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The effect of sustained attention level and contextual cueing on implicit memory performance for e-learning environments

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ABSTRACT

Cognitive-based individual differences, among which are attention and attention design, play a crucial role in designing personalized e-learning environments. In this study, the effects of dynamic and static cue types presented to users in e-learning environments on implicit memory performance of individuals with different sustained attention levels are investigated. The statistical analyses suggest that the contextual cues prepared in different presentation types do not have a common significant effect on implicit memory performance of individuals with high or low sustained attention levels. Besides it is determined that the cues presented in two different forms, i.e. dynamic and static, has an effect on participants' implicit memory performance as long as sustained attention is ruled out. Better results obtained by static cueing compared to dynamic cueing, on the other hand, is important for learning environment design for individuals experiencing attention deficit.

1. Introduction

Cognitive-based individual differences, among which are attention and attention design, play a crucial role in designing personalized e-learning environments. What individuals see, hear, feel or remember not only depend on information they perceive through their senses, but also are related to what they pay attention to (Driver, 2001). The external world contains too many stimuli for individuals and they face a considerable amount of stimuli at any given time that they cannot process. Like all other communication tools, the sensory system functions effectively within the confines of its capacity; but fails in the case of information overload (Roda & Thomas, 2006; Solso, Maclin, & Maclin, 2009). Therefore, maintaining the sustainability of attention by choosing effective methods in educational environments is quite worth exploring in detail (Rapp, 2006).

In order to enhance and realize learning, researchers pay a special attention to implicit memory, since it occurs especially when acquiring complex information in an incidental manner, without awareness of what has been learned (Sun, 2008). Arguably, using contextual cueing may be effective when designing content in e-learning environments to encode information implicitly.

The primary goal of this study, therefore, is to examine the effect of contextual cueing in different presentation types in e-learning environments on implicit memory performances of individuals with different sustained attention levels. Consequently, it is aimed to develop design principles that are compatible with individuals' cognitive characteristics to help in their participation in learning activities, and also that design elements are determined that will ensure the utmost benefit from e-learning environments.

1.1. Sustained attention and implicit memory

In learning environments, particularly in e-learning environments where multimedia based applications are employed, the individuals' attention level is an important component of learning. Creating learning experiences during environment planning, design and presentation that aims at maintaining participants' attention is crucial for participant motivation, class participation and for learning.

In order for participants engaged in e-learning environments to gain meaningful learning experiences, systems have been developed that are sensitive towards participants' attention levels, considering the individual differences based on cognitive characteristics. With these so-called adaptive systems, participants' behaviors are analyzed and suitable options are provided to the participants in line with these data (Rapp, 2006).

Attention is classified into three groups, namely selective, divided and sustained. Sustained attention is defined as an

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attention type wherein attention is continuously directed at a single task, by means of focusing attention to a certain point for a long period and through concentration (Coull, 1998; Roda, 2011).

Attention is crucial for learning particularly since problem solving is a requirement in school life. Moreover, in order to develop sustained attention in children with ADHD, various strategies such as self-control may be employed to improve children's academic achievement. Although this improvement in academic achievement does not produce clinically significant results, it does provide above mean scores. These results constitute data that should be taken into consideration with regards to sustained attention (Purdie, Hattie, & Carroll, 2002).

Clinical studies propose that the relationship between intelligence and academic achievement is balanced by means of sustained attention. Whether this finding is present outside of a clinical environment was investigated in a research in which 231 first and second grade high school students participated. Sustained attention was examined with regard to verbal, numeric and general intelligence scores. According to research findings, it is determined that sustained attention is significantly related to school performance. This study is important since it looks at the relationship between sustained attention, intelligence and school performance outside a clinical environment (Steinmayr, Ziegler, & Träuble, 2010).

Attention basically comprises three points of view: some chosen stimuli are processed more compared to others; we are limited in running simultaneous processes due to our limited capacity and process sustainability involving visual stimuli requires effort. Multiple Object Tracking (MOT) as a paradigm incorporates these three components. Proposed by Pylyshyn and Storm in 1988, this paradigm is based on a simple task. In the experiment, flickering objects are determined as targets and participants are supposed to find the targets' positions among multiple moving objects (Scholl, 2009).

A MOT task deals with attention through various aspects. Accordingly, MOT tasks require an attention continuing through a period of time, rather than changing attention. Secondly, it involves a sort of attention that focuses on multiple objects within a time interval rather than a single object. Thirdly, MOT is an active task in contrast to tasks used in many experimental studies wherein one waits for a target to appear. Finally, the magnitude of need for attention may be manipulated by MOT through tracking load (Scholl, 2009).

In their studies, Ogawa, Watanabe, and Yagi (2009) aimed at learning a dynamic image in a visual context and evaluating sustained attention during this process via MOT and contextual cueing. It was found that in cases, where trajectory was not changed in repeated experimental sets, the implicit contextual cues improved MOT performance. This result may be interpreted as it facilitates sustained attention process for repeated trajectories in dynamic images as well as renders visual search more effective by guiding the division of attention in environments involving normal contextual cueing. The results of this study produced data particularly for explaining implicit learning. Learning may be achieved by ensuring that cues in repeated environments support visual coding by means of contextual cueing.

The fact that learning processes involve complex tasks and that individuals are exposed to too many stimuli in e-learning environments is considered indicative of sustained attention's importance in learning processes.

Memory, where design differences in learning environments gain importance and processes regarding attention take place, is another crucial component that affects visual attention. There are different memory classifications in the literature. The first one of the models proposed on memory is the memory model where James (1890) classifies memory into two, namely primary and secondary. Subsequent studies have shown that this model is inadequate to explain memory. Memory models were approached in relation to serial and parallel information processing models. Serial information processing model led to the 3-component structure of memory model proposed by Atkinson and Shiffrin in the 1968's. According to this model, memory is divided into three categories, namely sensory, short-term and long-term. In the parallel information processing model, on the other hand, Craik and Lockhart (1972) considered memory as a process which led to the levels of processing model. According to this model, information may be coded on three different levels: shallow, medium and deep. Baddeley and Hitch (1974), on the other hand, proposed the working memory model and modeled memory in a more active manner. According to the working memory model, memory consists of executive functions, phonological loop, visuo-spatial sketch and multimodal episodic buffer. According to Tulving's (1983) hierarchical memory model developed on the basis of type of information stored, memory is categorized into episodic, semantic and procedural. According to the memory model proposed by Graf and Schacter on the basis of consciousness in 1985, on the other hand, memory is distinguished as implicit and explicit (Cangöz, 2005).

While implicit memory is defined as the type of memory where information acquired previously affects the performance of a task being performed and information is recalled automatically and unconsciously, explicit memory is defined as the type of memory in which prior information is recalled during the performance of a task (Schacter, 1987).

Attention and implicit memory structures play a crucial role in learning processes. Attention, in turn, is affected by several components in e-learning environments. These are distinctiveness of stimuli, intention, memory and perceptual organization. An element perceived as distinctive in visual environments is more conspicuous compared to others, regardless of attention. Thus, the higher number of distinctive features in a target leads to more effective results in a search conducted via a visual interface (Hillstrom & Chai, 2006).

1.2. Contextual cueing

During screen design in e-learning process, several elements are placed on screen and it is expected that individuals gain the utmost benefit from the content presented in such environments. While interacting with content in front of the screen is in itself a distracting factor, elements included in a screen design may easily distract individuals' attention. At this point, a problem arises regarding directing attention in screen designs for e-learning environments.

Individuals' attention may be immediately directed without adding extra information to designs in e-learning environments by introducing contextual cueing or attentional cueing (Mayer & Moreno, 2003). During the effective information selection phase in learning environments, individuals use previously recorded visual data in their previous experiences. This mechanism is called contextual cueing or memory based attentional guidance (Ogawa et al., 2009). The basic goal behind using such cues is to direct attention in learning environments to reduce work load (Roberts, 2008).

In studies examining content designs in e-learning environments, research regarding the effects of contextual cueing mostly focus on several variables, such as the effects on different presentation types (Anllo-Vento & Hillyard, 1996; Green & Woldorff, 2012; Heiser & Tversky, 2006; Lorch, Lorch, & Klusewitz, 1995; Mann, Newhouse, Pagram, & Campbell, 2000; Rickards, Fajen, Sullivan, & Gillespie, 1997), learning (Boucheix, Lowe, Putri, & Groff, 2013; Imhof, Scheiter, Edelmann, & Gerjets, 2013) and the effects on recall (Lorch et al., 1995; Rickards et al., 1997).