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Investigating the Effect of Two Mood Induction Procedures on Arousal and False Memory

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The present study sought to compare the efficacy of two MIPs in inducing arousal to investigate arousal's role in memory accuracy. This study used a 2 (Mood Induction Procedure: MIP) × 3 (Arousal State) between-subjects design to test how MIPs and arousal states interact to affect memory accuracy and false memory rates. One hundred and five college-age participants were assigned to one of three arousal conditions (low: sad, control: neutral, or high: fear). Half of the participants were induced via movie clips and half via guided imagery + music. Following mood induction, participants were instructed to memorize six wordlists and were tested with recall and recognition tasks. Arousal did not significantly change in any condition. There was no measurable effect of arousal state on memory. Results suggest MIP materials used in previous studies may be outdated and not effective.

Keywords: mood induction procedures (MIPs), arousal state, guided imagery + music, DRM paradigm, false memory

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Many years of investigation of memory and cognition have found that human memory is easily manipulated and prone to error. This error can have small day-to-day repercussions like misremembering a name, address, or even lead to larger problems like forgetting exam material or missing work deadlines. Mood has been a noted factor that influences memory (Roediger & McDermott, 2000). Mood is largely viewed as one's general affective state as opposed to emotion which is viewed as a more short-term, intense feelings in response to a clear cause (Forgas, 1995). The influence of mood can either enhance or diminish the formation of false memories, while also impacting true memories of events or information. Thus, understanding the relationship between mood and memory assists in learning how to influence it. For that purpose, mood induction procedures (MIPs) have been created and used to enable mood to be more closely studied in relation to memory. Mood induction procedures are techniques designed to elicit certain transient moods, like anxiety, anger, happiness, or sadness, in a controlled and measurable way (Devilly & O'Donohue, 2021). MIPs are used to measure and study various psychological mechanisms dependent on or influenced by mood.

In addition, the highly explored Deese–Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995) has been utilized in memory studies to investigate the underlying mechanisms that make humans prone to memory mishaps. The DRM paradigm is a false memory paradigm which identifies and elicits errors by using wordlists similar in meaning, topic, or sound. Semantic words are those linked by meaning (bed, pillow, rest) while phonologically similar words are linked by sound (phone, bone, dome). Participants are given these wordlists to study, each one linked to a critical lure which is a word conceptually or phonologically similar to the others but not on the list. For the above semantic word examples, the critical lure is sleep. Researchers can then measure false memory by tracking every time the participant falsely recalls or recognizes a critical lure. They can also measure how accurate the participant's memory is by looking at the hit rate (i.e., how many times they accurately recognized or recalled a previously studied word). These wordlists have made it easier to isolate certain techniques that can reduce or worsen false memory and memory inaccuracies. Oftentimes, researchers make use of MIPs along with the DRM paradigm to analyze mood's effect on memory. Research in this area is important because it may help discern what situations make people most vulnerable to instances of inaccurate memory based on their given mood.

Arousal-Memory Relationship

Focusing on arousal's relationship to memory, there is a pattern that previous studies have found. As described in Hanoch and Vitouch (2004), there has been an inverted U-relationship between emotional arousal and cognitive performance such that too little or too much emotional arousal inhibits performance on cognitive tasks such as memorization tasks. The inverted U-relationship is called the cue-utilization theory (Easterbrook, 1959). Experiments that give participants a task unrelated to their arousal state are measuring arousal-incongruent performance. This study aimed to investigate whether arousal has any effect on the memory of the neutral wordlists which are unrelated to the mood induction procedure responsible for inducing arousal (arousal-incongruent performance).

Moreover, the cue utilization theory established by Easterbrook (1959) provided this study with a theoretical framework from which many other previous studies have shown support in the form of arousal's effect on memory (whether it helps or hurts). Creating a specific amount of arousal without having a standardized value for "high" versus "low" makes it difficult to confidently predict how arousal will affect performance. This is because each study varies in MIPs and performance tasks and very few studies have analyzed the threshold for when arousal becomes useful versus hurtful; therefore, it was important to be able to understand which MIPs are most effective. Finding the threshold for when arousal becomes detrimental is vital for gaining a better understanding of what memories an individual can trust. In a broader context, gaining an understanding of the impact of arousal levels on memories can enhance decision-making. By assessing the intensity of their arousal levels, individuals can make judgments about how their memory might be influenced. For example, knowing that you witnessed something and were in a highly aroused state (i.e., extremely fearful or excited) can allow you to recognize and accept your memory of that event is likely more inaccurate than expected.

Valence versus Arousal

There are two schools of thought when considering what aspect of mood drives memory errors: arousal and valence. Arousal refers to the level of excitement or calmness in the emotional response to a stimulus, while valence indicates the positivity or negativity of the associated feeling (Sakaki et al., 2012). If valence were to affect memory, then there would be a distinct difference in recall and recognition accuracy depending on the valence of the mood condition (negative, neutral, or positive). However, a mood can have the same valence, like negative, but can have different arousal states (i.e. anger = high arousal, sadness = low arousal). Thus, if arousal is driving false recognition/recall, then there would be a difference in false memory rates when arousal is manipulated regardless of the valence of the mood.

To investigate the role of arousal and valence on false memory, Corson and Verrier (2007) assigned 222 French undergraduates to 1 of 5 groups which were control, sad (low arousal), angry (high arousal), serene (low arousal), happy (high arousal). Prior to being given the word lists, participants' mood was induced using guided imagery + music. The musical pieces were selected from Mayer et al. (1995) as were the vignettes and technique in general. The Brief Mood Introspection Scale (BMIS) was used to measure the participant's mood before and after mood induction. Each group was presented with 10 DRM words lists with 15 words strongly associated with the critical lure word. Participants were given 1 minute to recall words presented after every list. A 60-item recognition test was given consisting of 30 words from the word lists, 10 critical lures, and 20 unstudied words. This study found a significant effect of arousal on false recall and false recognition such that when participants were in a high arousal mood (regardless of valence), they falsely recalled more critical lure words than low arousal moods. There was no difference between high and low valence and false recall or false recognition. This implies that valence is not the driving force that affects mood.

More recently, Van Damme (2013) created a study to measure both using neutral DRM wordlists. Three hundred and one Belgian undergraduate students were placed in one of six conditions: happy (high arousal), serene (low arousal), angry (high arousal), sad (low arousal), neutral (control one), or no mood induction (control two). Mood induction was created using guided imagery + music. Participants listened to the music for one minute before being given a vignette to read that described the mood they were being inducted into. Each condition had eight vignettes read for 30 seconds each. To assess mood, participants were given the BMIS before and after mood induction. Next, the participants listened to a series of ten neutral DRM wordlists read out loud in a female voice with five math questions to take in between each list. They were then given either a new/old recognition test (Experiment 1) or a free recall test (Experiment 2).

Upon analysis, BMIS results indicated mood induction was effective in both experiments such that those in high arousal conditions (angry and happy) reported significantly higher levels of arousal than those in the low arousal conditions (sad and serene). Analyses also showed those in the low arousal conditions displayed significantly more false recognition than those in the high arousal conditions, regardless of valence. There was also no significant main effect of valence on false recognition rates. Additionally, without the use of critical lures, the free recall group showed no effect of arousal or valence on false recall rates. This implies that, without cues, false memory rates decrease regardless of arousal level. Thus, it was expected that false recall rates would likely be lower than false recognition rates in the present study.

Corson and Verrier (2007) and Van Damme (2013) both used guided imagery + music and found a significant effect of arousal on false recognition such that false recognition rates change depending on how high or low the arousal is. However, there is a discrepancy between Corson and Verrier (2007) and Van Damme (2013) on the direction of that relationship. Corson and Verrier's study demonstrated that high arousal creates higher false memory rates. Contrastingly, Van Damme's data demonstrated that low arousal created higher false memory rates.

Van Damme's (2013) study was intended to replicate results from Corson and Verrier (2007) and expand on them using more modern analyses, yet the result was a large discrepancy in findings. The discrepancy may have been due to the size and cultural differences of the samples. However, there were also key differences in methodology. Van Damme's study included a second control condition with no mood induction and manipulated the timing (immediate vs delayed) of the memory test. Additionally, Van Damme altered the design of the recognition test by counterbalancing the studied and unstudied words whereas Corson and Verrier used only one version of the test with all words (studied and unstudied) having been randomized. Given the differences in design and methodology between the two studies, it is difficult to determine which results are a more accurate representation of how arousal impacts memory. Based on the opposing findings of these studies, the current study sought to add to the literature in assessing the direction of the relationship between arousal and false recall and recognition.

Mood Induction Procedures

When using MIPs, there are multiple kinds that can be used to induce the same mood, but one may be more effective at inducing that mood than the others. As the primary component of the current study, it was necessary to find a valid and reliable method of inducing mood based on previous research.

Mayer et al. (1995) examined the efficacy of guided imagery vignettes + music to induce four moods: anger, sadness, happiness, and fear. Guided imagery vignettes provide participants with an easy-to-visualize description of a situation designed to evoke a specific mood and was enhanced with music that matched the mood. The first experiment of this study was designed to find the most effective vignettes and musical pieces to use. The second experiment was a within-subjects design that consisted of 36 undergraduate psychology students. The participants recorded their moods before and after each mood induction. To induce mood, participants were given headphones to listen to the selected music for one minute before they were directed to read and imagine the guided imagery vignettes. Results indicated that the happy mood induction did raise happiness. Additionally, the negative mood inductions of fear, anger, and sadness did raise negative mood from the baseline and lower positive mood from the baseline.

This study demonstrated that guided imagery + music performed well as an MIP. In addition, Mayer et al.'s (1995) first experiment allowed for the development of effective vignettes and music choices used in many other studies. Following Mayer et al's (1995) study, a meta-analysis conducted by Westermann et al. (1996) further contributed to literature comparing MIPs. This study sought to examine multiple kinds of MIPs including Film/Story (i.e. giving the participant a stimulus in the form of a scene or story with or without explicit instruction), Facial Expression (i.e. directing a participant to mimic the facial expression of someone feeling a positive or negative emotion).

The meta-analysis examined the mean weighted effect of previous studies utilizing the MIPs. Two hundred and fifty studies in total were examined. For the induction of positive moods, results indicated that film/story MIPs *with* instruction had the largest effect size, and film/story MIPs *without* instruction had the second-largest effect size. All other MIPs, except for facial expressions- which had the lowest effect size- had roughly the same low effect size. For negative moods, all MIPs had similarly large effect sizes as film/story MIPs *without* instructions with the exception of facial expression which had a low effect size close to zero. Yet still, film/story MIPs *with* instruction had significantly larger effect sizes than all other MIPs across all of the studies analyzed. In general, the positive mood inductions had lower effect sizes than the negative mood inductions thus indicating that MIPs are more effective at inducing negative moods. These data are consistent with more recent literature's findings such as Devilly and O'Donohuea (2021) and lend more support for the effectiveness of video clips and stories over other mood inductions, especially when inducing negative moods.

A study by Jallais and Gilet (2010) compared two mood induction procedures to investigate arousal versus valence in varying mood conditions. Each participant was placed in a mood condition (happy, sad, angry, and serene) and a procedure condition (guided imagery + music and autobiographical recall). There were 160 undergraduate participants (91% female) from the University of Nantes, and eight conditions total as this was completely between subjects. Before and after inducing mood, the researchers gave each participant a questionnaire to measure valence (BMIS) and arousal (a matrix first put forth by Eich & Metcalfe, 1989).

The key finding of this study was that happy and angry moods shared the same arousal state just as serene and sad moods shared the same arousal states. This negated the need to include both positive and negative mood conditions in the present study as only one mood that evokes low and high arousal respectively was necessary.

Furthermore, Jallais and Gilet (2010) study suggested that autobiographical recall is more effective than guided imagery + music perhaps due to the more personal and impactful nature of reimagining one's own memories. On the other hand, Devilly and O'Donohuea (2021) suggested that autobiographical recall is less effective at inducing mood than video clips. Together, these studies show how AR compares to guided imagery + music and video clips respectfully, but this does not provide a full picture. Thus, the present study aimed to bridge the gap between these two studies by directly comparing the efficacy of guided imagery + music to video clips.

To this point, direct comparisons of two or more MIPs are a commonly used way to study which MIPs are more effective. In fact, Zhang et al. (2014) directly compared autobiographical recall with music, guided imagery, viewing images with music, and embodying affective behaviors. While all MIPs were found to be effective, results indicated that viewing images with music and autobiographical recall with music induced a positive or pleasant mood significantly better than the other mood induction conditions. Viewing images with music was most effective at inducing a negative/unpleasant mood.

Zhang et al.'s (2014) study was consistent with other studies in showing the efficacy of such MIPs. This study suggested that video images may exhibit a stronger effect on negative mood induction than other procedures. While video clips were not used in this study, images were. Seeing as the images were an external visual stimulus and were accompanied by music which is an external auditory stimulus, these findings supported the use of mood induction that video clips provide.

The use of materials such as video clips for the purposes of inducing mood is a common and reliable process (Devilly & O'Donohuea, 2021; Westermann et al., 1996). A study by Hewig et al. (2005) created a revised set of films capable of inducing certain moods of amusement, sadness, anger, disgust, and fear. They compiled clips from films used in other studies such as *Halloween* for fear, *When Harry Met Sally* for amusement, and *The Champ* for sadness. In total, 38 participants total (21 females, 17 males) viewed all film clips (20 in total) in a randomized order. After each film, participants self-reported their emotional reaction to each movie clip. *The Champ* displayed high rates of sadness. Moreover, when viewing *The Champ* sadness was reported at a significantly higher rate than rage meaning that clip more strongly conveyed a lower arousal emotion rather than a high arousal emotion. Additionally, the clip for *Halloween* received a high rating of fear with disgust being the next highest rated emotion. However, there were significantly lower ratings of disgust than fear for that movie clip. This suggested that *Halloween* properly evoked high arousal emotions significantly more than low arousal emotions.

Hewig et al.'s (2005) study not only supports the effectiveness of movie clips at evoking specific emotions, but it also clarifies which emotions interact together in certain video clips. By analyzing a spectrum of emotions experienced by the participants when watching each clip individually, the researchers were able to better determine which clips best isolate singular emotions like fear and sadness in such a way that they do not interfere or cancel each other out in terms of the participant's arousal. Therefore, the current study sought to use these video clips.

Current Study

Overall, previous research has found a significant effect of arousal on rates of false memory, but with a lack of clarity on whether high arousal strengthens or hurts memory. Furthermore, studying the effect of mood induction, or more specifically, arousal induction, on memory is important research that may give insight into what times or situations memory may be vulnerable to influence by one's mood. It has been previously shown that video MIPs are quite effective at inducing moods compared to many other MIPs (Devilly & O'Donohuea, 2021; Westermann et al., 1996; Hewig et al., 2005). Also, guided imagery + music seems to be a commonly used MIP despite Jallais and Gilet's study (2010) finding it to be weaker than autobiographical recall. But as of now, the comparison of guided imagery + music and video MIPs combined with measuring false recognition has yet to be discussed in the literature. The present study aimed to understand the difference in these MIP formats while also looking at how they interact with arousal to create or reduce false memory. If a certain arousal state was found to create more memory error, knowing which method of mood induction creates more intense moods may help determine which situations lead people to becoming more vulnerable to memory errors (ex. an auditory experience versus a visual experience).

The purpose of this research was to further add to the literature concerning the relationship between MIPs and memory by directly comparing guided imagery + music to video clips in conjunction with measuring arousal's effect on false recognition. Both guided imagery + music and video clips use audio and visual components but with different formats. As previously stated, there may be a difference in the effectiveness of these two MIPs because guided imagery is more internally driven compared to video clips. Another aim of this study was to clarify the inconsistency in the literature regarding arousal's effect on false recognition when using neutral wordlists. For the purposes of this study, the independent variables were arousal state (high, low, and control), and type of MIP (guided imagery + music and video clips). The dependent variables were rates of false recognition, false recall, recognition accuracy, and recall accuracy. Strength of mood induction was also measured as a dependent variable.

Given previous research by Van Damme (2013), it was predicted that a high arousal state would yield lower rates of false recognition and recall than low arousal and control arousal states. Additionally, participants in a low arousal state were predicted to yield lower false recognition and recall rates than those in a control arousal state. This prediction is counter to the results from Corson and Verrier's (2007) study, but Van Damme's study had a larger sample size and served largely as a replication of Corson and Verrier, thus it was favored as a basis for the hypothesis. Moreover, based on the data from Hewig et al. (2005), Westermann et al. (1996), and Devilly and O'Donohuea (2021) it was predicted that video clips would yield significantly stronger induction into the assigned mood than guided imagery + music. There was no prediction as to how MIP would affect memory or how arousal state and MIP would interact to affect memory as these were exploratory variables.

Method

Participants

A total of 105 participants were recruited by the primary investigator via convenience sampling with each participant being randomly assigned to one of the six conditions using Psytoolkit (Stoet, 2010, 2017) computer software. Most participants were recruited from a small liberal arts college in the southeast United States. Of the participants, 77 identified as women, 22 identified as men, and 6 identified as other. In terms of ethnicity, 38 participants identified as White or Caucasian, 27 Black or African American, 10 Asian or Pacific Islander, 23 Hispanic or Latino, 6 Biracial or Multiracial, and 1 identified as other. Participant ages ranged from 18–34 years old ($M = 20.36$, $SD = 2.60$). During the recruiting process, participants enrolled in a psychology course or certain sociology courses received one extra credit point for their participation. No other compensation was provided. There were no direct benefits and no risks. The study was in-person and took approximately 30 minutes.

Design

The following experiment was a 2(MIP) × 3(Arousal State) between-subjects design. The MIP factor had two levels: guided imagery + music and video clip. The arousal state had three levels: high arousal (fear), low arousal (sad), and control (neutral). There were five dependent variables: recall accuracy, recognition accuracy, false recall, false recognition, and mood induction strength. Recall accuracy was scored as a sum of correctly recalled words. Participants could correctly recall up to 90 words. Recognition accuracy was analyzed as a proportion of correctly identified words out of the total amount of studied/old words given on the test (18). False recall was scored as a sum of how many critical lures participants write down (up to six out of all recall tests). False recognition was calculated as a proportion of how many critical lures were falsely recognized out of the six total critical lures presented. The last dependent variable was mood induction strength which was analyzed via a comparison of BMIS and AGRID scores pre-arousal induction and post-arousal induction.

Materials

Every condition consisted of six wordlists with 15-items each. There were six recall tests for each wordlist. A recognition test was also given to measure memory accuracy and false recognition rates. It had 48-items total (18 hit words, 18 miss words, six critical lure words, and six control lures). The study also included the Brief Mood Introspection Scale (Mayer & Gaschke, 1988) and Affect Grid (Russell, Weiss, & Mendelsohn, 1989) to measure each participant's arousal. In addition, a distractor task, consent form, and a demographics page were included.

Wordlists

All wordlists used were adapted from Watson et al.'s 2003 study. There were six 15-item wordlists as well as six open answer recall tests. There was also a recognition test which consisted of 18 words that were included in the studied wordlists and selected using an online random selection generator (three from each wordlist). These were called hit words because the correct recognition of one is a hit. There were also 18 words which came from wordlists not shown to/studied by participants. These words were called miss words as they should not have been recognized. The recognition test also included all six of the critical lures (one from each wordlist) and six control lures. Control lures were critical lures from wordlists that were not shown to participants. All words were randomly ordered using an online list randomizer.

The Brief Mood Introspection Scale (BMIS)

The Brief Mood Introspection Scale (BMIS) is a 4-point Likert scale made by Mayer and Gaschke (1988). It was used to measure the participants' arousal-calm mood before and after mood induction as well as at the end of the study. The scale is made of 16 items total, however only 12 items are used for the arousal-calm scoring. Each item consists of a mood-based adjective that participants reported feeling or not feeling. Items that represent low arousal/calm moods (i.e "Calm" and "Tired") were reversed scored. Using mean scoring, the highest score achievable is a 4 (indicated maximum arousal) and the lowest is a 1 (indicating maximum calm).

An analysis of inter-item reliability for the pre-BMIS displayed an acceptable Cronbach's alpha ($\alpha = .69$). The pre-BMIS scores were subsequently transformed to a mean composite score ($M = 2.05$, $SD = 0.44$). Inter-item reliability of post$_1$-BMIS yielded a Cronbach's alpha of .58. A subsequent mean composite score was created (M = 2.04, SD = 0.44). Inter-item reliability of $post_2$-BMIS yielded a Cronbach's alpha of .65. A subsequent mean composite score was created (M = 1.92, SD = 0.41). All three BMIS measures (pre, $post_1$, and $post_2$) were transformed into mean composite scores with items "calm" and "tired" reversed scored. Scores ranged from 1–4 such that values higher scores indicated higher arousal.

Affect Grid

As a secondary measure of each participant's arousal, the Affect Grid (AGRID), created by Russell, Weiss, and Mendelsohn (1989), was used. The self-report questionnaire consists of a 9x9 grid with a horizontal dimension that measures participant's current mood in terms of valence (negative to positive) and a vertical dimension that measures a participant's arousal (low to high). Arousal state was recorded as a single score from 1 (very low arousal) to 9 (very high arousal).

Vignettes

For the guided imagery + music condition, four vignettes for the fear mood condition and four vignettes for the sad mood condition were taken from Mayer et al. (1995). The music for the sad condition was Chopin's piece from 1839: Opus 28/#6 from *Preludes.* The music for the fear condition was *Psycho* by Herrmann written in 1960. For the control condition, participants were given four neutral-self vignettes adapted from Marcusson-Clavertz et al. (2019). To be consistent with the other conditions, vignettes were changed from first to second person. These vignettes consisted of neutral statements focused on self-reflection. Participants were given one minute to read each statement while music played simultaneously.

Video Clips

For the video clip MIP condition, the fear condition featured clips from the movies *Halloween* (1978) (as used in Hewig et al., 2005) and *Lights out* (2016). The *Halloween* clip features a scene wherein a terrified women is being chased through her house by a serial killer in a mask. She finds several bodies from his previous victims before he emerges from shadows and slashes at the women causing her to fall down a set of stairs. The *Lights Out* clip features a man in a warehouse noticing a shadowy figure in the dark which gets closer to him when he turns off the lights. Fearfully, he runs toward a lit room and grabs a bat to defend himself. The lights flicker off and his bloody body falls to the ground. For the sadness condition, clips from *The Champ* (1979) (as used in Hewig et al., 2005) and *Marley and Me* (2008) were shown. The Champ clip features a little boy crying over the dead body of a boxer following a boxing match. Adults stand around him as he begs from the man to wake up. The *Marley and Me* clip features a dog and his sorrowful owner at the vet where the dog is being put down. Simultaneously, a montage of the dog's time with the family goes by. The dog slowly closes his eyes as the man silently cries. For the control condition, participants watched an informational YouTube video titled "The Three Kingdoms Period explained in 4 minutes". These clips were started and stopped at specific times to last as close to four minutes as possible (see *Appendix A*).

Procedure

Participants received notice of the study via word of mouth, email, and university community forums. Potential participants were asked if they would like to participate in this study. If they agreed, they were given a designated date and time to take the study. The study was designed to take around 30 minutes.

Upon arrival, participants were given a consent form. Once they consented to the study, they took the pre-BMIS and pre-AGRID. Afterwards, they were either induced into a sad, angry, or neutral mood through either guided imagery + music or through video clips. This was based on their randomly assigned condition. If in a guided imagery condition, they were given one minute to read each vignette and imagine the scenario as vividly as possible while music played in the background for the entire four minutes. For example, participants in the sad condition listened to Opus 28/#6 from Preludes while reading the first vignette. Every minute, the vignette would change, and the music would continue playing. Once all 4 vignettes were shown, the music was stopped. They were given a piece of paper and pencil to write any thoughts or feelings they had toward each scenario. Vignette prompts were viewed on a TV screen approximately four feet from the participant. After one minute, the investigator would change the screen to feature the next prompt. Because there were four vignettes, the guided imagery took four minutes total. Participants were simultaneously listening to music based on the arousal condition throughout the four minutes. The music came from the built-in TV speakers. Once mood induction was completed, they were asked if they were familiar with the music and asked to report how vivid their imagination was. This acted as an attention check and helped to disguise the true research question. Responses, as well as observations of the participant during mood induction, were assessed by the experimenter based on how appropriate they were, and any potentially inattentive responses were noted. For the video clip conditions, participants watched the video clips based on their assigned arousal condition for approximately four minutes. They were then asked if any of the clips were familiar to them and how impactful it felt. This, again, acted as an attention check and cover of the study's true purpose. After mood induction, all participants took the post-BMIS and post-AGRID. The pre and post BMIS along with the MIPs were administered on Psytoolkit to consolidate materials and standardize the procedure but instructions were delivered verbally by the PI.

Following this, participants were told that they were going to be shown multiple wordlists and they should pay attention to each word as closely as possible because they will be asked to recall the words. The wordlists were administered one word at a time with three seconds to study each word and half of a second in between. After this, a recall test was given in which the participants had one

Table 1. Descriptive Statistics for False Memory and Memory Accuracy

Score Type	*M*	*SD*	*n*	Minimum	Maximum
Recognition Accuracy	0.78	0.14	102	0.27	0.98
False Recognition	0.24	0.18	102	0.00	0.90
Recall Accuracy	0.54	0.09	104	0.32	0.78
False Recall	0.31	0.26	104	0.00	0.83

Table 2. Results of Two Mixed-Subjects ANOVAs Assessing Mood Induction Strength

	F ratio	Degrees of freedom	*p* - value	pη²
BMIS				
Arousal State	0.41	2	.66	.01
BMIS	11.03	2	**<.001**	.10
MIP	1.27	1	.26	.01
Arousal State × BMIS	2.85	4	**.025**	.05
Arousal State × MIP	0.08	2	.92	.00
MIP × BMIS	0.00	2	.99	.00
MIP × BMIS × Arousal State	0.52	4	.72	.01
AGRID				
Arousal State	1.70	2	.19	.03
AGRID	0.13	1	.72	.00
MIP	1.20	1	.28	.01
Arousal State × AGRID	5.31	2	**.006**	.10
Arousal State × MIP	0.31	2	.73	.01
MIP × AGRID	0.11	1	.74	.00
MIP × AGRID × Arousal State	0.96	2	.39	.02

Note. n = 105. ANOVA = analysis of variance; MIP = mood induction procedure; BMIS = brief mood introspection scale; AGRID = affect grid.

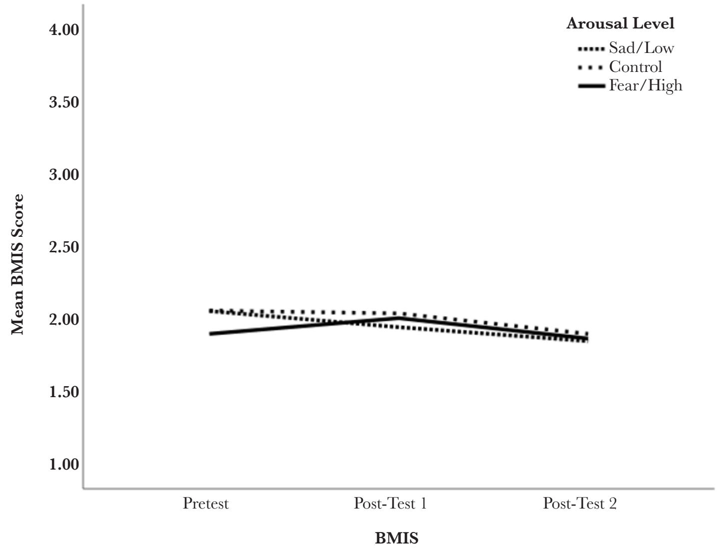

Figure 1. Mean Score on BMIS by Time of Scoring

Note. *n* = 105. BMIS = Brief Mood Introspection Scale.

minute to recall as many of the 15-items as possible. The wordlist and recall test procedure were repeated six times. Afterwards, all participants were given five minutes to complete a distractor task in the form of a third-grade math worksheet from www.k5learning.com. After the distractor task, all participants were given the 48-item recognition test in which they were instructed to select if each word was "old" or "new" (see *Appendix B*). Participants were not timed during this test. Lastly, participants were given another post-BMIS in order to measure the degree of arousal effect loss that may have occurred over time. The wordlists, recall tests, distractor task, recognition test, and third BMIS were all administered on Psytoolkit to increase standardization.

Finally, the participants filled out a demographics form on Psytoolkit and were given the option to watch a short compilation of funny animal clips on YouTube as a way to diffuse any lingering negative mood. Confidentiality was maintained via the encryption of the participant's data which was only accessible by the primary investigator and protected via a private account login. Participants' names or personal identifiers were not at all recorded or linked to their data.

Results

Preliminary Analysis

Data were first scanned for anomalies such as outliers. The false recognition and recognition accuracy scores for two participants were excluded from the dataset because they selected the same response for all 48 items, skewing the mean scores. However, the false recall and recall accuracy data from the two participants were not skewed and were included. No other data points appeared skewed or missing.

Mood Manipulation Check

Mood induction strength was measured using the Brief Mood Introspection Scale (BMIS) and the Affect Grid (AGRID). The BMIS was administered three times: before mood induction, immediately after mood induction, and at the end of the study (around 20 minutes post mood induction). The AGRID was administered two times: before mood induction, and immediately after mood induction. No reliability analysis was performed for the AGRID as it was a single-item measure.

To assess the strength of mood induction over the course of the entire study using the BMIS, a 3(arousal state: high, control, low) × 3(BMIS: pre, post1, post2) × 2(MIP: guided imagery + music, video clips) mixed-subjects ANOVA was conducted (see Table 2). Results indicated a significant main effect of BMIS such that participants reported significantly higher arousal on the pre-BMIS (M = 2.05, SD = 0.44) and post$_1$-BMIS (M = 2.04, SD = 0.44) as compared to the post$_2$-BMIS (M = 1.92, SD = 0.41). However, there was not a significant change in arousal between pre-BMIS and post$_1$-BMIS. There was also a significant interaction between BMIS and arousal state such that those in the sad condition reported significantly lower arousal on the post$_2$-BMIS (M = 1.87, SD = 0.43) than the pre-BMIS (M = 2.09, SD = 0.47) (see Figure 1). However, there was not a significant difference in arousal between the pre-BMIS and post$_1$-BMIS (M = 1.95, SD = .39). In the control condition, there was no difference in arousal between the pre-BMIS (M = 2.09, SD = 0.44), post$_1$-BMIS (M = 2.08, SD = 0.45), or post$_2$-BMIS (M = 1.98, SD = 0.46). Lastly, those in the fear condition reported significantly lower arousal on post$_2$-BMIS (M = 1.89, SD = 0.32) than on the post$_1$-BMIS (M = 2.09, SD = 0.48). However, there was not a significant difference in arousal between the pre-BMIS and post$_1$-BMIS or

Table 3. Pearson Correlations between Dependent Variables

	1.	2.	3.	4.
1. False Recognition	--			
2. False Recall	.13	--		
3. Recognition Accuracy	**−.93****	−.08	--	
4. Recall Accuracy	−.32**	−.21*	.38**	--

Note. n = 105.
**p < .05. **p < .01*

Table 4. Results of MANOVA and ANOVAs Assessing Arousal State and Mood Induction Procedure on Memory Accuracy and False Memory

	F ratio	df	*p* - value	pη²
Recognition Accuracy				
Arousal State	1.45	2	.24	.03
MIP	1.09	1	.30	.01
Arousal State x MIP	0.15	2	.87	.00
Recall Accuracy				
Arousal State	1.16	2	.32	.02
Mood Induction Procedure	0.00	1	.99	.00
Arousal State x MIP	0.45	2	.65	.01
False Recall				
Arousal State	0.32	2	.73	.01
Mood Induction Procedure	0.15	1	.70	.00
Arousal State x MIP	0.29	2	.74	.01
False Recognition				
Arousal State	1.86	2	.16	.04
Mood Induction Procedure	0.73	1	.39	.01
Arousal State x MIP	0.27	2	.76	.01

Note. n = 105. MANOVA = multivariate analysis of variance; ANOVA = analysis of variance; MIP = mood induction procedure

between the pre-BMIS and $post_2$-BMIS. There were no other significant main effects of this ANOVA. There were also no other significant interactions.

To assess the strength of mood induction before and immediately after mood induction using the AGRID, a 3(arousal state) × 2(AGRID: pre, post) × 2(MIP) mixed-subjects ANOVA was conducted (see Table 2). There was a significant interaction between AGRID and arousal state such that on the post-AGRID, participants in the fear condition ($M = 5.53$, $SD = 2.19$) reported significantly higher arousal than participants in the sad condition ($M = 4.08$, $SD = 1.84$). However, there was not a significant difference in participant scores between the control condition ($M = 5.09$, $SD = 1.99$) and fear condition, and no significant difference between the control condition and sad condition. When taking the pre-AGRID, there were no differences in scores between the control condition ($M = 5.20$, $SD = 2.08$), the sad condition ($M = 4.86$, $SD = 1.94$), or the fear condition ($M = 4.35$, $SD = 2.01$). There were no significant main effects. Lastly, there were no other significant interactions.

False Recognition and Recognition Accuracy

To assess how arousal state and mood induction procedure (MIP) affected false recognition and recognition accuracy, a 3 (arousal state) × 2 (MIP) completely between-subjects MANOVA was conducted. A preliminary Pearson correlation analysis indicated a significant negative correlation between false recognition and recognition accuracy, $r(100) = -.93$, $p < .001$, such that the higher a participant's recognition accuracy score, the lower their false recognition score. To justify a MANOVA, a Pearson's correlation between the dependent variables needed to be .6 or higher. There was not a strong enough correlation between false recall and recall accuracy to justify performing a second MANOVA (see Table 3). The results of the MANOVA showed no significant interactions or main effects (see Table 4).

Recall

To assess how arousal state and mood induction procedure affected false recall, a 3 (arousal state) × 2 (MIP) completely between-subjects ANOVA was conducted (see Table 4). Results indicated no main effects and no interaction. To assess how arousal state and mood induction procedure affect recall accuracy an additional 3 (arousal state) × 2 (MIP) completely between-subjects ANOVA was conducted. Results indicated no main effects and no interaction.

Discussion

The current study consisted of two main parts. First, it sought to compare the strength of two mood induction procedures (video clips and guided imagery + music) in inducing high, low, and neutral arousal. Secondly, it sought to examine the accuracy of true and false memories as a result of arousal induction.

Arousal Induction

The hypothesis that video clips would produce stronger mood induction as compared to guided imagery + music was not supported. There was no successful induction of arousal using the mood induction procedures tested in this study. This is contrary to findings from previous studies (Hewig et al., 2005; Westermann et al., 1996; Devilly & O'Donohuea, 2021). When strength of mood induction was analyzed via AGRID, there were no main effects of MIP, arousal state, or AGRID. The only significant interaction found that, after mood induction, participants in the fear condition reported higher arousal states than those in the sadness condition. This finding was not supported by the BMIS data. When strength of mood induction was measured using the BMIS, there was only one significant main effect which found that at the end of the study, participants had lower arousal states than at the beginning of the study. All other main effects of MIP, arousal state, and BMIS were not significant. Only one interaction was significant and it showed that participants in the sadness condition had significantly lower arousal at the end of the study than before mood induction. The culmination of these data did not provide strong enough evidence of a successful mood induction. As a result, there were no found main effects of arousal state or MIP on false memory or memory accuracy. There was also no interaction between arousal state and MIP on memory.

Previous literature has shown strong support for video clips and guided imagery as valid mood induction procedures (Hewig et al., 2005; Westermann et al., 1996; and Devilly & O'Donohuea, 2021, Mayer et al., 1995). However, the present study did not find success in either mood induction procedure. The largest likely contributor for the lack of findings was the insufficient sample size. Because the study was not adequately powered, it cannot be definitively stated that the lack of a detected effect is due to a failure of the MIPs. However, looking beyond that, there may be several other reasons for why there was a failure to induce high and low arousal states in participants.

Firstly, for the video clip condition in particular, this study blended previously used movie clips and more modern, movie clips (i.e. *Marley and Me* and *Lights Out*). Though these clips have not been previously tested for their efficacy as MIPs, they were included to modernize the materials. Hewig et al. (2005)'s video clips from *Halloween* and *The Champ* were included for their known effectiveness at inducing the respective moods of fear and sadness; however, during the data collection process of the current study, they did not resonate with the participants. Indeed, participants reported feeling more sadness and understanding when watching the *Marley and Me* clip as opposed to *The Champ*. This may be also due to the fact that the two sadness clips evoke different kinds of emotion (i.e., human death compared to animal death). The death of a family pet may resonate with most participants as losing a pet is a more commonly experienced phenomenon at a young age. Additionally, participants reported feeling more fear/emotional impact towards *Lights Out* rather than *Halloween*. This suggests that although the movie clips tested in Hewig et al. (2005) may have been effective 17 years ago, they no longer have the same emotional impact on younger adults now. This is, in part, due to the lower quality audio and visual effects creating a less impactful experience for the participants. All participants were young adults more acclimatized to high quality effects when viewing videos. Because of this, there may have been an age-related reason behind a lack of emotional impact. Some studies have found that, when watching movie clips with a negative effect, younger adults report a weaker emotional reaction than older adults (Fernández-Aguilar et al., 2020; Mather & Ready, 2021). This is because emotional processing and interpretation change with age. The reasons behind age differences in emotion are complicated and still being investigated, but for the purposes of this study, it emphasizes the importance of having a wider age-range in the sample. Although the older video clips may not have resonated as well as the newer ones, the current study cannot conclusively determine that any of the video clips used are ineffective as MIPs due to its underpowered nature.

Additionally, the guided imagery + music condition also did not work as an effective MIP despite being replicated from Mayer et al. (1995). Again, the limited sample size is the biggest factor in why these results occurred, however, there may be other contributing factors. Participants may not have been attentively imagining each scenario. Providing participants with the task of writing out their thoughts and feelings as they imagined each scenario was intended to inspire greater attentiveness. However, not everyone wrote with the same level of depth. Many participants wrote in short, clipped details which may have reflected the lack of immersion in their imagination.

Interestingly, the weakness of guided imagery + music as a mood induction procedure is not consistent with findings from Mayer et al. (1995), Corson and Verrier (2007), and Van Damme (2013). While Jallais and Gilet (2010) did demonstrate that guided imagery + music was not one of the strongest MIPs, it did show it could induce arousal changes. In addition to the low sample size, the current study's methodology may also have led to a lack of arousal induction. The lab set up consisted of the participant looking at a TV screen across from them. Both the screen and primary investigator were directly across from the participant allowing them to see both during arousal induction. The experimenter being in view during induction, as well as the bright lights and formal room setting, might have made participants feel monitored. Participants may have felt uncomfortable appearing emotionally vulnerable.

Moreover, this highlights a potentially problematic aspect to MIP usage in studies: they are not standardized. When presenting video clips, music, and vignettes, previous studies make no note of specific requirements for the way in which the materials should be presented. From background lighting to screen size to music volume and mode of listening (external speakers or headphones), it may be beneficial for future studies using MIPs to have a regulated system for administering the procedure. This would better ensure any mood changes are due to the MIP itself and not outside factors.

Arousal on Memory

Furthermore, due to the lack of arousal induction, the hypothesis that high arousal would reduce rates of false recognition and recall as compared to low arousal, and low arousal would reduce rates of false recognition and recall as compared to neutral arousal, was not supported. As a result, this study was not able to confirm or refute the findings of Corson and Verrier (2007) or Van Damme (2013).

The only significant change in arousal did not appear to be due to any of the MIPs, but rather the study itself. There was a significant decrease in arousal from the beginning of the study to the end. These results, though not expected, show that participants were in a lowered arousal state when taking the recognition test. As seen in Table 1, the average scores of recognition accuracy and false recognition suggest that lowered arousal did not impact recognition memory in a significantly positive or negative way. The lowered arousal may have, in part, been due to the length of the encoding phase. However, only six wordlists with 15 items each were given. Including the recall tasks, this phase took approximately 10–15 minutes total. This timing matches the standard timing based on previous studies using the DRM paradigm (Zhang et al., 2017; Van Damme, 2013; Corson & Verrier, 2007). Given that this number of items and wordlists was not any larger than wordlists previously used on memory and mood studies, it is unlikely that encoding time contributed largely to the lack of results in the current study.

Limitations

The primary limitation of this study was the sample size. To achieve a medium effect size for a 3x2 between subjects design, a sample size of 158 participants would have been necessary. Due to the sample not reaching this size, the founds effects are limited in terms of their implications.

Another limitation of this study was that it used change in arousal state to define high and low arousal. In other words, the difference between the arousal of the participant before and after mood induction was what defined high or low arousal. If the participant's arousal increased significantly, they were considered to be in a high arousal state moving forward. The limitation with this strategy is that it made it difficult to determine the true extent of the participant's arousal state. For example, if a participant responded to the pre-AGRID with an 8/9 that would indicate high arousal. If they went on to respond with a 9/9 on the $post_1$-AGRID, that is only a one-point increase in their arousal. In this study, that score change would be interpreted as a small change in arousal when that participant's arousal would be considered high. The inverse may occur as well with low arousal conditions. This method of operationalizing high and low arousal did not, however, hinder the results of this study because no condition displayed a significant enough high or low arousal state. Essentially, all participants had roughly the same arousal level so any skew from measuring change in arousal was negligible.

Given mood induction did not appear to be successful in the current study, it may be prudent to replicate this study with a sample size large enough to achieve sufficient power and find an effect. However, despite the limited sample size, there is still reason to reassess the efficacy of previously used mood induction materials and begin creating new materials. Selecting newer clips, music, vignettes, and other materials has the potential to increase the intensity of mood induction for more contemporary participant samples. With modern technology like artificial intelligence and virtual reality, there are more ways to make interactive induction procedures than ever before. Moreover, creating MIPs that are more participant-driven may be even better at inducing stronger arousal states. Rather than having participants passively watch or imagine a situation, they could be placed in a situation and instructed to act or make decisions that affect their mood. For example, to induce high arousal, participants could be placed in a stressful condition such as having a time constraint or feeling pressured to perform well on a difficult task. For a low arousal condition, participants could be placed in a quiet, dimly lit room and be instructed to meditate or rest. These may have a stronger effect on arousal because it forces the participant to be actively involved in whatever is altering their mood and arousal state.

Conclusion

The present study could not make any claims on how memory errors do or do not change based on high versus low arousal. Despite the limitation of a small sample size, this study still displayed, to an extent, the transience of mood by finding a significant decline in arousal across all conditions from the beginning to the end of the study. It also highlighted the difficulty of manipulating mood by finding minimal changes in mood despite using two valid mood induction procedures on. However, in finding a lack of results with previously established MIPs, this study emphasizes the potential for creating newer, more effective MIPs that create a more realistic environment for the participant to operate within.

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Appendix A
Video Clips and Lengths

Fear Condition:

-*Lights Out* (2016):
https://www.youtube.com/watch?v=nD8KtgWozeM
Stop at 2 minute 40 seconds
-*Halloween* (1978):
https://www.youtube.com/watch?v=vmbvdeG49MI
Stop at 1 minute and 22 seconds

Total Viewing Time: 4 minutes 2 seconds

Sad Condition:

-*The Champ* (1979):
https://www.youtube.com/watch?v=OU-T9OsOtKI
Start at 1 minute, Stop at 2 minute 15 seconds

-*Marley and Me Marley* (2008):
https://www.youtube.com/watch?v=EOO8TwyVFYI
Full clip: 2 minutes and 41 seconds

Total Viewing Time: 3 minutes 56 seconds

Neutral Condition:

- "The Three Kingdoms Period explained in 4 minutes": https://www.youtube.com/watch?v=18K99HXTp7o

Total Viewing Time: 4 minutes and 11 seconds

Appendix B
Recognition Test + Answer Key

INSTRUCTIONS: Please read each word and circle "Old" or "New" indicate whether it is a word you were previously shown (Old) or if it is a word you were not shown (New).

1.	Old	Stars	**New**	25.	Old	Cheek	**New**
2.	Old	Glove	**New**	26.	Old	Chair	**New**
3.	Old	Car	**New**	27.	**Old**	Round	New
4.	Old	Answer	**New**	28.	Old	Face	**New**
5.	**Old**	Address	New	29.	Old	Flood	**New**
6.	Old	Lips	**New**	30.	Old	Nation	**New**
7.	**Old**	Express	New	31.	Old	Rain	**New**
8.	**Old**	Send	New	32.	**Old**	Sofa	New
9.	Old	Palm	**New**	33.	**Old**	Mark	New
10.	Old	Hand	**New**	34.	Old	Ethics	**New**
11.	**Old**	Kick	New	35.	**Old**	Pal	New
12.	Old	Test	**New**	36.	Old	Frown	**New**
13.	**Old**	Eraser	New	37.	Old	Exam	**New**
14.	Old	Fair	**New**	38.	Old	Wave	**New**
15.	**Old**	Engine	New	39.	**Old**	Shatter	New
16.	Old	Mail	**New**	40.	**Old**	Seat	New
17.	Old	Quiz	**New**	41.	Old	Mist	**New**
18.	Old	Flag	**New**	42.	Old	Pour	**New**
19.	Old	Ball	**New**	43.	Old	Pen	**New**
20.	Old	Glass	**New**	44.	**Old**	Hit	New
21.	Old	Lab	**New**	45.	Old	Right	**New**
22.	**Old**	Table	New	46.	**Old**	Garage	New
23.	**Old**	Lens	New	47.	**Old**	Trunk	New
24.	Old	Fist	**New**	48.	**Old**	Pane	New

HIT (18) MISS (18) CRITCAL LURE (6) CONTROL LURE (6)

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