



# Action memory and knowledge-based cuing in school-aged children: The effect of object presentation and semantic integration

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## ARTICLE INFO

### Keywords:

Action memory  
Enactment effect  
Knowledge-based cues  
Objects  
School-aged children  
Semantic integration items

## ABSTRACT

Research into memory has found that declarative knowledge provides rich information about the world and improved memory performance. The present research investigates the effects of knowledge-based cues on memory for action events and on the enactment effect. Cued recall of action phrases was examined in four groups of 8-14-year-olds (410 children in total). The object cues (i.e., real vs. imaginary objects) and semantic relational cues (i.e., well-integrated vs. poorly integrated items) were manipulated in three encoding conditions: verbal tasks, experimenter-performed tasks, and subject-performed tasks. Results indicate that enacted encoding has a recall advantage over verbal encoding regardless of the cue manipulations, though presenting objects and semantic-integrated items can moderate the enactment effect. In addition, providing further information about prior knowledge can directly influence memory performance across age groups. These results are discussed in relation to the effect of knowledge-based information in facilitating memory strategies and cognitive processing in school-aged children.

## 1. Introduction

Considerable research in the last three decades has established that knowledge is an important factor in processing data and responding to stimuli (Rumelhart and Ortony, 1977; Schneider and Pressley, 1997). Research into long-term memory has also demonstrated that declarative knowledge can support learning, which in turn influences memory behaviour and memory performance (Bjorklund, 1985; Ornstein, Baker-Ward, and Naus, 1988). Based on prior knowledge, people can construct inferences that go beyond the information they are presented with and integrate different pieces of information into their mnemonic representations to improve memory function (Casteel, 1993; Yuill and Oakhill, 1992). The richness of the knowledge base in memory tasks is therefore a significant determinant of learning and memory performance (Schneider, 2015).

It has been assumed that task-relevant person's knowledge can influence memory performance and memory development (e.g., Bjorklund, 1985; Ornstein et al., 1988; Schneider and Pressley, 1997). In the presence of more declarative knowledge, more items can be retrieved because they can be elicited by more stimuli (Schneider, 2015). Evidence confirming these findings comes from experiments investigating the role of various cues, such as object presentation and semantic relational cues, in memory tasks. Paris and Lindauer (1976)

presented isolated sentences as to-be-remembered items and then older and younger children were asked to retrieve the sentences. Half the sentences addressed real objects that were presented to the subject at the encoding of each sentence. The other half of the to-be-encoded sentences addressed imaginary objects. It has been found that older children recalled equally well under both conditions, whereas younger children achieved better memory performance when real objects were presented. Paris and Lindauer (1976) concluded that older children with more declarative knowledge saved both real and imaginary objects as retrieval cues, integrating them into their mnemonic representations of the sentences, a task at which younger children were not completely adept. In another study, Ghatala (1984) presented words to children and asked them questions related to each word; subjects were then instructed then to recall as many words as they could. The findings revealed that older children recalled more items than did younger ones, fitting well with the idea that older children use the knowledge evoked by questions as retrieval cues. Taken together, cues related to prior knowledge can improve the usage of memory strategies, activate the representation of specific items, and stimulate association among sets of items in long-term memory, all of which leads to better memory performance (Bjorklund, 1987; Schneider, 1993, 2015). The idea that adding cues connected to knowledge can affect memory performance has been studied more specifically in the context of action memory.

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<https://doi.org/10.1016/j.actpsy.2018.04.011>

Received 15 October 2017; Received in revised form 22 March 2018; Accepted 19 April 2018

Available online 26 April 2018

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In action memory studies, participants are instructed to learn a series of verb–object phrases presented one at a time. In the enacted-encoding condition, the subjects perform each action phrase, i.e., subject-performed tasks (SPTs), or encode similar action phrases by observing an experimenter performing the respective action, i.e., experimenter-performed tasks (EPTs). In the verbal-encoding condition, subjects passively read or listen to the list of action commands, i.e., verbal tasks (VTs). Later, the participants are asked to remember as many of the encoded action phrases as possible (e.g., Cohen, 1989; Zimmer et al., 2001). It is well established that enacted items are typically remembered better than are items encoded only verbally, a robust finding referred to as the enactment effect (for reviews, see Engelkamp, 1998; Kormi-Nouri, 1995; Nilsson, 2000). In the literature on action memory, different types of cues are used in retrieving items, and these cues moderate the enactment effect (Engelkamp and Zimmer, 1997; Feyereisen, 2009). Presenting objects involved in the actions and the semantic relationship between the verb and noun are two examples of cues used in action memory (e.g., Kormi-Nouri, 2000; Kormi-Nouri and Nilsson, 1998). These cues improve the usage of strategies, associations between components of items, and associations between items and their contexts – i.e., cognitive processes more generally.

Two practices have traditionally featured in enactment effect research, i.e., presenting physical objects or imaginary objects. Bäckman and Nilsson (1984) proposed that object features such as size, weight, and colour influence the SPT effect. Nyberg, Nilsson, and Bäckman (1991) conducted two experiments to investigate the role of objects in the enactment effect. In the first experiment, subjects were presented with real objects for SPTs but not for VTs, and a clear-cut enactment effect was observed. In the second experiment, real objects were presented for both SPTs and VTs and the SPT effect was not evident. These results suggest that the objects are necessary for the enactment effect to occur. Moreover, by controlling object presentation in the encoding and test phases, Steffens, Buchner, and Wender (2003) confirmed that the advantage of SPTs over VTs was eliminated.

Other researchers have proposed that the enactment effect is independent of the object effect: that is, providing a physical object is not required for the emergence of the SPT effect, though it does increase the magnitude of the effect (e.g., Steffens, Buchner, Wender, and Decker, 2007; Zimmer and Engelkamp, 2003). Kormi-Nouri (2000), in a systematic study of adults, confirmed that the enactment effect is not affected by manipulating the object presentation. He reported that participants outperformed in SPTs versus VTs in both the real- and imaginary-object conditions. He proposed the episodic integration view, i.e., that both verb and object are involved during enacted encoding, regardless of the presentation of real or imaginary objects, and that both are equally crucial in facilitating cognitive processing (Kormi-Nouri, 2000). Furthermore, Kormi-Nouri and Nilsson (1998, 1999) also proposed that real objects enhance item-specific processing, leading to an SPT advantage over VT. Although the presentation of objects makes a difference in the execution of action phrases in many studies, the findings become more complex when the SPT effect and EPT effect are compared (Nilsson, 2000).

Results concerning the interaction between objects (real or imaginary) and encoding conditions (SPTs or EPTs) are so far unclear in action memory research. On one hand, studies have demonstrated that participants performed equally well in both SPT and EPT conditions using actual objects (Cohen, 1981, 1983) and imaginary objects (Ratner and Hill, 1991). On the other hand, performance in SPTs was superior to performance in EPTs using imaginary objects at encoding (Engelkamp and Zimmer, 1996). In clarifying the interaction between object and encoding conditions, Engelkamp and Zimmer (1996) assumed that the use of objects in the encoding phase would improve memory performance in both SPT and EPT conditions, but in different ways.

Concurrently, a positive influence of a semantic relationship between the verb and noun on enactment effect has been shown in

previous research. In an experimental design broadly following that of Kormi-Nouri and Nilsson (1998), memory for well-integrated action phrases (with high semantic integration between verb and noun, e.g., “read the book”) is compared with memory for poorly integrated action phrases (with low semantic integration between verb and noun, e.g., “roll the lemon”). It was assumed that both enacted encoding and verbal encoding would be affected by the semantic integration due to episodic integration of the verb and the noun. However, this effect differed between SPT and VT conditions. On one hand, SPT produces more episodic integration between the verb and noun than does VT; on the other hand, a well-integrated improves the semantic integration of the components of each action event more than does a poorly integrated item. A combination of semantic integration in well-integrated items and episodic integration in SPTs increases the size of the enactment effect. As a result, memory performance for well-integrated items was better in SPT conditions than VT conditions, and the enactment effect was more pronounced for well-integrated items than poorly integrated items. Moreover, with the inclusion of EPTs, Feyereisen (2009) found superior memory performance in SPTs and EPTs compared with the VT encoding condition for both well-integrated and poorly integrated items and that there was no interaction between encoding conditions and semantic association. He provided more evidence for similarity between SPTs and EPTs, supporting the episodic integration view in the adult population (Feyereisen, 2009). Generally, the controversy concerning the introduction of objects and presentation of semantic integration items is more complex in memory research with children.

It has been established that there are some variations as function of age in the number of retained items and their accessibility. In that, the enacted encoding influence memory performance differently in adults with the different ages due to facilitate memory trace with increased accessibility (Spranger, Schatz, and Knopf, 2008). In children population, there is age-related difference in memory output and accessibility because of child's prior knowledge (e.g., Badinlou, Kormi-Nouri, Mousavi Nasab, and Knopf, 2017). In children, knowledge is often regarded as affecting the child's mental representation of objects. In addition, the relationships between the objects and their contexts influence children due to the use of strategies and information processing (Bjorklund, 1987; Pressley, 1982; Schneider and Pressley, 1997). Kormi-Nouri, Moniri, and Nilsson (2003) demonstrated that children's memory performance was superior in SPTs with real objects than in SPTs with imaginary objects and that performance in both conditions was better than in the VT condition (Kormi-Nouri et al., 2003). Furthermore, the size of the enactment effect was the same in children of all ages when physical objects were presented at the encoding of verb–object phrases (Mecklenbräuker, Steffens, Jelenec, and Goergens, 2011). The magnitude of the enactment effect was therefore more pronounced in older than younger children both in experiments with imaginary objects (Ratner and Hill, 1991) and when subjects were asked to imagine themselves performing actions with imaginary objects (Foley and Johnson, 1985). The use of real rather than imaginary objects could therefore be important for the encoding of enacted items and for the size of the SPT effect in children (Mecklenbräuker et al., 2011). Also, it was proposed that association between action and object leads to understand sentence as a physical movement and the manipulation of real objects leads to the complex representation of the word comprising different sensory and motor components (Glenberg and Kaschak, 2002), which influence to storage of information in memory. However, to our knowledge, no study has examined the effect of object presentation on the SPT and EPT effects in children.

Regarding semantic integration, only one study has considered the role of semantic relational cues in a population of children. Kormi-Nouri et al. (2008) found that children recalled well-integrated items better than poorly integrated items, but found no interaction effect between encoding conditions and type of items as well as no interaction between age group and type of items. There is still a need for further

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