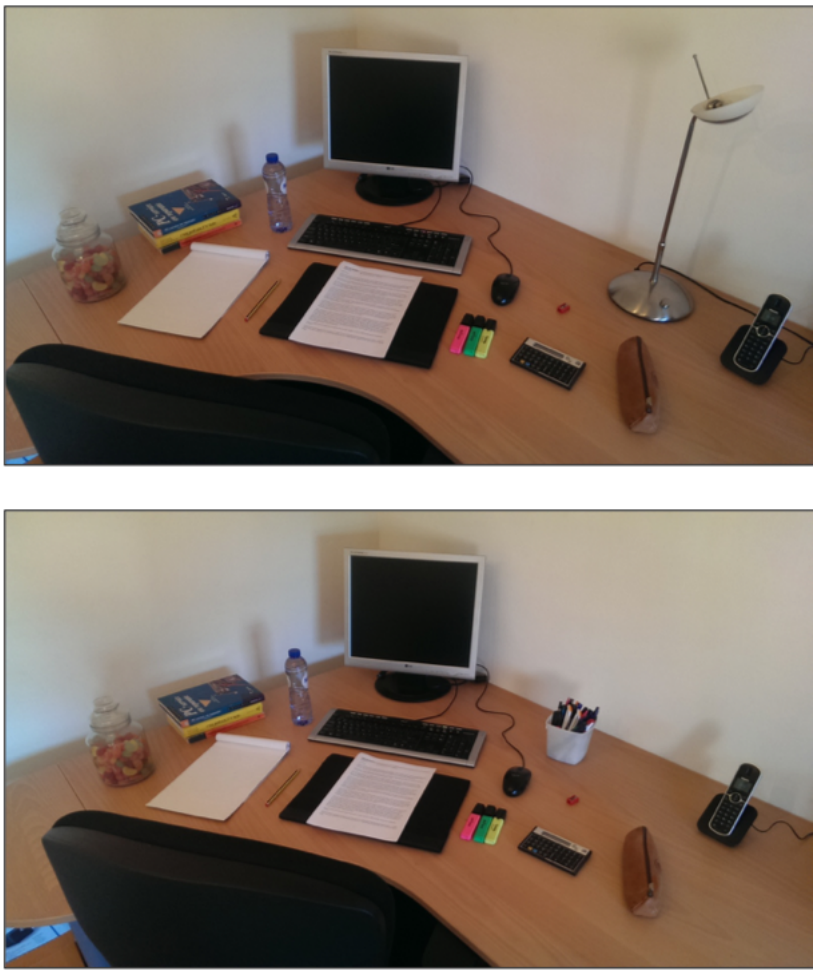

Figure 2. Sample pictures used with pairs of participants. Although each participant thought the pictures were identical, each was missing a critically associated item – Picture 1 (top picture) contains a lamp but no pen organizer whereas Picture 2 (bottom picture) contains a pen organizer but no lamp.