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Capturing students' attention: An empirical study

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Abstract: College students (n=846) enrolled in a general education course were randomly assigned to either an arousal (experimental) or no-arousal (control) group. The experimental group was exposed to a topic-relevant, 90-second external stimulus (a technique used to elevate arousal and focus attention). The control group listened to the instructor take roll. Both groups then listened to the same 30-minute lecture followed by an exam. An independent-samples t-test found a significant difference in exam scores measuring information retention between arousal (M=13.36, SD=1.5) and no-arousal (M=12.85, SD=1.4) conditions; t (844)=5.20, p < .001. Results suggest introducing a lecture with an external stimulus increases information retention.

Keywords: arousal, attention, memory, retention

I. Introduction.

Boredom is a significant issue in higher education (Craig, Graesser, Sullins, & Gholson, 2004; Pekrun, Goetz, Titz, & Perry, 2002; Shernoff & Csikszentmihalyi, 2003). In a series of five studies, Pekrun, Goetz, Daniels, Stupnisky, and Perry (2010) found a positive relationship between boredom and attentional problems while a negative relationship existed between boredom and academic performance. In a subsequent review, Pekrun, Goetz, Frenzel, Barchfeld, and Perry (2011) found that boredom was negatively related to motivation to learn, processing of information, and memory. Wallace, Kass, and Stanny (2002) and Wallace, Vodanovich, and Restino (2003) found a strong association between boredom and cognitive-based mistakes (e.g., attention deficits and memory failures). These academic related issues may lead to lower GPAs (Maroldo, 1986) and higher dropout rates (Farmer & Sundberg, 1986).

Boredom is also prevalent in higher education. Mann and Robinson (2009) found that 59.0% of university students experience boredom with 30.0% experiencing boredom most or all of the time. According to a 2010 Higher Education Research Institute (HERI) report, the weighted national norm for first-year students feeling bored in the classroom was 39.2% (Pryor, Hurtado, DeAngelo, Blake, & Tran, 2010). Pekrun et al. (2010) found boredom to be experienced significantly more than other negative emotions directly tied to learning and achievement (i.e., anxiety, anger, hopelessness). This academic emotion was one of the most cited reasons for dropping out of college (Farmer & Sundberg, 1986). Compared to other developed countries, "the United States now has the highest college dropout rate in the industrialized world" (Symonds, Schwartz, & Ferguson, 2011, p. 10).

Evidence supports the need to address the deleterious effects of this significant and widespread academic emotion. However, boredom involves motivational, cognitive, and physiological factors that are difficult to define and measure (Farmer & Sundberg, 1986; Mikulas & Vodanovich, 1993; O'Hanlon, 1981; Pekrun & Linnenbrink-Garcia, 2012). In developing a comprehensive definition of boredom based on a systematic, cross-disciplinary review, Vogel-

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Walcutt, Fiorella, Carper, and Schatz (2012) synthesized that "boredom occurs when an individual experiences both the (objective) neurological state of low arousal and the (subjective) psychological state of dissatisfaction, frustration, or disinterest in response to the low arousal" (p. 102). This aversive state and associated suboptimal arousal can negatively affect the motivation to learn.

One potential strategy to mitigate the negative effects of boredom is to increase arousal (Belton & Priyadharshini, 2007). A prevalent teaching strategy with prolific anecdotal evidence is the use of an external stimulus – a hook, trigger, attention getter/grabber, or anticipatory set (e.g., Feden & Vogel, 2002; Hidi & Renninger, 2006; Hunter, 1994; McCarty & Siccone, 2001; Moore, 1987; White, 2007; Willis, 2006). These external stimuli capture students' attention by touting the ability to increase arousal (decrease boredom), focus attention, and enhance learning and memory (Willis, 2006).

Although theoretically grounded in cognitive psychology and neuroscience, a paucity of empirical evidence exists on the efficacy of arousing techniques on attention and learning (Banas, Dunbar, Rodriguez, & Liu, 2011; Berk, 2011; Carlson, 2011). This is surprising given the widespread acceptance of attention getters used in the classroom and the recent contributions from "brain-based learning" – a neuroscience moniker used to describe the comprehensive and interdisciplinary approach to teaching and learning based on the science of nervous system structures and functions (Caine & Caine, 2004). Buskist and Groccia (2011) commented, "it is ironic that within higher education institutions dedicated to the discovery, transformation, and dissemination of knowledge, the choice of teaching strategies is based largely on experiential, commonsense, or anecdotal evidence" (p. 6).

The following review of literature will provide an overview of arousal, attention, and memory. Although the three concepts are interdependent, arousal is often identified as the precursor to attention (Posner & Peterson, 1990). If there is sufficient arousal, attention to the stimulus allows cognitive processing of the stimulus resulting in the forming and storing of a memory (Wei, Wang, & Klausner, 2012).

A. Arousal.

The use of an external stimulus is intended to heighten arousal. Difficult to define and complex in function, arousal in its basic form is a multifaceted, interdependent construct that "underlies all motivated behavioral responses, cognitive functions, and emotional expression" (Pfaff, Ribeiro, Matthews, & Kow, 2008, p. 11). Although a comprehensive understanding of arousal has yet to be established and is beyond the scope of this paper, arousal is often considered the primary mechanism of the central and autonomic nervous system, and is considered both a physiological and psychological state based on sensory excitability (Berlyne 1960; Eysenck, 1982; Loewenstein, 1994). This neural excitation originates from sensory input received by the Reticular Activating System (RAS), which then sends the information to the limbic system for processing (see Lieberman, 2011, for a review of this process). Arousal is responsible for activating and regulating numerous mechanisms (e.g., attention and memory), and can range from sleep to a state of alertness (Eysenck, 1982; Robbins & Everitt, 1995).

As a construct, arousal has been used in numerous learning theories. The earliest, most notable is the Yerkes-Dodson Law (Yerkes & Dodson, 1908). Although the inverted U-shaped function between arousal and performance (learning) has been mislabeled, widely criticized, and viewed as simplistic and unidimensional (Baumler, 1994, as cited in Hancock & Ganey, 2003;

Eysenck, 1982; Hanoch & Vitouch, 2004; Mandler, 1975), the basic premise of a curvilinear relationship has been replicated in studies with animals (Broadhurst, 1957) and humans (Dickman, 2002), with too much arousal leading to feelings of anxiety and too little arousal resulting in boredom (Apter, 1997; Belton & Priyadharshini, 2007; Csikszentmihalyi, 1975). Anderson (1990) argued that arousal and the inverted-U hypothesis could be pragmatically useful in exploring a wide range of behaviors and associated emotions. A moderate level of arousal has been purported to stimulate curiosity and interest (Berlyne 1960; Renninger & Hidi, 2011).

Jepma, Verdonschot, van Steenbergen, Rombouts, and Nieuwenhuis (2012) investigated the neural mechanisms underlying curiosity and argued that curiosity is a basic biological drive and motive for learning. According to Berlyne (1960), curiosity is a state of moderate arousal induced by external stimuli that presents conflict or uncertainty, and this motivated approach behavior seeks to resolve the conflict through the acquisition of knowledge. Through a number of experiments, Berlyne (1966, 1970) found that external stimuli comprised of collative properties (e.g., novelty, incongruity, ambiguity, surprise) evoked curiosity and exploratory behavior more than neutral forms of external stimuli (e.g., familiar, simple, clear, expected). Thus, beginning a class with a novel or unexpected question, puzzle, or poem would cause an increase in arousal followed by curiosity and the motivation to explore or seek information needed to answer the question, solve the puzzle, or appreciate the poem. Resolving this "information gap" through curiosity leads to positive affect and increased learning and memory (Loewenstein, 1994).

In a study using functional Magnetic Resonance Imaging (fMRI), Kang et al. (2009) showed a correlation between curiosity (stimulated by trivia questions) and cortical activity in brain regions associated with anticipated rewards. These results support Berlyne's (1966, 1970) earlier findings that external stimuli increases curiosity (interest) and the resulting motivated behavior to resolve the conflict. Jepma et al. (2012) also used fMRI to test predictions related to curiosity and found that learning and memory is enhanced when curiosity is reduced.

The term "interest" has been associated with curiosity. Hidi and Anderson (1992) and Izard (1977) noted Berlyne did not clearly differentiate between the two terms. However, Litman and Jimerson (2004) suggested that interest was one type of curiosity associated with positive affect rather than a deprivation state motivated to reduce an aversive condition. Hidi and colleagues (Hidi, 1990; Hidi & Anderson, 1992; Hidi & Harackiewicz, 2000) argued interest as well as curiosity is critical to learning and would benefit students who do not have a pre-existing interest in an academic topic or activity. Hidi and Renninger (2006) identified two types of interest (situational and individual). Whereas individual interest refers to one's preferences for certain activities, situational interest focuses on the characteristics of the activity and is more relevant to capturing students' attention (Hidi & Renninger, 2006).

Situational interest is a transitory affective response to a stimulus originating from a specific object, environment, activity, or event, which focuses an individual's attention. Individual interest refers to a more stable predisposition that evolves over time through continued cognitive and affective processing of a specific content area or activity. Situational interest is more closely associated with capturing students' attention (Hidi, Renninger, & Krapp, 2004) and can be evoked by novel, but meaningful stimuli. Turner and Silvia (2006) found that novel stimuli (i.e., visual art and poetry) triggered situational interest. However, Renninger and Hidi (2011) noted that the trigger or collative stimuli associated with situational interest needs to be relevant and meaningful. Mitchell (1993) found that novel stimuli (i.e., puzzle and computer interaction) were more apt to stimulate situational interest whereas relevancy and meaningfulness of the trigger were more associated with maintaining situational interest. Chen, Darst, and Pangrazi (2001) observed not only an increase in situational interest from participants exposed to novelty and challenge, but also an increase in cognitive processing (e.g., attention). As with curiosity, situational interest should result from exposure to a novel and relevant external stimulus. This external stimulus is purported to elevate arousal, and in turn, focus and sustain attention (Anderson, 2005; Calvo & Lang, 2004).

B. Attention.

As the name implies, attention-getting devices are intended to focus the students' attention on class content (external stimulus). From a neural perspective, Norton and Pettegrew (1979), and Penner (1984) defined attention as receptive and cognitive processes that bring awareness to arousing stimuli entering consciousness. These processes involve "(a) orienting to sensory events, (b) detecting signals for focal (conscious) processing, and (c) maintaining a vigilant or alert state" (Posner & Peterson, 1990, p. 26). Berlyne (1960) supported the strong relationship between higher levels of arousal and the intensity (narrowing) of attention. Studies have established that arousal is positively related to a narrowing of attention and negatively related to the number of cues (details) utilized (Gable & Harmon-Jones, 2008; Riggs, McQuiggan, Farb, Anderson, & Ryan, 2011).

The "cue utilization hypothesis" (Easterbrook, 1959) provides an explanation of the inverted U-shaped relationship between arousal and performance (i.e., learning), and is based on selective attention. The basic tenet of the hypothesis is that arousal is inversely related to one's span of attention or cue utilization. An increase in arousal will lead to attention narrowing or a restriction of cues that can be processed, whereas a decrease in arousal will result in attention widening or a broadening of cues. Depending on the situation, this can be beneficial or detrimental. When attention is inadequate or inappropriate, learning is negatively affected (Easterbrook, 1959; Eastwood, Frischen, Fenske, & Smilek, 2012).

For example, if an instructor elevates students' arousal before a lecture, there is a higher probability that relevant, central details of the lecture material will be attended to and retained in memory. At the same time, less attention will be directed to irrelevant or peripheral details (e.g., an incoming text message from a friend, a novel noise originating from the back of the classroom, thoughts of what to eat for lunch after class). Excessive arousal results in students' attention being too focused/restricted that relevant elements of the lecture material are not processed or retained in memory, whereas the attention of under aroused students will wander and be easily distracted by competing stimuli.

Mather and Sutherland (2011) developed an Arousal-Biased Competition (ABC) theory to explain that arousal, whether elicited by stress hormones, external stimuli, or internal dialogue, narrows attention and stimulates the modulation of sensory processing, information encoding, and memory consolidation. The ABC theory proposes that arousal modulates attention by prioritizing competing stimuli. This bias leads to an enhanced memory processing and consolidation for high priority stimuli and decreased processing and consolidation for low priority stimuli. Prioritization occurs through interdependent "top-down" and "bottom-up" mechanisms that capture attention. Top-down influences tend to be cognitive based and goal relevant (e.g., class expectations, prior knowledge, explicitly stated learning outcomes). Bottom-up influences are more emotionally based and perceptually salient (e.g., disturbing video, contradictory statement, powerful statistic).

Mather and Sutherland (2011) reviewed empirical evidence that exists for both top-down and bottom-up processes that prioritize stimuli, focus attention, and increase memory. For example, Zeelenberg and Bocanegra (2010) found that participants exposed to an arousing sound could recall a list of words significantly better than participants who were not exposed to an arousing sound. Liu, Graham, and Zorawski (2008) demonstrated that participants who viewed an arousing video recalled a set of pictures significantly better than participants who viewed a neutral video. Sarter and Lustig (2009) reviewed literature on arousal, attention, and memory, and concluded, “the assumption that attended stimuli are encoded more effectively into memory than less attended ones is straightforward and supported by substantial evidence” (p. 639).

In a classroom setting, top-down strategies may include explicitly stating the learning outcomes for the lecture (e.g., students will identify two consequences of drinking and driving) or asking questions pertaining to the lecture that elicit prior experience or knowledge of the subject area (e.g., how many of you have driven or been in a car with someone under the influence of alcohol). Bottom-up methods would include showing a disturbing picture of a video related to the lecture (e.g., consequences of drinking and driving). Just as arousal affects attention, attention affects learning and the ability for perceived stimuli to be encoded into short-term and long-term memory. Wei, Wang, and Klausner (2012) argued “because attention is the main gatekeeper to processing, storing, and retrieving information, learning cannot proceed in its absence” (p. 91). Learning and the process of working with information also involves memory.

C. Learning and Memory.

Learning and memory (LM) are two distinct, but interrelated processes. Learning is associated with information acquisition and subsequent behavior change, and memory is responsible for encoding, storage, and recall of information (Lieberman, 2011). Cowan (1997) explained that encoding information, a process that is modulated by arousal and attention, is the first step in forming a memory. Encoding involves the perception of an external stimulus, which is then converted into an engram (i.e., a hypothetical memory trace) by the brain region responsible for processing the stimulus (e.g., visual cortex, language area).

Storage or retention of information consists of an ongoing consolidation process (e.g., long-term potentiation). This process involves an increase in strength and frequency of neuronal communication – the firing between nerve cells synapses. Stronger communication leads to a more accurate memory and a greater likelihood of memory retention from short-term to long-term memory (Cowan, 1997). Substantial empirical evidence supports the basic notion that arousal and attention modulate and precedes learning and memory (see discussion in Craik & Lockhart, 1976; Kyndt, Cascallar, & Dochy, 2012; Posner & Petersen, 1990; Riggs, McQuiggan, Farb, Anderson, & Ryan, 2011; Risko, Anderson, Sarwal, Engelhardt, & Kingstone, 2012).

As discussed in the previous two headings, arousal and attention have been empirically linked to memory. Murty, Ritchey, Adcock, and LaBar (2011) conducted a meta-analysis of fMRI studies and found a positive relationship between arousal and memory. In addition, Murty et al. found that emotional stimuli were remembered better than neutral stimuli. In the context of teaching, a poem that evokes imagery or emotion would enhance memory more than a poem using neutral words. Given that a strong theoretical framework has been established, a review of research examining the effects of an external stimulus on arousal, attention, and learning will be presented. The limited evidence that exists is primarily within the area of instructional communication (e.g., humor and multimedia).

D. Humor and Multi-media.

The definition of humor varies among scholars, but the following characteristics are widely accepted: (a) Verbal or nonverbal communication, (b) positive emotions, and (c) incongruous meanings (Martin, 2007). One theory used to explain the humor process that incorporates arousal and attention is the Instructional Humor Processing Theory (IHPT) (Wanzer, Frymier, & Irwin, 2010). Arousal is used to explain IHPT in that resolving incongruous meaning(s) is an interaction between physiological arousal and cognitive appraisal. The incongruity creates cortical conflict stimulating a physiological need to maintain homeostasis by resolving the incongruity. According to IHPT, an individual needs to perceive and resolve the incongruity within a humor message. This increased arousal (curiosity motivation) for resolution directs attention as long as the humor is relevant.

Further, Wanzer et al. (2010) suggested that the mental processing and elaboration resulting from the humorous message increases learning and recall. The IHPT predicts that instructor's use of humor in the classroom will enhance motivation, positive affect, and learning to the extent the humorous message captures students' attention, is relevant and appropriate, and resolution of the incongruity is successful. Martin (2007) stated "the novelty and emotionally arousing properties of humor may help to attract and sustain students' attention onto the lesson, thus facilitating acquisition of information" (p. 354). In determining the efficacy of humor on motivation and learning, Banas et al. (2011) reviewed forty years of research on humor in educational settings and found generally positive, but inconsistent results.

Ziv (1988) found positive effects of humor on cognitive learning in a classroom setting. Two groups were randomly assigned to a humor and no-humor condition. The same instructor delivered the information to both conditions with the humor group being presented with three to four concept-relevant jokes after presenting the concept and before an end-of-class review. The no-humor group was presented with the same information without jokes. The humor group performed significantly better on a post-lecture exam, and findings were replicated in another class using a different instructor in the following semester. Ziv cautioned that the majority of humor research has been conducted in artificial (experimental) settings and generalizing results to educational settings is limited. One study resulting in inconsistent results involved the effects of humor messages on learning. Kaplan and Pascoe (1977) examined three versions of a lecture used to deliver humorous messages to students before assessing information recall. One lecture presented humorous examples that were relevant to the topic; one lecture presented unrelated humor; and one lecture presented a mix of relevant and irrelevant humor. No significant results were found with immediate recall as measured by an 11-item quiz. However, after six weeks, students in the relevant humor lecture scored significantly better than the other two conditions on the same 11-item quiz. However, total quiz scores did not differ between conditions. Kaplan and Pascoe posited that inconsistent findings might be attributed to humor only improving information recall for those items related to the humorous messages, and concluded "general comprehension and retention of a classroom message is not significantly improved by the use of humor" (p. 64-65). Further, conceptual and methodological issues related to humor research create difficulty in understanding how humor functions in the classroom (Banas, et al., 2011). Teslow (1995) asserted that existing evidence is dated and study replication is scant. More recent studies have investigated multimedia effects on learning and memory including some forms of humor (e.g., cartoons, humorous video).

Multimedia messages have been reported to act as an external stimulus that elevates arousal, focuses attention and enhances learning and memory (Berk, 2011). Research investigating the effects of multimedia on memory is often based on the cognitive theory of multimedia learning (Mayer, 1997). The theory proposes that auditory and visual processing occurs independently, but in parallel within working memory. This allows an individual to access more cognitive capacity to process information presented in text and pictures. Mayer (2003) reviewed research demonstrating that participants presented with information in two modes of representation (e.g., visually and verbally) learned significantly better than if presented with one mode of representation. This finding was demonstrated in text- and computer-based environments. For example, Mayer and Anderson (1991, 1992) found that participants listening to a narration on how a bike pump operates while watching an associated animation were able to generate significantly more solutions to subsequent problem-solving questions related to the topic. Eaton and Uskul (2004) examined a single mode of information delivery (i.e., film clip), and found that students scored significantly higher on test questions related to film clips than on questions unrelated to the film clip. This finding has been replicated in other studies (Kirsh, 1998; Mathis & Tanner, 1991). Studies examining multimedia messages in PowerPoint presentations have demonstrated similar results (Berk, 2011).

The above review of literature supports the framework that an external stimulus will evoke arousal, focus attention, and result in information retention. Moreover, the external stimulus needs to be germane to the course content, contain collative properties, and produce a moderate level of arousal. In addition, the review of literature also identifies the need to address the following observed deficits: (a) to examine information retention after exposure to an external stimulus, (b) to study the effects of external stimuli and arousal in a classroom setting, (c) to research other forms of external stimuli other than humor and multimedia, and (d) to provide empirical data for evidence based teaching strategies. Specifically, the purpose of this study was to examine the effects of arousal on information retention among college students in a classroom setting. The research question examined was whether student exposure to a 90-second external stimulus (i.e., attention grabber) would result in an increased retention of lecture information.

II. Methods.

The study was a randomized experimental design involving 846 students over a four-year period in a general education classroom at a large, urban university. The following methods will describe the variables, participants, instruments, procedure, and data analysis used in the study. It was hypothesized that participants exposed to an external stimulus will recall lecture information better than participants not exposed to an external stimulus.

A. Variables.

The dependent variable was information retention as measured by the response performance on a 15-point exam covering a 30-minute lecture on alcohol and leisure. It was hypothesized that students exposed to a pre-learning external stimulus (i.e., poem, game, puzzle) would retain information from a lecture significantly better than students who are not exposed to a pre-learning stimulus. The independent variable arousal was operationalized as a 90-second external stimulus and was divided into arousal (experimental) and no-arousal (control) conditions. Three types of external stimuli (i.e., poem, game, puzzle) were used to increase arousal and were based on Berlyne's (1966) collative properties (e.g., novelty, ambiguity, surprise). In the first year, the experimental groups within both class sections listened to a poem related to alcohol and its consequences. The poem (external stimulus) was 90-seconds in duration and contained words designed to create visual imagery used to elicit an emotional response. The second year experimental group participated in a 90-second movement game called "no need for alcohol." The game consisted of paired students standing up, clapping their hands once, and pointing both thumbs in one direction. Without talking, the clapping and pointing would continue until both students pointed in the same direction, at which time, the first student to point to the other student saying "no need for alcohol" was the winner. Both students were then instructed to move quickly to another location (a minimum of 15 feet) and begin another round of the game. Instructions took 45 seconds while students were in a standing position and game play persisted for an additional 45 seconds. At the end of the 90-second attention activity, students were told to sit in their seats. In year three, the experimental group participated in a 90-second word search puzzle. Students were instructed to search for multiple occurrences of two words (alcohol and leisure) in a 15x15 letter grid. Two occurrences of each word were hidden within the puzzle. In year four, a different 90-second poem on alcohol was used in the experimental group. Similar to the first poem, the content addressed the antecedents, behaviors, and consequences of alcohol, and contained moderately graphic phrases to elevate arousal.

B. Participants.

Research participants consisted of students taking a one semester, upper-division course that fulfilled a university-wide general education (GE) requirement. Participants included students from 16 course sections (2 sections per semester over 4 consecutive years). Students taking the class represented a wide range of majors; however, the majority of students were pursuing a degree in Child and Adolescent Development or Recreation, Parks, and Tourism. The class roster showed that more than 90% of students were juniors or seniors at time of enrollment. Although no demographic information was collected, course enrollment of general education courses is an approximate representation of the university population (58% female; 30% White non-Latino, 26% Asian, 14% Chicano or Mexican American, 9% Latino, 9% Filipino, 6% African American; average age 22.7 years old – San Francisco State University, 2011). The eight semesters of data included responses from a total of 846 students. The duration of the course was 110 minutes and was divided into two, 55-minute sessions allowing 50 minutes for the arousal condition, 50 minutes for the no-arousal condition, and a 10-minute transition between conditions. The same instructor taught all 16 sections of the course. Class size averaged 53 students (range = 49-62).

C. Instruments.

Two instruments were used to collect data. One instrument (i.e., exam) measured the dependent variable, information retention. The purpose of the exam was to determine the retention of information immediately following a 30-minute lecture on alcohol and leisure. The exam consisted of 15 questions worth one point each. The questions ranged from true/false (4 questions) and multiple choice (4 questions) to matching (4 questions) and short-answer (3 questions). For example, one True/False question asked whether "*a 150-pound individual can detoxify two (2) ounces of alcohol in 30 minutes.*"

The second instrument measured instructor enthusiasm. Instructor enthusiasm has been shown to impact learning (Lammers & Smith, 2008) and may have acted as a moderating variable. The instructor presented the lecture in both the arousal and no-arousal conditions for all 16 sections of the course and attempted to convey a uniform presentation to both conditions through an identical PowerPoint outline and associated script. A semantic differential scale (i.e., a 7-point rating scale using bipolar adjectives at each end) was used to measure instructor enthusiasm (enthusiastic – unenthusiastic) for all students.

D. Procedure.

One-week before the day of the experiment, students in each class section were randomly assigned to one of two groups (arousal or no-arousal condition). Each group attended either the first half of class or the second half of class depending on whether they were assigned to the arousal or no-arousal condition. The arousal (experimental) group was exposed to a 90-second external stimulus (i.e., poem, game, puzzle) while the no-arousal (control) group listened to a 90-second roll call where the instructor pronounced the first and last name of each student in the class. After completion of the 90-second activity (external stimulus or roll call), both groups listened to the same 30-minute lecture on the antecedents, behaviors, consequences (ABCs) of drinking alcohol, and alternative leisure activities.

At the end of the lecture, students were given an exam that included the enthusiasm scale. The 10-minute, 15-point exam covering the 30-minute lecture and discussion on alcohol and leisure was given to students in both groups. Students did not place their name or any demographic identifiers on the exam, and the exam was not used for course grading purposes. At the bottom of the page, students were instructed to rate the instructor's enthusiasm using a 7-point semantic differential. After 10 minutes, students were asked to stop writing and submit their exam to the instructor. Students were excused after they submitted their exam and exited through the east door. The second group of randomly assigned students entered from the west for the second half of class and the procedure was repeated. This process was reversed for each section.

For example, the experimental group was exposed to the 90-second external stimulus during the first half of class in section one while the experimental group of section two attended the second half of class. This procedure was reversed for the no-arousal condition. The control group listened to the 90-second roll during the second half of class in section one, while the no-arousal group of section two attended the first half of class. Each year of the study, the same procedure was followed for the experimental and control groups, except for the type of external stimuli used in the arousal condition.

E. Data Analysis.

Data were analyzed using IBM SPSS 19. Descriptive and inferential statistics were calculated in order to describe the sample and determine if there was a significant difference between the arousal and no-arousal conditions, and whether a significant difference existed within the four arousal conditions (i.e., poem1, game, puzzle, poem2).

III. Results.

The dependent variable was information retention as measured by the performance score on a 15-point exam. There were 846 individual test scores with a minimum score of 9 and a maximum of 15. The mean score for all tests was 13.11 and was slightly negatively skewed (-.482). There were 49 to 62 students (μ=52.88) that completed the exam in each of the 16 sections.

A Pearson correlation matrix was created to see if any bivariate correlations were significant (Table 1. Correlation Matrix for N = 846). As hypothesized, the only significant correlation (p<.000) was between the experimental group (0=control or 1=experimental) and the score on the 15-point exam (r=0.176).

Table 1. ***Correlation Matrix for N = 846.***

		15-pt Exam	7-pt Scale	Arousal Condition	Stimuli Type/Year	Semester	Section
15-pt exam (Information Retention)	Pearson Correlation	1	.026	.176**	-.022	.004	-.013
	Sig. (2-tailed)		.450	.000	.532	.916	.699
7-pt Scale (Instructor Enthusiasm)	Pearson Correlation	.026	1	-.022	.008	.025	-.039
	Sig. (2-tailed)	.450		.517	.812	.461	.255
Arousal Condition (Experimental Group)	Pearson Correlation	.176**	-.022	1	.001	.005	.003
	Sig. (2-tailed)	.000	.517		.968	.888	.935
Stimuli Type/Year (Poem1, Puzzle, Game, Poem2)	Pearson Correlation	-.022	.008	.001	1	-.020	-.021
	Sig. (2-tailed)	.532	.812	.968		.566	.551
Semester	Pearson Correlation	.004	.025	.005	-.020	1	-.005
	Sig. (2-tailed)	.916	.461	.888	.566		.889
Section	Pearson Correlation	-.013	-.039	.003	-.021	-.005	1
	Sig. (2-tailed)	.699	.255	.935	.551	.889	

** Correlation is significant at the 0.01 level (2-tailed).

An analysis of the 7-point enthusiasm score using an independent *t*-test found that there was no statistically significant difference between groups (p>.05). This provides some evidence that the moderating effect of instructor enthusiasm did not differ between the experimental and control group. An independent t-test on the 15-point exam measuring recall found that the mean score for the experimental group (μ=13.36, n=434) was significantly greater than the control group (μ=12.85, n=412) at p<.000. A calculation of the effect size (Cohen's d = 0.35) found that the number was between a small (.2) and medium (.5) effect size (Valentine, & Cooper, 2003). An ANOVA was performed to test if there were differences between external stimulus types (i.e., poem1, puzzle, game, poem2). The mean difference among each external stimulus was not statistically significant (p>.05).

A multivariate regression was conducted to test the relationship between the group membership (experimental or control) and the exam score. The overall model and predictor was significant (p<.000). The R^2 was 0.031 (3.10% of variance explained) for the single predictor of group membership. None of the other variables were significant predictors (class, semester, year).

Data were collected during eight consecutive semesters, so a further analysis was done to see if time or the nesting structure had any impact on the data. A visual inspection of the mean scores across time showed no obvious changes between semesters or across years (Figure 1. Mean Scores across Time).

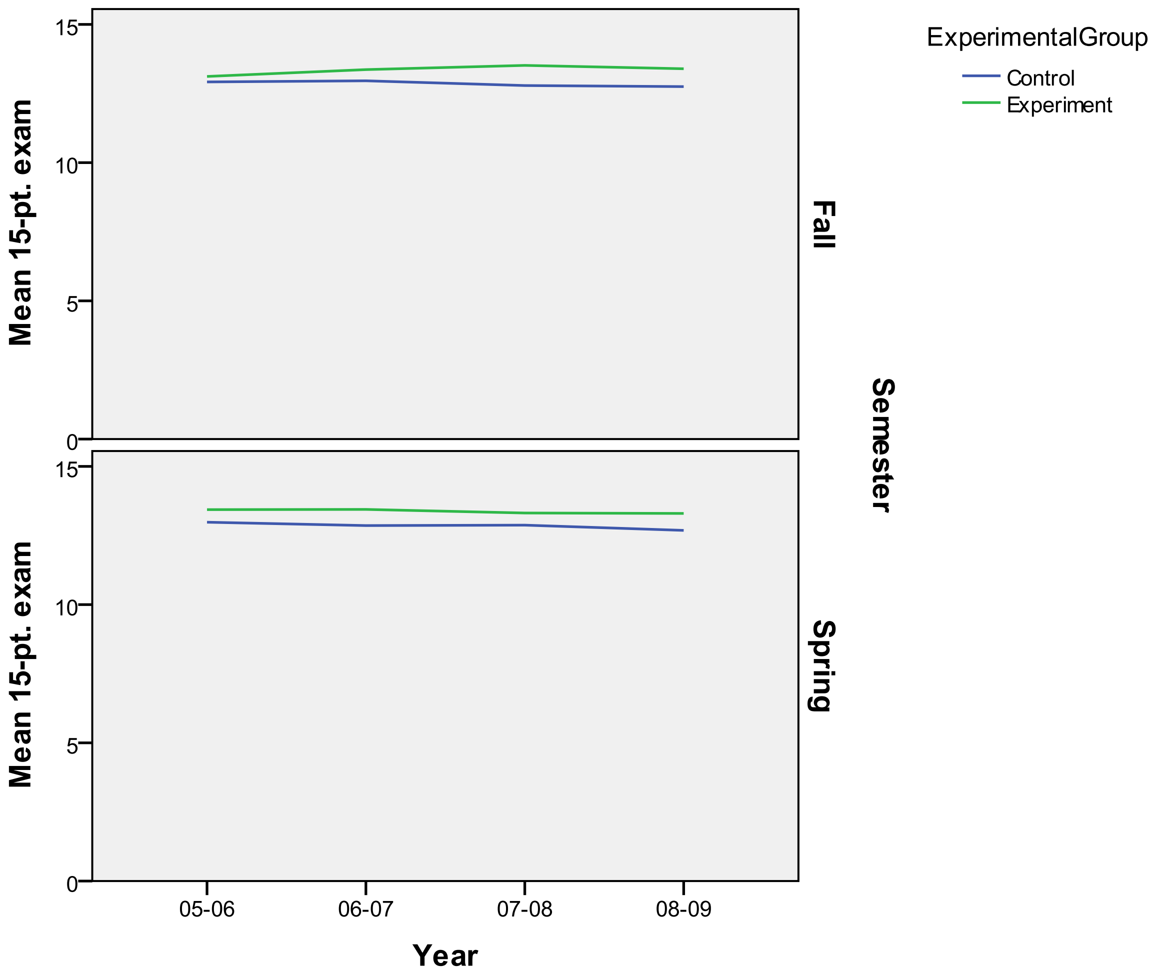

Figure 1. Mean Scores across Time**.**

A mixed effects model (i.e., hierarchical linear model or multi-level model) was conducted to further investigate whether there were any nesting effects. The model with only group membership as a fixed effect (independent variable) significantly increased the fit indices [both Akaike and Bayesian Information Criteria (AIC and BIC) decrease by 23.91] from the base-line model where only the intercept was allowed to vary (Burnham & Anderson, 2002). Entering additional terms to test if there was any nesting by class, semester, or year found that none of these significantly improved the fit of the model to the data. There were no nesting effects found in the data, but the difference between conditions (arousal versus no-arousal) continued to be evident.

An analysis of the exam scores found that there were no changes over time or differences between classes within the same group; however, there was a difference between the arousal and no-arousal conditions. There was also no difference between types of external stimuli (i.e., poem1, game, puzzle, poem2). The exam score for the experimental group was statistically significantly higher than the mean exam score for the control group. The arousal condition explained a small percentage (3.1%) of variance in the overall scores ($R^2 = 0.031$), and a small size.

IV. Discussion.

The results of this study found that students exposed to a topic-relevant, 90-second external stimulus (i.e., poem, game, puzzle) before a 30-minute lecture demonstrated significantly better information retention, as measured by response performance on an exam, than students exposed to a neutral stimulus. Although the results were statistically significant, the measure of strength as calculated by Cohen's *d* was between a small and medium effect size. If looking at the mean differences between groups, the arousal group had less than a 1-point advantage on a 15-point exam. Although statistically significant, the practical significance of a ½-point or 3.3% grade differential is the determination of whether the incremental change is worth the time and effort of introducing students to an attention grabber. In determining the efficacy of attention grabbers, limitations will be identified and the importance of future research will be discussed.

A. Limitations.

One limitation of this study involved the researcher and instructor as the same individual. Although effort was made to deliver an identical presentation using the same PowerPoint slides and associated script, there is a possibility that some aspect of the lesson differed between the experimental and control group. While a videotaped lecture to both groups may have controlled for experimenter bias, the results may not be as generalizable to a face-to-face classroom setting. In addition, instructor enthusiasm may have been a limitation, but student reports showed no significant difference between the experimental and control groups.

A second limitation involved the operationalization of the constructs, arousal and memory. Although theory and limited research (Berlyne 1966, 1970; Mather & Sutherland, 2011) support the 90-second, topic relevant, external stimulus used in the experimental group (i.e., poem, game, puzzle), a physiological measure of arousal would have provided additional support and added validity. The dependent variable may also suffer from a measurement issue. For example, response performance on an exam may not accurately measure whether the information was retained. Students may have retained information that was not asked on the exam. In this study, if a student was able to recall information from the lecture, information was retained in long-term memory (Lieberman, 2011).

A third limitation may have resulted from the 90-second roll call used as the control equivalent to the 90-second external stimulus. Research has shown that hearing one's name increases arousal and shifts attention (Wood & Cowan, 1995). However, calling out 49 to 62 names for 90 seconds may have induced a baseline drop in arousal and thus, an inappropriate control. The methodological limitations of potential experimenter bias, instructor enthusiasm, variable measurement, and a questionable control lend themselves to future study.

B. Future Research.

This study only begins to address the dearth of empirical studies examining the learning effects of external stimuli. For example, in terms of arousal itself, how much arousal is needed to capture a student's attention? Evidence suggests that too much (anxiety) or too little (boredom) arousal can have deleterious effects on attention and memory (Berlyne, 1960; Cowan, 1997; Easterbrook, 1959), but no research was found identifying an optimal level arousal or range of intensity that results in improved learning or memory in a classroom setting.

What is the optimal duration of an external stimulus? Although a 90-second external stimulus in this study produced significant improvement in retention of information from a lecture, would the perception of a startling noise or disturbing picture, which can take milliseconds, be long enough to focus attention and enhance information retention? Would a 5-minute external stimulus result in positive gains or would the duration lead to desensitization and feelings of boredom?

In terms of timing, our study found a positive impact on retention from a pre-learning external stimulus; however, there is also evidence that providing post-learning arousal enhances memory recall (Liu, Graham, & Zorawski, 2008; Nielson & Powless, 2007). Research should compare pre- and post-learning arousal effects on memory as well as examine whether a pre- and post-learning external stimulus would have an additive effect on memory.

In addition, retention was measured immediately after a 30-minute lecture in this study. Measuring retention after longer delays (e.g., 1-2 weeks, end of semester) should be examined to determine durability of an external stimulus. Advances in neuroscience, PET scans, fMRIs, and other physiological indices of both central nervous and autonomic arousal may provide additional details of brain region activity as well as strengthen our understanding of cognitive processes. Future research should use these measurements for arousal as well as attention and memory rather than indirect measurements (i.e., external stimulus and post-lecture exam).

Finally, individual differences are an additional area of study that may provide insight into developing appropriate external stimuli. For example, Eysenck (1982) theorized that extroverts required higher levels of arousal to focus attention while introverts required less arousal. Although this study found no statistical difference between external stimuli types, this area needs further research. Bloom's (1956) three domains of learning (i.e., cognitive, affective, psychomotor) may be useful to investigate the salient features of different external stimuli types. Future studies should develop taxonomy for different external stimuli based on their functional differences.

C. Conclusion.

This study provided empirical support that implementing a hook, trigger, attention getter/grabber, and/or anticipatory set enhances learning and memory through increasing arousal (decreasing boredom) and focusing attention. Although results were statistically significant, a ½-point increase on a 15-point exam does not equate to anecdotal evidence and claims espoused by voluminous teaching improvement materials. In addition, due to a dearth of empirical evidence examining external stimuli and information retention in a classroom setting, generalizability is limited and further research is needed to validate current findings.

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