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RUNNING HEAD: BETTER EYEWITNESS

Who is the Better Eyewitness?

Adults *and* Children

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## Abstract

Suggestibility is regarded as a major issue when children testify in court. Many legal professionals and memory researchers view children as inferior witnesses. Although differences exist between children and adults in suggestibility, these are much more complex than is usually assumed. We show that under certain conditions, adults are more susceptible to suggestion and false memories than children. We demonstrate that age-related shifts in suggestibility and false memory appear contingent on how fast and automatic children and adults make associations when experiencing events. Specifically, when confronted with suggestive information about a related, but non-experienced detail, adults more frequently than children, automatically generate links between items experienced and those already in memory making them more susceptible to suggestion than children.

Keywords: Suggestibility; Development; False Memory; Developmental Reversal; Associative Activation.

## **Who is the Better Eyewitness?**

### **Adults *and* Children**

Many child development textbooks suggest that children underperform on most, if not all, tasks related to cognition (Bjorklund & Causey, 2017). Textbooks on developmental psychology regularly stress that the ability to plan and inhibit improves with age (Zelazo et al., 2003). In the current article, we focus on the development of memory. Here, the critical assumption is that children's memory is generally inferior to that of adults. One practical issue discussed in this context is that when suggestive interviews are used (e.g., by the police), children are more likely to accept these suggestions than adults. This topic bears relevance to the legal field where children are regularly viewed as inferior witnesses and special care is devoted to interview children in a correct manner (Bruer & Pozzulo, 2014).

Such a perspective is also shared among some memory researchers. For example, Volpini, Melis, Petralia, and Rosenberg (2016) recently echoed this by stating that "younger children are almost always more susceptible to suggestibility" (p.104). Likewise, Kassin et al. (2001) found that the majority of psychologists with legal experiences agreed that young children are more vulnerable to suggestion than adults. Are these views etched in scientific stone? We doubt this. We review literature showing that age-related shifts in suggestibility are variable but do conform to certain theoretical principles. Thus, under certain well-specified conditions, adults might be even more prone to suggestive interviewing techniques than children.

### **A Short History**

Around 1903-1904, the German psychologist William Stern commented on the reliability of children's testimony (Sporer, 1982). He reported on a case in which statements of a young boy were likely influenced by suggestive pressure and advised that these statements should be discarded. Around 1910, the Belgian psychologist Johan Varendonck (Whipple, 1913) stressed that suggestive questions might have adversely affected statements

of two young child witnesses. The American professor Guy Whipple wrote the first reviews on the reliability of children's memory (Whipple, 1909, 1911). His key argument was that children's memories were inherently unreliable even when pertaining to autobiographical experiences. This focus on the unreliability of children's memory even led to bizarre statements such as the one by the founding father of legal psychology, Hugo Münsterberg (1908), who wrote that "Experiments with school children, especially, seem to show that the girls have a better memory than the boys as far as omissions are concerned; they forget less. But they have a worse memory than the boys as far as correctness is concerned: they unintentionally falsify more" (p.54). Thus, already at the start of psychology as an academic discipline, children were regarded as inferior witnesses.

Scientific interest in the reliability of children's memory increased exponentially in the 1980s and 1990s because of several high profile daycare abuse cases in different countries such as the United States. In these cases, many children reported having been abused by the same person or persons. One notorious example was the McMartin preschool in which hundreds of children allegedly remembered having been sexually abused by three teachers at their preschool. However, the children reporting these allegations were subjected to suggestive interviews, ones that likely affected their recall, leading inexorably to erroneous recollections (Garven, Wood, Malpass, & Shaw 1998). Discussions surrounding these daycare abuse cases reinforced the idea of children's memory as exceptionally prone to suggestive pressure and false memories. Subsequently, studies have looked into children's vulnerability to suggestion and false memory. *Prima facie*, the bulk of these studies seemed to confirm the idea that children are poor witnesses.

### **Children Are Most Suggestible**

Cases such as the McMartin preschool case contained various interviewing techniques that likely contaminated children's testimonies (e.g., suggestive questions, inviting speculation). There is much research attempting to mimic these circumstances and their

effects on memory (Garven et al., 1998; Schreiber, Wentura, & Bilsky, 2001). However, for the current purpose, we have specifically focused on developmental research using various sorts of suggestive manipulations (i.e., presenting misinformation on details and events). If we home in on false memory, myriad studies exist showing that suggestion is more likely to infect younger children's than older children's and adults' memory. In a pioneering study by Ceci, Ross, and Toglia (1987), 3- to 12-year-old children were read a story about a girl on her first day at school. Children received information that the girl had a stomach ache. One day later, some children were presented with misinformation implying that the little girl had a headache. Specifically, these children were interviewed and asked whether they could remember the story about the headache. Two days later, all children received a recognition test. The youngest children (3- to 4-year-olds) most often accepted the suggestion.

This pattern has been replicated many times (e.g., Kulkofsky & Klemfuss, 2008; Roebbers & Schneider, 2005). In one of our own experiments, 4- to 5-year-olds and 8- to 11-year-olds had to remove three pieces of clothing from a puppet (Otgaar, Candel, Smeets, & Merckelbach, 2010). Half of the children were also presented with false evidence suggesting that they had removed one extra piece of clothing. Specifically, without children seeing it, a confederate removed one extra piece of clothing after which it was suggested to the children that they removed four pieces of clothing. During three follow-up interviews with 1-week intervals, children had to report which pieces of clothing they had taken off. Four- to 5-year-olds were more likely to falsely report that they took off four pieces of clothing than 8- to 11-year old children.

Some studies have used a false memory implantation paradigm to examine whether children can create what has been termed rich false memories (e.g., Loftus, 2005; Otgaar, Smeets, & Peters, 2012). In contrast to typical misinformation experiments, in false memory implantation studies, participants are not presented with stimuli and then receive misinformation about these stimuli afterwards. Here, participants are immediately exposed to

suggestive false narratives implying that they experienced a fictitious event. For current discussions concerning developmental trajectories in suggestibility, developmental studies using this paradigm are relevant because they shed light on children's willingness to acquiesce to external suggestions. We falsely suggested to 7- to 8- and 11- to 12-year-olds that they were abducted by a UFO or that they almost choked on a candy when they were 4 years old (Otgaar, Candel, Merckelbach, & Wade, 2009). False memory rates for both events were statistically higher in younger (7/8-year-old) than older (11/12-year-old) children. A similar pattern emerged in a study (Otgaar, Candel, Scoboria, & Merckelbach, 2010) in which children were fed false stories such as receiving a rectal enema or getting with their fingers stuck in a mousetrap: False events were more likely to be implanted in younger (7/8-year-old) than older (11/12-year-old) children's memory.

The notion that (younger) children are especially sensitive to including suggestion in their memory reports is confirmed when we examine the available work that has been conducted in this area over the past few decades. If, for example, we consider all studies in which false suggestive information (i.e., misinformation) was presented to different age groups, then it is obvious that most of them observed an age-related decrease in susceptibility to suggestion-based false memory (see Figure 1 and Appendix A). However, this is only one part of the story.

### **Associative Activation, Mental Representations, and False Memory**

According to associative activation theory (AAT; Howe, Wimmer, Gagnon, & Plumpton, 2009) some false memories arise because of associative activation spreading through a dense network of interrelated nodes. Essentially, AAT is a network model of memory where nodes (e.g., concepts, not simply words) are interconnected and are also linked to overarching themes (various meanings associated with the concepts). AAT successfully predicts false memories (and their developmental trajectories from childhood through adulthood) not just in studies involving word lists, but also pictures (e.g., Howe,

2008), visual scenes (e.g., Lew & Howe, 2017), stories (e.g., Howe & Wilkinson, 2011), and autobiographical false memories (Otgaar et al., 2012). It also predicts changes in false memory rates as a function of the emotional state of the individual and the material being remembered (e.g., Bland, Howe, & Knott, 2016; Knott, Howe, Toffalini, Shah, & Humphreys, in press). Thus, this theory is particularly well-suited to inform our understanding of developmental trends in children's eyewitness remembering.

For example, when experiencing an event (e.g., robbery), nodes related to that event, but not part of the current experience, may become activated (e.g., seeing a gun) and increase the likelihood of a false memory. Throughout the course of life, people acquire more knowledge resulting in faster and more automatic associative activation. The net effect of this is that under some conditions (i.e., when surrounded by associatively related cues), adults are more susceptible to false memory than children precisely because they are more likely to generate faulty associations.

Thus, AAT assumes that under these conditions, false memory follows an age-related increase, which stands in contrast to the work on false memories induced by suggestion (see Figure 1; but see also below). So, a specific form of false memory called *spontaneous* false memory is more likely to be evoked in adults relative to children. Spontaneous false memories are purely caused by internal mechanisms such as associative activation and are not the result of external influences such as suggestive questions. The principal procedure used to elicit spontaneous false memories is the Deese/Roediger-McDermott (DRM; Deese, 1959; Roediger & McDermott, 1995) paradigm. In this paradigm, participants receive words (e.g., baker, dough, knife, flour) that are all associated with a non-presented word called the critical lure (i.e., bread). Studies have demonstrated that participants falsely recollect the critical lure at rates often indistinguishable from true memory rates (Roediger & McDermott, 1995). These false memories are more easily induced in adults than in children, a phenomenon termed *developmental reversal* (Brainerd et al., 2008).



Such reversal effects have not only been found with associative word lists. Other stimuli capturing associative relations have revealed developmental reversal effects as well. Lyons, Ghetti, and Cornoldi (2010) presented 6-, 7-, 9-, 10-year-olds, and adults with photographs depicting a common script (e.g., eating in a restaurant). A script refers to a knowledge structure containing interrelated details denoting the typical actions occurring during an event. The photographs included effects (e.g., wiping up water from a table) of non-presented causes (e.g., knocking over a glass of water). The authors found an age-related increase in participants falsely remembering having seen the cause in the originally presented photographs.

The developmental reversal phenomenon indicates that adults more easily generate spontaneous false memories than children, whereas for false memories evoked by suggestion, the reverse is true. However, recent work from our laboratory has revealed that developmental trends for both types of false memories are not always consistent. For example, in one of our studies (Otgaar, Howe, Peters, Smeets, & Moritz, 2014), we presented children (7- to 8-year-olds and 11- to 12-year-olds) and adults with visual scenes (e.g., beach) containing associatively related details (e.g., sand, water). Some related details were left out (e.g., bath towel). These not-presented related items were often *spontaneously* and incorrectly remembered. Furthermore, and contrary to the developmental reversal effect, children (7/8-year-olds and 11/12-year-olds) were more likely to produce spontaneous false memories than adults when visual scenes were used. The explanation for this is that according to Otgaar and colleagues (2014), the visual scenes helped children to distill the underlying theme. According to AAT, visual material may compensate for children's lack of associative networks compared with adults. For children, this additional thematic assistance might make them more prone to false memory creation than adults. In fact, when we presented children and adults with videos to foster spontaneous false memory, we found the same. Because the

theme of videos is readily identified, children rather than adults were most susceptible to spontaneous false memories (Otgaar, Howe, Peters, Sauerland, & Raymaekers, 2013).

The variability of false memory development shows that developmental trends in false memories are not fixed and can follow a trajectory that is opposite to what one would expect. This is also what has been suggested by a developmental-representational account (Ceci, Fitneva, & Williams, 2010) which has parallels with AAT. According to this theory (and AAT as well), children's background knowledge or mental representations about events drive developmental effects in suggestibility. That is, because young children have not acquired as much knowledge as older children and adults, they are less likely to relate external (misleading) information that is connected to that knowledge. Ceci and colleagues reasoned that these trends can be easily altered when considering someone's knowledge base of an event.

In one experiment, Ceci, Papierno, and Kulkofsky (2007) provided 4- and 9-year old children with 257 sets of three pictures and they had to decide in each set which picture did not belong with the other two. The goal of this similarity rating task was to map children's representations and associations of these stimuli in order to later predict children's proneness to suggestion. So, one to three months later, these children and other children of the same age groups listened to a story which was illustrated using pictures of objects from the first part of the experiment. After two days, some children received misinformation about the story. For example, in one story, a boy and a girl saw an eagle in the zoo, but received the false suggestion that they saw a robin. Five to seven days later, children received a memory test including pictures that had either been presented or served as the misleading stimuli. The most interesting result was that when stimuli (e.g., eagle and robin) were highly associated, they were more likely to be misremembered than when such association did not exist. Importantly, they found this effect irrespective of age when age-relevant similarity ratings were used. That is, older children were most susceptible to misinformation when stimuli were

highly related and drawn from their similarity ratings and so too were younger children when those related stimuli came from their similarity ratings.

### **Children Are Least Suggestible**

In many child (sexual) abuse cases, expert witnesses may tell triers of fact to be cautious with children's reports as they might easily be infected by suggestion. However, developmental trends in false memory can be altered. Developmental reversal effects have been well documented in the area of spontaneous false memory. Whether they also might occur with false memories elicited by suggestion has been a key question in our recent empirical work. Our prediction was that when children and adults are presented with stimuli containing associatively-related information and receive information suggesting that a related but not presented item was shown, adults, and not children, should be most susceptible to suggestion. This prediction carries considerable ecological validity because when children and adults witness events that they then provide testimony about, the elements of the events tend to be highly interrelated.

Our counterintuitive prediction has been confirmed in a number of recent studies. For example, in four experiments, children (4/6- (Experiments 2, 4) 6/9- (Experiments 1, 2, 3, 4) and 10/12-year-olds (Experiments 1, 2, 4)) and adults (Experiments 1, 3) were shown a video (e.g., bank robbery) containing associatively-related details (e.g., robber, vault; Otgaar, Howe, Brackmann, & Smeets, 2016). Crucially, following this, in the first two experiments, they were presented with an eyewitness misinformation account falsely stating that, for example, a gun was present during the crime. In the last two experiments, half of the children also received the same misinformation but now an interviewer provided the false suggestions. Next, participants received a recognition test. In all experiments, we found evidence for developmental reversal effects. Specifically, in the first experiment, we found that adults and 11-year-olds had higher misinformation scores than 6/7-year-old children and in Experiment 3, we also showed that adults were more susceptible to misinformation

reporting than 7/8-year old children. In Experiment 2, even younger children (4/6-year-olds) were included and here, 10/12-year-olds produced more false memories than the 7/9- and 4/6-year-olds. Similar findings were observed in the fourth experiment in which 11/12-year-olds were more likely to produce false memories than 7/8-year-olds and 4/5-year-olds.

What these studies suggest is that even very young children (i.e., 4-year-olds) can evince lower false memory rates than older children. Why this is relevant is because previous research has shown that this younger age group of 4/5-year-olds are especially sensitive to external suggestions due to social factors such as accepting information from authority figures (e.g., Leichtman & Ceci, 1995). Our results show that when misinformation is presented that is directly related to one's knowledge base, even 4/5-year-olds can be the least prone to suggestion.

In another study (Otgaar, Howe, Brackmann, & van Helvoort, 2017), children (7- to 8-year-olds and 11- to 12-year-olds) and adults viewed pictures (e.g., a desk) containing associatively-related details (e.g., books, laptop). They viewed the stimuli in pairs believing they received the same pictures. Each version of the picture included a critical item that was associatively related to the scene, but absent in the other picture version. Following this, participants had to discuss and retrieve all details that they could still remember. The idea behind this discussion is that participants would mention (suggest) details that while present in their pictures were absent in the pictures of the other participants. After this, participants had to individually report everything they could still recollect. Again we found that children were not more susceptible to suggestion than adults at both recall moments. In fact, they were equally susceptible to suggestion and when correcting for response bias, adults were even more prone to suggestion.

These findings counter the default view that suggestibility is a problem primarily for children. Under some conditions – namely those fostering associations – adults are just as, or even more, suggestible than children. This perspective is not commonplace in the scientific

literature and although others have found adults to be more susceptible to memory errors than younger children (4- to 7-year-olds) as well (e.g., Kim, Kwon, & Ceci, 2017), this work has not focused on altering developmental trends in suggestibility, something that has been a major focus of our research (but see Ceci et al., 2007).

### **False Memory Development in Court**

What these data show is that when suggestions involve associatively-related information (similar to that used to elicit spontaneous false memories), young children are less susceptible to these suggestions than older children and adults. Because most eyewitness accounts involve information that is highly interrelated, our studies raise a crucial question: how might this more balanced idea of children's susceptibility to false memory affect decisions in the legal arena? It is a given fact that the science of memory plays a crucial role in child sexual abuse cases where children's statements are often the only piece of evidence (Howe, Knott, & Conway, 2018; Otgaar & Howe, 2018). However, and more pointedly, the key issue is whether the scientific findings reviewed here are relevant to legal cases where children's memories serve as (the only) evidence.

Consider the case in which the first author (HO) provided his expert opinion. It involved a 6-year-old child claiming to have seen her mother being stabbed to death by her father (Brackmann, Otgaar, Sauerland, & Jelacic, 2016). HO was asked by the prosecution to write a report concerning the accuracy of the girl's statement while a clinical psychologist was hired by the defense on the same matter. The clinical psychologist argued that the child spontaneously formed a false memory of the murder. His reasoning was based on the default notion that children are exceptionally susceptible to false memories. HO concluded that no signs of suggestion existed and that young children can be less likely to form spontaneous false memories. The judge deemed the statement of the girl accurate enough to convict the father to 18 years of imprisonment.

One may contend that in many cases, it is not certain what details of an event are associated with each other. However, we want to argue that many – if not all – of the events (e.g., having dinner) that we encounter contain interrelated details (e.g., cooking, washing the dishes). For forensically relevant events, such associations might exist as well. Indeed, we agree with Holliday, Reyna, and Brainerd (2008, p. 76) who argued that “[f]alse memories induced by meaning related information embody several features of forensically relevant memories. For child witnesses of domestic violence, for example, such violence is not usually a single episode but rather a series of repeated events that are substantially similar but not exactly the same.”

What we want to stress here is that associative activation is likely to play a role in repeated events where children have already developed a script of the event. To provide an estimate of the number of legal cases in which children are interviewed about repeated events and hence, to have an idea of the number of cases in which reversal effects might occur, we examined verdicts of Dutch legal cases. Specifically, in the Netherlands, one can access information (e.g., verdicts) concerning diverse cases via an online database (<http://www.rechtspraak.nl>). To have a rough indication of cases on repeated experiences in children, we entered the following keywords as search terms: interview (in Dutch: studioverhoor) AND child (in Dutch: kind). Furthermore, we filtered the data by only looking at cases in 2017. Our search identified 38 cases. Of those 38 cases, 29 (76%) were cases in which children were interviewed (age range: 5-17). In these child interviewing cases, 18 (62%) cases concerned events that children experienced repeatedly, and 24 (83%) cases referred to sexual abuse cases. Other cases in which children were interviewed involved domestic violence, the abduction of children, and witnesses to sexual behavior of the suspect.

Our approximation here suggests the following. First, although repeated experiences of the same event can lead to the creation of false memories of related but not experienced

details in children involved in these cases, it is likely that the creation of such memory errors is less likely to occur in younger than older children. Second, this reversal effect is also likely to take place when these children are confronted with external suggestions that are linked to the repeated experience. The conclusions that we draw from these data should not be used to argue that younger children are –by definition- less suggestible than older children and adults. The central message should be that in situations involving for example scripts, the lack of knowledge in children might guard them from making spontaneous memory errors or going along with suggestions.<sup>1</sup>

Of course, in actual cases, it might be difficult to decide whether children (or adults) had sufficient background knowledge of an event. One option would be to examine whether the DRM paradigm would be a reliable and valid method in legal cases as a proxy for someone's knowledge base. If so, it could serve a similar function as the Gudjonsson Suggestibility Scale (e.g., Gudjonsson, 2003) which is oftentimes used in legal cases to have an indication if someone (e.g., suspect) is likely to succumb to suggestive interviewing techniques. However, although this might seem promising, recent research has failed to show any meaningful relations between false memories elicited by the DRM paradigm and false memories elicited by other paradigms (e.g., misinformation paradigm, false memory implantation; e.g., Otgaar & Candel, 2010; Patihis, Frenda, & Loftus, in press). Hence, it is important to examine whether the DRM paradigm might be helpful in reversal effects in more realistic experiences.

### **Concluding Remarks**

The long-standing, knee-jerk response concerning children's lack of testimonial accuracy is incorrect. Although widely believed to be true (Knutsson & Allwood, 2014), children do not necessarily show a heightened susceptibility to suggestion. For decades, preschoolers have been shown to be more suggestible than older children and adults (Bruck

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<sup>1</sup> We want to thank Stephen Ceci for advising us to conduct this analysis on legal cases

& Ceci, 1999; Goodman & Reed, 1986). However, our argument here is that young children are not always the most suggestible, and in situations that rely on the activation of scripts, stereotypes, schemas, and other forms of connected meaning their lack of knowledge can sometimes protect them from external suggestions. That is, recent evidence shows that adults are sometimes at even greater risk of accepting suggestive information than children. The time is ripe to stop portraying children as inherently problematic eyewitnesses and acknowledge that they sometimes outperform adults, even when it comes to memory performance.



## References

- Bjorklund, D.F., & Causey, K.B. (2017). *Children's thinking: Cognitive development and individual differences*. SAGE Publications.
- Bland, C., Howe, M. L., & Knott, L. M. (2016). Discrete emotion-congruent false memories in the DRM paradigm. *Emotion, 16*, 611-619.
- Brackmann, N., Otgaar, H., Sauerland, M., & Jelicic, M. (2016). When children are the least vulnerable to false memories: A true report or a case of autosuggestion? *Journal of Forensic Sciences, 61*, S271-S275.
- Brainerd, C. J., Reyna, V. F., & Ceci, S. J. (2008). Developmental reversals in false memory: A review of data and theory. *Psychological Bulletin, 134*, 343-382.
- Bruck, M., & Ceci, S. J. (1999). The suggestibility of children's memory. *Annual Review of Psychology, 50*, 419-439.
- Bruer, K., & Pozzulo, J.D. (2014). Influence of eyewitness age and recall error on mock juror decision-making. *Legal and Criminological Psychology, 19*, 332-348.
- Ceci, S.J., Fitneva, S. A., & Williams, W. M. (2010). Representational constraints on the development of memory and metamemory: A developmental-representational-theory. *Psychological Review, 117*, 464-495.
- Ceci, S.J., Ross, D.F., & Toglia, M.P. (1987). Suggestibility of children's memory: Psycholegal implications. *Journal of Experimental Psychology: General, 116*, 38-49.
- Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology, 58*, 17-22.
- Garven, S., Wood, J.M., Malpass, R.S., & Shaw, J.S. (1998). More than suggestion: The effect of interviewing techniques from the McMartin Preschool case. *Journal of Applied Psychology, 83*, 347-359.

- Goodman, G. S., & Reed, R. (1986). Age differences in eyewitness testimony. *Law and Human Behavior, 10*, 317–332
- Gudjonsson, G. (2003). *The psychology of interrogations and confessions: A handbook*. West Sussex, England: John Wiley & Sons.
- Holliday, R. E., Reyna, V. F., & Brainerd, C. J. (2008). Recall of details never experienced: Effects of age, repetition, and semantic cues. *Cognitive Development, 23*, 67-78.
- Howe, M. L. (2008). Visual distinctiveness and the development of children's false memories. *Child Development, 79*, 65-79.
- Howe, M., Knott, L.M., & Conway, M.A. (2018). *Memory and miscarriages of justice*. Psychology Press.
- Howe, M. L., & Wilkinson, S. (2011). Using story contexts to bias children's true and false memories. *Journal of Experimental Child Psychology, 108*, 77-95.
- Howe, M. L., Wimmer, M. C., Gagnon, N., & Plumpton, S. (2009). An associative-activation theory of children's and adults' memory illusions. *Journal of Memory and Language, 60*, 229-251.
- Kassin, S. M., Tubb, V. A., Hosch, H. M., & Memon, A. (2001). On the "general acceptance" of eyewitness testimony research: A new survey of the experts. *American Psychologist, 56*, 405-416.
- Knott, L. M., Howe, M. L., Toffalini, E., Shah, D., & Humphreys, L. (in press). The role of attention in immediate emotional false memory enhancement. *Emotion*.
- Knuttsen, J., & Allwood, C.M. (2014). Opinions of legal professionals: Comparing child and adult witnesses' memory report capabilities. *The European Journal of Psychology Applied to Legal Context, 6*, 79-89.

- Kulkofsky, S., & Klemfuss, Z.J. (2008). What the stories children tell can tell about their memory: Narrative skill and young children's suggestibility. *Developmental Psychology, 44*, 1442-1456.
- Lew, A. R., & Howe, M. L. (2017). Out of place, out of mind: Schema-driven false memory effects for object-location bindings. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 43*, 404-421.
- Münsterberg, H. (1908). *On the witness stand: Essays on psychology & crime*. New York: Doubleday.
- Leichtman, M.D. & Ceci, S.J. (1995). The effects of stereotypes and suggestions on preschoolers' reports. *Developmental Psychology, 31*, 568-578.
- Loftus, E.F. (2005). Planting misinformation in the human mind: A 30-year investigation of the malleability of memory. *Learning & Memory, 12*, 361-366.
- Lyons, K.A., Ghetti, S., & Cornoldi, C. (2010). Age differences in the contribution to recollection and familiarity to false-memory formation: A new paradigm to examine developmental reversals. *Developmental Science, 13*, 355-362.
- Otgaar, H., & Candel, I. (2011). Children's false memories: Different false memory paradigms reveal different results. *Psychology, Crime & Law, 17*, 513-528.
- Otgaar, H., Candel, I., Merckelbach, H., & Wade, K.A. (2009). Abducted by a UFO: Prevalence information affects young children's false memories for an implausible event. *Applied Cognitive Psychology, 23*, 115-125.
- Otgaar, H., Candel, I., Scoboria, A., & Merckelbach, H. (2010). Script knowledge enhances the development of children's false memories. *Acta Psychologica, 133*, 57-63.
- Otgaar, H., Candel, I., Smeets, T., & Merckelbach, H. (2010). "You didn't take Lucy's skirt off": The effect of misleading information on omissions and commissions in children's memory reports. *Legal and Criminological Psychology, 15*, 229-241.

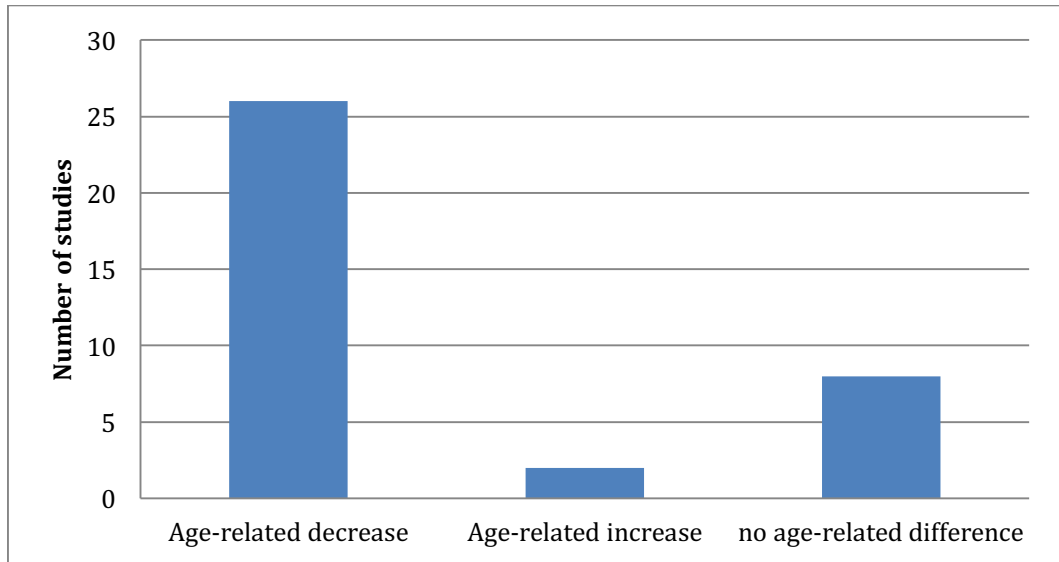
- Otgaar, H., & Howe, M.L. (2018). *Finding the truth in the courtroom: Problems with deception, lies, and memories*. Oxford University Press.
- Otgaar, H., Howe, M.L., Brackmann, N., & van Helvoort, D. (2017). Eliminating age differences in children's and adults' suggestibility and memory conformity effects. *Developmental Psychology, 53*, 962-970.
- Otgaar, H., Howe, M. L., Brackmann, N., & Smeets, T. (2016). The malleability of developmental trends in neutral and negative memory illusions. *Journal of Experimental Psychology: General, 145*, 31-55.
- Otgaar, H., Howe, M.L., Peters, M., Sauerland, M., & Raymaekers, L. (2013). Developmental trends in different types of spontaneous false memories: Implications for the legal field. *Behavioral Sciences & the Law, 31*, 666-682.
- Otgaar, H., Howe, M.L., Peters, M., Smeets, T., & Moritz, S. (2014). The production of spontaneous false memories in childhood. *Journal of Experimental Child Psychology, 121*, 28-41.
- Otgaar, H., Smeets, T., & Peters, M. (2012). Children's implanted false memories and additional script knowledge. *Applied Cognitive Psychology, 26*, 709-715.
- Patihis, L., Frenda, S.J., & Loftus, E.F. (in press). False memory tasks do not reliably predict other false memories. *Psychology of Consciousness: Theory, Research, and Practice*.
- Roebbers, C.M., & Schneider, W. (2005). The strategic regulation of children's memory performance and suggestibility. *Journal of Experimental Child Psychology, 91*, 24-44.
- Roediger, H. L., & McDermott, K. (1995). Creating false memories: Remembering words not presented in a list. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 21*, 803-814.
- Schreiber, N., Wentura, D., & Wolfgang, B. (2001). "What else could he have done?" Creating false answers in child witnesses by inviting speculation. *Journal of Applied Psychology, 86*, 525-532.

- Sporer, S.L. (1982). A brief history of the psychology of testimony. *Current Psychological Reviews, 2*, 323-340.
- Volpini, L., Melis, M., Petralia, S., & Rosenberg, M.D. (2016). Measuring children's suggestibility in forensic interviews. *Journal of Forensic Sciences, 61*, 104-108.
- Whipple, G.M. (1909). Psychology of testimony and report. *Psychological Bulletin, 6*, 153-170.
- Whipple, G.M. (1911). Psychology of testimony and report. *Psychological Bulletin, 8*, 307-309.
- Whipple, G.M. (1913). Psychology of testimony and report. *Psychological Bulletin, 10*, 264-268.
- Zelazo, P.D., Müller, U., Frye, D., Marcovitch, S., Argitis, G., Boseovski, J., Chiang, J.K., Hongwanishkul, D., Schuster, B.V., Sutherland, A., & Carlson, S.M. (2003). The development of executive function in early childhood. *Monographs of the Society for Research in Child Development, 68*, 1-137.

**Figure Caption**

*Figure 1.* Overview of developmental studies on the misinformation effect showing age-related decreases (younger children more suggestible than older children), age-related increases (older children more suggestible than older children) and no age differences

Figure 1



## **Appendix A**

The studies in this review were detected using four search engines (Web of Science, PubMed, ScienceDirect, and Google Scholar). We searched for experimental papers that were written in English and published after 1978. We selected this time frame as Ceci and Bruck (1993) reported that only very few methodologically sound papers had been published before 1978. The terms we employed for the literature search were: (children OR development) AND (suggestibility, misinformation, OR false memories). We also had several inclusion/exclusion criteria. We only incorporated experiments that introduced misinformation (e.g., via suggestive questions) following some sort of experienced event (misinformation paradigm). Also, we searched for papers that compared a minimum of two different age groups with at least one of them being a child group.



*Developmental studies on the misinformation effect.*

Study	Age (years)	Event	Form of misinformation	Result		
				Younger <u>more</u> suggestible than older	Younger <u>less</u> suggestible than older	No difference
Cohen & Harnick (1980)	9, 12, college students	Video about petty crime	Misleading questions	x		
King & Yuille (1987)	6, 9, 11, 16	Staged event	Misleading questions	x		
Ceci, Ross, & Toglia (1987), exp. 1	3 - 12	Auditory story + slides about a girl's day at school (no crime)	Misleading information	x		
Ornstein, Gordon, Larus (1992)	3, 6	Physical examination	Misleading questions	x		
Oates & Shrimpton (1991)	4 - 12	Blood collection, interaction with stranger	Misleading questions	x		
Marin, Holmes, Guth, & Kovac (1979)	5 - 22	Staged event (interaction between experimenters, no crime)	Misleading questions			x (only one leading question)
Duncan, Whitney, & Kunen	7, 9, 11, college	Slides with	Misleading		x	

(1982), exp. 2	students	short <i>Star Wars</i> episodes	verbal information			
Flin, Boon, Knox, & Bull (1992)	6, 10, adults	Staged event (talk about foot hygiene, no crime)	Misleading questions			x
Rudy & Goodman (1991)	4, 7	Interaction with stranger, watching interaction (playing board game)	Misleading questions	x actions that occurred		x overall
Saywitz, Goodman, Nicholas, & Moan (1991)	5, 7	Physical examination (genital and non-genital)	Misleading questions	x		
Perner & Wimmer (1988)	2 - 4	Narrative about mother interacting with children (no crime)	Embedded in narrative (only one item)	x		
Ackil & Zaragoza (1995)	7, 9, 11, college students	Video about camp experiences (no crime)	Embedded in narrative	x		
Welch-Ross, Diecidue, & Miller (1997)	3 - 5	Narrative about day of a girl	Misleading questions	x (4 min delay)		x (1 week delay)
Hünefeldt, Rossi-Arnaud, & Furia (2009)	4 - 7	Cartoon-video	Misleading questions	x		

Hünefeldt, Lucidi, Furia, & Rossi-Arnaud (2008)	4 - 7	Cartoon-video	Misleading questions	x	
Kulkovsky & Klemfuss (2008)	2 - 5	Staged event baking cookies	Misleading questions	x	
Bright-Paul, Jarrold, & Wright (2008)	3 - 7	Slide show about theft	Embedded in narrative	x	
Quas, Malloy, Melinder, Goodman, D'Mello, & Schaaf (2007)	3, 5	Playing alone in laboratory	Biased interviewer/misleading questions	x (misleading questions)	x (only in free recall single interview, long delay)
Roebbers, Howie, & Beuscher (2007)	6 - 8	Video about treasure hunt	Misleading questions	x	
Melinder, Endestad, & Magnussen (2006)	3, 6	Video showing children playing together	Misleading questions	x	
Roebbers & Schneider (2005)	6, 7, 8, adults	Video about treasure hunt	Misleading questions	x	
Roebbers, Gelhaar, & Schneider (2004)	5 - 10	Staged event, video or slide show about visit of magician	Misleading questions	x	
Alexander, Goodman, Schaaf, Edelstein, Quas, & Shaver (2002)	3 - 7	Vaccination	Misleading questions	x	
Gobbo, Mega, & Pipe (2002), exp. 1	3, 5	Participation, observation or	Misleading questions	x (immediate interview)	x (interview 1 week later)

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Roebbers & Schneider (2002)	6, 8, 10	narration about playing with salt-dough Video about money theft and treasure hunt	Misleading questions	x	
Roebbers, Bjorklund, Schneider, & Cassel (2002)	5, 7, 10, adults	Video about theft of a bike	Misleading questions	x	
Newcombe & Dour (2001)	5, 6	Story accompanied by pictures about pet	Embedded in narrative	x	
Templeton & Wilcox (2000)	3, 4, 6, adults	Video showing <i>Sesame Street</i>	Embedded in narrative	x (original test)	x (modified test)
Otgaar, Candel, Smeets, & Merckelbach (2010)	4-5, 8-11	Instructed interaction with a puppet	Erroneous feedback	x (commission error)	x (omission error)

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## False Memory Development