

# Positive and negative sources of emotional arousal enhance long-term word-list retention when induced as long as 30 min after learning

Kristy A. Nielson<sup>a,b,c,\*</sup>, Mark Powless<sup>a</sup>

<sup>a</sup> Department of Psychology, Marquette University, P.O. Box 1881, Milwaukee, WI 53201-1881, USA

<sup>b</sup> Integrative Neuroscience Research Center, Marquette University, Milwaukee, WI, USA

<sup>c</sup> Foley Center for Aging and Development, Departments of Neurology and Psychiatry and Behavioral Medicine, and the Functional Neuroimaging Research Center, Medical College of Wisconsin, Milwaukee, WI, USA

Received 9 March 2006; revised 27 February 2007; accepted 14 March 2007

Available online 27 April 2007

## Abstract

The consolidation of newly formed memories occurs slowly, allowing memories to be altered by experience for some time after their formation. Various treatments, including arousal, can modulate memory consolidation when given soon after learning, but the degree of time-dependency of these treatments in humans has not been studied. Thus, 212 participants learned a word list, which was followed by either a positively or negatively valenced arousing video clip (i.e., comedy or surgery, respectively) after delays of 0, 10, 30 or 45 min. Arousal of either valence induced up to 30 min after learning, but not after 45 min, significantly enhanced one-week retrieval. The findings support (1) the time-dependency of memory modulation in humans and (2) other studies that suggest that it is the degree of arousal, rather than valence that modulates memory. Important implications for developing memory intervention strategies and for preserving and validating witness testimony are discussed.

© 2007 Elsevier Inc. All rights reserved.

**Keywords:** Memory consolidation; Memory modulation; Time-dependent facilitation; Emotion; Arousal; Eyewitness accuracy; Valence; Intervention; Enhancement

## 1. Introduction

Emotional and arousing events are recollected with greater frequency than similar but neutral events, which is likely an adaptive function, effectively highlighting important stimuli and events to protect and prepare an organism for similar future occasions (McGaugh, 2000). Memory consolidation, believed to underlie this highlighting process, is the outcome of a complex set of neurobiological processes occurring after the initial formation of a memory (McGaugh, 2000; Müller & Pilzecker, 1900; Rev-

elle & Loftus, 1992; Torras-Garcia, Portell-Cortes, Costa-Miserachs, & Morgado-Bernal, 1997). Thus, events occurring after learning can modulate memory consolidation.

A variety of substances, including glucose and the adrenal hormones epinephrine and norepinephrine, are released into the bloodstream during times of arousal, stress and emotion and indirectly alter brain stem and amygdalar function (Gold, 2005; Hamann, 2001; McGaugh, 2000; McGaugh, Cahill, & Roozendaal, 1996). When administered soon after learning, these substances alter memory with the classic “inverted-U” dose response effect that has been shown for other aspects of performance (McGaugh, 2000; Yerkes & Dodson, 1908). Although the efficacy of these post-training treatments varies with multiple factors, such as dose or intensity of treatment,

\* Corresponding author. Address: Department of Psychology, Marquette University, P.O. Box 1881, Milwaukee, WI 53201-1881, USA.

E-mail address: [kristy.nielson@marquette.edu](mailto:kristy.nielson@marquette.edu) (K.A. Nielson).

their efficacy also typically diminishes with time such that they are most effective when given shortly after learning (cf. McGaugh, 1989, 2000).

The vast majority of human studies examining the effects of arousal on learning or memory have used inherently emotional materials or interventions before or coincident with the learning task. As such, it is impossible to decipher in these studies whether the effect is on attention, encoding, consolidation or some combination of these phases. However, several recent studies have demonstrated memory modulatory effects in human participants by comparable mechanisms of action as have been shown in rodent studies using various post-training treatments including norepinephrine (Southwick et al., 2002), glucose (Manning, Parsons, & Gold, 1992), nicotine (Colrain, Mangan, Pellett, & Bates, 1992), and non-invasive treatments such as muscle tension (Nielson & Jensen, 1994; Nielson, Radtke, & Jensen, 1996), stress (Cahill, Gorski, & Le, 2003) and negative and positive emotional arousal (Nielson & Bryant, 2005; Nielson, Yee, & Erickson, 2005). Importantly, no human study has yet examined the time-dependency of these effects; no study has varied the delay of the intervention after learning. Furthermore, no human study has compared the effects of positively and negatively valenced stimuli within the same paradigm.

The purpose of the present study was to evaluate the time dependency of modulating memory consolidation in humans. We employed a word-list learning task that was followed by a positively or negatively valenced arousal stimulus after delays of 0, 10, 30 and 45 min. Control participants experienced no stimulus after learning. Because human studies with delayed interventions have not been done, it was difficult to hypothesize which treatments would be effective. Based on the human literature, the immediate condition of either valence was expected to be effective and although the animal literature varies it suggests that systemic treatments given soon after learning are most effective (cf. McGaugh, 1989, 2000). Thus, it was hypothesized that arousal of either valence occurring at either 0 or 10 min after learning would enhance retention measured one week later; it was less predictable whether longer delays would be effective.

## 2. Experiment 1

Experiment 1 was conducted to identify a positively valenced arousal stimulus for use in the primary experiment. In previous studies, negative arousal sources, such as accident or surgical scenes have often been used in research in part because subjective responses to such stimuli are relatively consistent across participants. In contrast, responses to positive arousal sources, such as comedy, are more variable across participants. In order to identify a comedic arousal source that would have relatively universal affective appeal, a variety of comedy video clips were assessed for suitability. Twenty clips suggested by the authors and research assistants were preliminarily viewed as potential

arousal sources for a memory modulation study. From these, five were selected for pilot testing.

### 2.1. Methods

#### 2.1.1. Participants

Forty-two undergraduate students (33 female, 9 male; mean age = 18.81, SD = .86) were included in this study and received course credit for their participation. Procedures were reviewed and approved by the Internal Review Board.

#### 2.1.2. Materials

Five video clips were evaluated by each participant: (1) “Saturday Night Live (SNL)” *Jingleheimer Junction* (4 min); (2) “Even Stephens” skit (4 min, 10 s); (3) “Spaceballs” scene (50 s); (4) “Adult Swim’s” *Spaceghost* scene (11 min, 30 s); (5) “SNL” *Behind the Music, Blue Oyster Cult* skit (5 min, 45 s). Two questions were posed after each clip about current arousal and mood state and eight questions were posed about the clips themselves (attempting to evaluate both cognitive and affective components of the humor response) (Gavanski, 1986). Each question was posed on a 10-point Likert-type scale (1 = not at all, 10 = extremely): (1) current mood; (2) current arousal; (3) funny; (4) smile; (5) laugh; (6) witty; (7) funny to others; (8) ridiculous. Participants were also asked to indicate which clip was their favorite.

#### 2.1.3. Results

The results are presented in Table 1. The favorite clip, chosen by 43.9% of participants was SNL *Jingleheimer Junction* ( $X^2(4) = 20.1$ ,  $p = .001$ ), with “SNL” *Behind the Music* second highest (23.8%). These two clips and the “Even Stephens” clip were consistently highly rated for mood, arousal and humor across the various questions asked. It appeared that any of the three clips would be effective for producing arousal, but the clip also chosen as favorite most consistently (“SNL” *Jingleheimer Junction*) was selected for use in the primary experiment.

## 3. Experiment 2

### 3.1. Methods

#### 3.1.1. Participants

Two hundred and twelve undergraduate students (155 female, 57 male) were included in this experiment and received course credit for their participation. Procedures were reviewed and approved by the Institutional Review Board. Quasi-random assignment was made to group experimental conditions upon entrance to the room. Several sessions were used to achieve adequate cell populations, but all conditions were represented at each session with no less than seven participants per condition at any time. Five groups were used: Control (no arousal;

متن کامل مقاله

دریافت فوری ←

**ISI**Articles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات