IPA
International Journal of Psychology
Vol. 2, No.2, Winter 2008
PP. 52-64

Iranian **P**sychological
Association

The Effect of Arousal on False Recall and False Recognition among Children

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To investigate children false recall and false recognition under arousal, 100 elementary school students were presented lists of semantically associated words. All words in each list were associated with a non presented word or critical lure. The participants in arousal condition watched an emotionally exciting video clip and had exercise for some time. The results indicated that both groups had a relatively high false recall and false recognition. Also, the aroused participants had a higher rate of false memory than the control group. These findings are consistent with results of other researchers who showed that, false memories are significantly more frequent under conditions of high arousal.

Keywords: arousal, false recall, false recognition, false memory, DRM paradigm.

The effects of mood and arousal variations on cognitive processes, and specifically on memory, have been widely studied. Isen (1999) proposed that a positive mood, compared with a neutral mood, fosters a richer elaboration of information, leading to a larger number of conceptual relations in semantic memory. Generally speaking a happy mood favors the use of heuristics, the use of various knowledge structures stored in the long-term memory (Bodenhausen, Mussweiler, Gabriel, & Moreno, 2001;

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Corson, 2002), and the production of new information beyond the available data (Fiedler, 1988). Conversely, subjects in a negative mood appear to make less use of conceptual relations (Ellis, Varner, Becker, & Ottaway, 1995).

False memories have been investigated for a long time. Bartlett (1932) was the first researcher who conducted a series of systematic studies on the topic. He showed that people could recall a story falsely over several recall attempts. After the pioneering research by Bartlett on false memories, various paradigms were developed for studying these kinds of memories (for example, Bransford and Franks, 1971; Brewer, 1977; Loftus and palmer, 1974; Sulin and Duling, 1974).

Recently, researchers have focused on studying false recall and false recognition using a paradigm based on list-learning procedures (Roediger and McDermott, 1995). In this paradigm, lists of semantically associated words are presented to participants and after some specific time, they are asked to recall and recognize the items. A typical finding in such experiments is that, participants tend to falsely recall and recognize non-presented items which are semantically associated to the presented items .

Roediger and McDermott (1995) found that a high percentage (65 to 80%) of their participants remember words that are not presented to them. The Roediger and McDermott findings have been replicated by other investigators (e.g., Abdollahi, 2001; Libby and Neisser, 2001) and the effects of various stimuli on it have come into focus (McDermott, 1996; Robinson and Roediger, 1997; Toglia and Neuschatz, and Goodwin, 1999).

Fiedler and Stroehm (1986) suggested that arousal enriches the representation of encoded information. In the same vein, on the basis of the level-of-processing theory, Schwartz (1975) proposed that low arousal is associated with a shallow level of encoding, whereas high arousal favors a more elaborative encoding and an immediate access to information. Moreover, Porter, Spencer, and Birt (2003) obtained results showing that arousal affects suggestibility, which is known to be correlated with the production of false memories. Thus, the effects of mood on false memory

need not be due to valence, but could be due to arousal, as whatever participants?

The purpose of this experiment was to investigate the effect of arousal (both physiological and emotional) on the rate of false recall and false recognition among children using the DRM (Deese-Roediger-McDermott) materials. Research has Long revealed that arousal may affect the processes of acquisition, storage and retrieval of information (Revelle and Loftus, 1992). During the last four decades, various studies have been conducted on such an effect. It is to be pointed out that since arousal is an inseparable part of any mood and emotion, so all findings on the various attributes of mood and emotion could readily be linked to arousal. However, some researchers have tried to tease apart the specific contributing effects of mood, emotion and arousal on cognitive processes, but with no complete success.

In a study Eysenck (1975) assigned 52 undergraduates to 1 of 4 groups on the basis of scores on the Extraversion scale of the Eysenek personality Inventory and on the General Activation Scale of the Activation-Deactivation Adjective Check List. Subjects learned 2 lists composed of categorically related groups of words, with the number of categories and the number of words in each category varied. Memory was probed by simultaneously presenting a category name and an item-position cue and recording recall latency. Eysenck's results showed that activation (arousal) and extraversion interactively determined the recall latency for both category and item recall.

In another study on the effects of arousal on memory, Clark, Milberg and Ross (1983) examined, in 3 studies, how mood is stord in memory and the changes in arousal reoccur with subsequent moods that may prime affectively toned material stored earlier. In study 1, 37 Subjects learned a list of phrases while experiencing enhanced arousal and a second list while experiencing normal arousal. Subjects were given a recall test for phrases on both lists when they were experiencing either enhanced arousal or normal arousal. Their results support the hypothesis that level of arousal serves as an effective cue for material previously stored with information

about similar levels of arousal. In Study 2, 16 Subjects followed the procedures of Study 1, but at recall half the subjects viewed either an erotic or non-erotic film before a recall test of lists of phrases learned earlier.

Results provide additional support for the hypothesis. In study 3, 44 subjects listened to a story while stepping up or down on a block (high arousal) or while stringing cardboard disks together (normal arousa). All participants took a memory test; half from each arousal condition were told they had done well and half were told results were not yet available. Finally, all Subjects filled out a survey about their university. Results show that in the presence of arousal induced by success, Subjects rated their university more favorably. Clark, Milberg and Ross (1983) conclude that arousal, may be stored in memory along with other material.

Varner and Ellis (1998) propose that the cognitive activity associated with the experience of an emotional state mediates the occurrence of mood-congruent processing. In their two experiments with 112 undergraduates, they examined the role of cognitive activity in selective processing of words in a mood congruence paradigm. Four induction procedures were used: a depressed-mood induction, a schema induction organized around the writing a paper, an arousal induction, and a control neutral-mood induction. The memory task consisted of recalling a word list composed of negatively associated and thematically organized words. Selective processing was demonstrated in conjunction with the depressed-mood and organizational-scheme induction procedures. In contrast, the arousal and neutral induction procedures did not produce selective processing of words form the list. Varner and Ellis's findings support the thesis that cognition mediates the selective processing typical of mood congruence as distinct from arousal processes per se.

Heuer and Reisberg (1990) describe a study with 40 undergraduates that challenges the claim that emotional arousal causes a narrowing of attention and thus impoverished memory encoding. Results from a long-term (2-week), incidental learning procedure showed that emotion promoted memory for information central to an event and peripheral details. This finding contrasts with the results of explicit instructions to remember or to

attend closely to the event, both of which seemed to promote memory for the event's gist at the expense of details.

In still another study, Fiedler and Stroehm (1986) examined mood-congruent memory of 36 college students as a function of the structure of the information to be remembered (categorical vs isolated) and the participants arousal (stimulating drug: theophyllin vs placebo). Free recall of photographs showing either pleasant or unpleasant scenes was assessed for under positive or neutral mood states. Although the arousal manipulation did not affect recall performance, findings highlight the importance of the information structure. A mood-congruency effect was obtained for the isolated pictures but not for categorical materials, suggesting that structural constraints on the recall process can override the influence of mood on memory. A general recall advantage of positive mood was observed.

Pesta, Murphy, and Sanders (2001) conducted a study to examine whether emotional lures could be falsely remembered. They presented young adults with orthographic associates of either emotional (e.g., bitch) or nonemotional (e.g., shave) words. Consistent with the hypothesis that the emotional salience of the lures would serve to increase their distinctiveness, the participants recognized significantly fewer emotional than nonemotional lures.

An experiment by Payne, Jackson, Hoscheidt, Jacobs and Nadel (2004) demonstrates that exposure to a significant stressor simultaneously enhances memory for emotional aspects of an event and disrupts memory for non emotional aspects of the same event. These results are consistent with theories invoking differential effects of stress on brain systems responsible for encoding and retrieving emotional memories (the amygdala) and non-emotional memories (the hippocampal formation), and inconsistent with the view that memories formed under traumatic levels of stress are qualitatively the same as those formed under ordinary circumstances (e.g., McNally, 2003).

Storbeck and Clore (2005) used the Deese-Roediger-McDermott (DRM) paradigm to investigate the effects of mood on false memories. Storbeck

and Clore (2005) tested the hypothesis that a happy mood leads to a higher proportion of false recall of critical lures than sad or neutral moods do. Levels of veridical recall were similar for participants in the three mood groups, but the positive-mood and control groups recalled more critical lures than the negative-mood group did. Thus, the observed difference in false recall of critical lures was due to a lower level of false recall in the negative-mood group, rather than a higher level in the positive mood group. The authors suggested that gist processing, which is reduced with negative mood, was the mechanism underlying the observed result.

In a priming experiment testing the effects of both valence and arousal (Corson, 2006), a mood-induction procedure was used to create two positive-mood groups, one with high arousal (happiness) and one with low arousal (serenity, relaxation), and two negative-mood groups, again one with high arousal (anger) and one with low arousal (sadness). Lexical decision was considerably facilitated in the positive and negative-mood groups with high arousal, whereas the low arousal moods did not lead to any facilitation. In addition, the results for a neutral-mood group were equivalent to those for the low-arousal groups.

Corson and Verrier (2007) research tested the effects of both valence and arousal on recall and recognition and indicated that the effect is actually due to arousal. In fact, whether participants mood is positive, negative, or neutral, false memories are significantly more frequent under conditions of high arousal than under conditions of low arousal.

The effects of arousal on memory may be traced to neurobiological mechanisms and processes. Hormones and specific brain structures such as the amygdala may mediate such effects. For example, Cahill and McGaugh (1998) review evidence supporting the view that specific hormonal and brain systems that activate emotional arousal regulate long-term memory storage. Extensive research in animals implicates stress hormones and amygdala complex as key interacting modulators of memory consolidation for emotional events. In addition, there is considerable evidence suggesting that amygdale is not a site of long-term explicit or declarative memory storage, but serves to influence memory-storage processes in other brain

regions, such as the hippocampus, striatum and neo-cortex. Human subject studies confirm the prediction of animal work that the amygdala is involved in the formation of enhanced declarative memory for emotionally arousing events. Such a kind of view indicates that arousal exerts its impact on memory via neurobiological routes. But a new question could be whether arousal in its physiological and emotional forms might influence false memories in children (Ceci and Bruck, 1993).

On the whole, in this experiment it is predicted that arousal may increase the rate of false memory in children. Such an effect has been observed with adults (Abdollahi, 2001, Corson, 2006, Corson and Verrier, 2007). Therefore, it may be replicable in children.

Method

Subjects. One hundred elementary school students (Mean age=10.09) participated in the experiment. None of the participants were afflicted with any cardiovascular diseases and all of them had intact hearing ability.

Materials. The materials consisted of 5 lists each containing 15 words identical to those used by Roediger and McDermott (1995). Each list contained words to be presented for the study and a target word (critical lure) that was not presented for the study. The study words that were highly associated to the critical lure and ordered such that the strongest associated occurred first in the list. The lists were presented auditoryly by the experimenter.

Design and procedure. In this study arousal induction is the independent variable and false recall and false recognition are the dependent variables. The participants were randomly assigned to two equal number conditions in a post-test only design with respect to the dependent variables. One group of them (experimental) was asked to watch a 6-minute frightening video clip episode. They were required to run some distance (50 meters) before and after these activities, the participants heart rate (HR) were monitored utilizing a computerized HR monitoring device. The participants were presented with the materials immediately after the arousal induction procedure. Other participants (Control) underwent no

arousal-induction procedure, but like the experimental group, their heart rates were monitored before receiving the materials.

Results

Arousal assessment

Table 1.shows, heart rate measures for the experimental and control conditions.

Table 1
Heart rate measures (Means) for the experimental and control conditions

Condition	Before	After
Experimental	74.56	91.05
Control	73.11	------

In this experiment it was observed that the arousal-induction procedures for the experimental group were effective. There was a significant difference between pre and post arousal heart rate measures (t=7. 16, df=49). Also, there was no significant difference between the heart rate measures for the two groups in the pre-test. (t=0. 98, df=98, p<0.001).

Veridical and false recall and recognition for each condition, the mean proportion of (the 5 total) lists on which the non-presented words were recalled and recognized is presented in Table 2.

Table 2
Mean proportions of veridical recall and recognition for the experimental and control condition

Condition	Recall	Recognition
Arousal	.62	.68
No arousal	.57	.60

As can be seen in Table 2, the groups remembered (recalled and recognized) the presented words with a high rate (Recall mean for the

experimental condition =.62 and for the control condition=.57; Recognition mean for the experimental condition=.68 and for the control condition=.60). The recall and recognition rate between the two groups were significant, and participants of arousal group recalled and recognized more words. (Z= 0.5, df=98, P<0.05 FOR recall and Z=0.8, df=98, P<0.05, for recognition). In Table 3, it can be observed that the rate of false recall and false recognition is high.

Table 3

Mean proportions of false recall and false recognition for the experimental and control groups

Condition	Recall	Recognition
Arousal	.45	.58
No arousal	.38	.46

The participants in the two conditions falsely recalled and recognized a considerable rate of critical lures or non-presented words (false recall mean for the experimental condition=.45 and for the control condition=.38 and false recognition for the experimental condition=.58 and for the control condition=.46).

The false recall and false recognition measures between the two groups were significant (Z=1.607, for recall and Z=2.05, for recognition, p<0.01), that is consistent with prediction of this study about effects of arousal on false memory in children.

Discussion

The findings of this study reveal that the rate of false recall and false recognition is high and this goes counter to the laypersons and many psychologists who believe that memory is like a video that stores every aspect of past experiences and events. These findings are consistent with results in the research with adult populations (Roediger and McDermott, 1995; Payne, Neuschatz, Lampinen, Lynn, 1997; Schacter, Verfaellie, Anes, 1997).

Before elaborating on the effects of arousal, it is appropriate to draw on the results of the control group; that is the group which was not under high arousal. It can be observed from the data that even without any salient arousal, the participants in this condition revealed a relatively high recall and false recognition.

The findings of this experiment also, indicated that physiological and emotional arousals may affect how information is falsely retrieved from memory. Specifically, the experiment had a high rate of false recall and false recognition lures or the non-presented words and this increase in false recall could be attributed to the effect of arousal induced by exercise and watching an emotion-arousing video clip. The findings are consistent with those obtained by Eysenck (1975), Clark, Milberg and Ross (1983), Heuer and Reisberg (1990), Roediger and McDermott (1995), Libby and Neisser (2001), Payne, Jackson, Hoscheidt, Jacobs and Nadel (2004) about the effect of arousal on memory and those by Abdollahi (2001), Storbeck and Clore (2005), Porter, Spencer, and Birt (2003), Corson (2006) and Corson &Verrier (2007), about the effect of arousal on false memory. Therefore, both children and adults are influenced by arousal when remembering past veridical and false events.

But what about the effects of arousal on the false memories obtained in this experiment? Why did arousal induced false recall and false recognition? Is there any relationship between age and susceptibility to false remembering under conditions of high arousal? As mentioned in the introduction, research for long has shown that arousal can lead to enhancement of memory and findings in neuropsychological studies of memory have revealed that the brain loci for veridical and false memories are the same (Schacter, 1999). In sum, it can be concluded that false memories like veridical memories can be enhanced by high arousal. Also, children are more susceptible to this effect of arousal on memory, because lack of sufficient cognitive monitoring and meta-memorial abilities to control such effects (Ceci and Bruck, 1993). However, further research is needed to test the relevance of diverse mechanisms to the production of false memories in the DRM paradigm.

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Received: 21 /5/ 2009
Revised : 29/11/ 2009
Accepted: 22 / 2/ 2010