

Does REM mentation reflect emotional memory? Assessing dreams with a modified Emotional Stroop Task

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Summary. Previous research has found evidence of relationships among sleep states and memory sources. However, the use of text-analysis of dream reports limits the validity of measures of emotion. In order to determine whether dreams reflect emotionally significant memories, a new technique for measuring the emotional significance of dream imagery to the dreamer was designed (using a modified emotional Stroop task). Results support the idea that sleep mentation imagery (most likely from REM) may reflect emotional memory, and suggest that modified cognitive tasks (such as the Emotional Stroop) may serve as novel methodological approaches for studying sleep mentation.

Keywords: Sleep mentation, dreams, emotion, Stroop task

1. Introduction

Recent research suggests that REM sleep, the sleeping brain state most often associated with dreaming, preferentially supports the consolidation of recently acquired emotional memories into a more stable long term form (Diekelmann, Wilhelm, & Born, 2009; Nishida, Pearsall, Buckner, & Parker, 2009; Payne, Chambers, & Kensinger, 2012; Peigneux & Smith, 2011; Vandekerckhove & Cluydts, 2010). Research findings have also demonstrated that dreams reflect memory processes (though evidence does not necessarily suggest that dreams play an active role in facilitating those processes; Wamsley et al., 2010). More specifically, research findings have suggested that mentation following REM awakenings reflect emotional memory (Cavallero, 1993; Cicogna, Cavallero, & Bosinelli, 1986; Monroe et al., 1965). Further experimental findings have also linked sleeping brain processes to emotional memory consolidation during REM sleep; these studies have suggested that sleep following learning preferentially enhances memory for the emotional components of the experience (Payne, Chambers, & Kensinger, 2012; Payne, Stickgold, Swanberg, & Kensinger, 2008). While the link between the known processes of emotional memory consolidation during REM sleep and the production of REM mentation that reflects emotional memory sources is currently not understood, challenges arise in measuring the actual emotional significance of those dream images to the dreamer (i.e. assessing whether dream images are reflective of memory sources that are emotional).

In terms of measuring the emotional significance of dreams to the individual, methods that rely on text-analy-

sis are limiting. Many methodological approaches, such as content analysis (Hall & Van de Castle, 1966), rely on words in the dream report; this therefore allows the analysis of only the emotions that are explicitly stated by the dreamer in the dream report. Even when emotions are mentioned in the dream report, though, often the total number of emotion-words mentioned is used as an empirical measure of emotion. More recent research has utilized measures such as subjective ratings of the emotional tone of dreams as rated by an independent investigator (Dale, DeCicco, & Miller, 2013) to try and assess dream emotions more accurately. Further investigations have used measures such as self-report to gain information regarding the emotional significance of dreams to the dreamer (Bilborrow, Davidson, & Scott, 2013).

However, the frequency of emotion-related words mentioned in a dream report and subjective assessments given by the researcher are not necessarily an indication of the degree of emotional significance that the imagery holds for dreamer (they are only measures of how frequently emotion-provoking or emotion-denoting words appear in the dream report, or how the researchers interpret the dream content). In order to determine whether dream imagery is emotionally salient to the dreamer (and to determine whether REM mentation does in fact reflect emotional memory), new research techniques are required to assess the actual emotional valence of imagery itself to the dreamer independently of the presence of emotion related words in the dream report. It was therefore proposed that by using an already established method for measuring the emotional salience of words, it would be possible to empirically measure the emotional significance of dream imagery to the dreamer.

In order to assess whether dream imagery (most likely from REM sleep) reflects emotional memory, a modified emotional Stroop task was designed to measure the emotionality of dream images. Stroop tasks have traditionally been used to measure reaction time interference when individuals are presented words that cause distraction. Individuals are presented with words that are written in colours,

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and have to respond to the colour while ignoring the word itself – however, because reading is such an automatic process, distracting words interfere with participants' ability to respond only to the colour (resulting in slowed reaction times). Traditional Stroop interference involves using words that denote colours which are incongruent with the colour the word is written in (i.e. Participants are slower to respond to a red coloured word when the word itself says "Blue").

It has also been shown, though, that words that carry an emotional connotation (e.g. words like "sadness") produce slower Stroop task response times (this is known as an 'Emotional Stroop Task'); more importantly, previous studies have further demonstrated that neutral words (non-emotion words) which have become associated with an emotional response through conditioning (experience) also produce slower reaction times, even though the word itself does not denote an emotion (Klein, 2007; Richards & Blanchette, 2004; Sutton, Altarriba, Gianico, & Basnight-Brown, 2007).

1.1. Hypothesis

It was hypothesized that if REM dreams (the most frequently reported dreams) reflect emotional memory, as has been suggested by previous findings (Cavallero, 1993; Cicogna, Cavallero, & Bosinelli, 1986; Monroe et al., 1965), some measurable level of emotional arousal should be present when individuals are presented with articles from their dreams. It was therefore predicted that if a modified emotional Stroop task was administered using words based on individuals' own dream reports, measured reaction times would be slower (indicating that dream images themselves hold conditioned emotional associations for the dreamer).

2. Method

2.1. Participants

Participants consisted of 31 students from Trent University, Ontario (Canada). The mean age of participants was 26 years. 22 of the participants were female (7 male). All participants were offered \$20 for their time in participation.

2.2. Measures and Procedure

All participants were asked to write down one dream that they remembered from any time within the past two weeks, and to underline the most salient words from that dream (the "main" or "key" words of the dream report). Some examples of dream words submitted include grave, son, smell, and grandmother. They then performed free-association on those words in order to generate a list of words from the individuals' own lexicon which would act as a sample of random control words for comparison (to account for possible confounding effects of using words which have been generated by the participant – and are therefore familiar to them – versus simple random words chosen by the experimenter). Additionally, a set of random syntax (non-meaningful; e.g. Whichever, However, etc.) words were also selected by the researcher as an additional control.

The three word sets (neutral, free-association, and dream words) were used to construct three separate emotional Stroop tasks for each participant – thus each participant was administered two different Stroop tasks based on their own dream and free-association words, and one which was the same for all participants (neutral words). Since each partici-

part had to be administered different Stroop tasks for two of the conditions, a total of 63 different Stroop Tasks were programmed for this experiment. Participants responded to coloured words on a computer screen by pressing coloured keys on a key-pad which matched the word-colours (red, yellow, green, and blue), while ignoring the word itself. Reaction times were measured in milliseconds for each word response, and a mean reaction time was calculated for each of the three tasks for each person. Each participant completed each task list once, and each of the three tasks consisted of the presentation of thirty words, followed by a one minute break before the next task. Participants completed one acclimatization task (for which data was discarded), one task based on random syntax words (control condition), one task based on their free-association words (control condition), and one task based on key words taken directly from their dreams (experimental condition).

Emotionality was operationally defined as a classically or operantly conditioned association between any article and an emotional reaction, where the article itself did not represent an emotion (i.e. conditioned fear of dogs from life experience connects dogs with an emotional reaction of fear). Therefore, because emotion-carrying words (e.g. Anger, Sadness, etc.) would result in a confounding reaction time delay, these words were excluded from the dream-Stroop (i.e. words such as 'Dogs' would be included, but if participants noted 'Fear' as a key word in the dream or as a free-association word, it would be excluded). Additionally, words denoting colours (e.g. 'Red', 'Blue', etc.) were excluded to prevent traditional Stroop task interference.

The presentation order of the three experimental tasks was counterbalanced to eliminate order effects. Presentation order of words within each list was randomized; the colour of each word was also randomized for each presentation, such that if the same word was presented more than once, the colour of that word would not necessarily be the same each time it was presented.

2.3. Apparatus

Stroop response time data were collected using E-Prime® software. Reaction times were recorded for each single response made by all participants, and the mean reaction time for all responses was calculated for each trial. All response times were measured in milliseconds. Participants responded by pressing coloured keys on a standard computer keyboard when words appeared on the computer screen. Data was analyzed using IBM SPSS® statistical software.

3. Results

A one-way repeated measures ANOVA was used to statistically analyze the resulting mean reaction times for each participant across the three Stroop task conditions (see Figure 1). Mauchly's test of sphericity indicated that the assumption of sphericity had been violated, $X^2(2) = 12.512, p < 0.05$. Results of the repeated measures ANOVA with a Greenhouse-Geisser correction determined that mean Stroop task reaction times differed significantly among the three conditions, $F(1.481, 44.431) = 21.01, p < 0.001$. Analysis using the Bonferroni post-hoc revealed that reaction times were significantly slower for dream words ($M = 878.29, SD = 159.02$) than both the syntax control ($M = 763.03, SD = 90.60; p < 0.01$) and the free-association control ($M = 821.03, SD = 123.34; p < 0.01$). These results indicate that the level

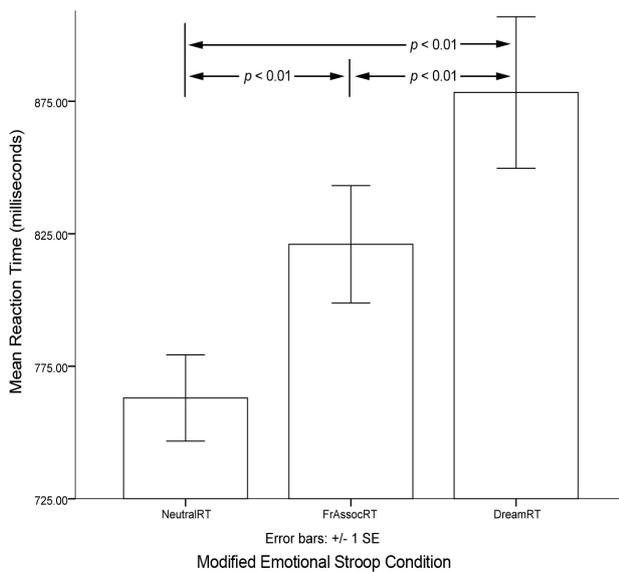


Figure 1. Plot of mean Stroop task reaction times for the control and experimental conditions. NeutralRT = mean Syntax Control Words reaction time, FrAssocRT = mean Free-Association Words reaction time, and DreamRT = mean Dream Words reaction time.

of emotional arousal from the presentation of individuals' own dream items was significant enough to result in a delayed response on the Stroop task, while non-dream words also selected by the participants and neutral (Syntax) words selected by the researcher did not yield significant slowing of Stroop task responses relative to the dream words. In addition, words generated by the dreamer (Free-Association Control Words) also resulted in significantly slower reaction times than syntax words ($p < 0.01$), indicating that familiarity with words from participants' own lexica produced slower responses than words selected by the researcher (though still significantly less so than dream words).

4. Discussion

These findings suggest that dream imagery reflects content that is emotionally significant to the dreamer. Since REM dreams are the type of dream most frequently remembered (Monroe et al., 1965; Nielsen, 2000), it is strongly suspected that the sample of dream reports analyzed here most likely reflects REM dreams more than NREM dreams. It may be the case that, because REM brain processes are involved in the consolidation of emotionally significant memories (Smith, 2008), REM mentation (which is produced simultaneously, and therefore by the same brain state as emotional memory consolidation) reflects the consolidation of emotional memories. This would be in agreement with previous findings suggesting that REM dreams are reflective of emotional memory, while NREM dreams are not (Cavallero, 1993; Cicogna, Cavallero, & Bosinelli, 1986; Monroe et al., 1965). However, in order to draw conclusions regarding the relationship between emotional memory consolidation and REM mentation, a more extensive investigation (involving a pre-sleep learning condition) would be necessary; addi-

tional controls, such as the use of dream words from other participants, would also lend further support to the experimental paradigm.

In addition, these findings are in agreement with previous findings regarding the use of the emotional Stroop task for measuring the emotional significance of words to individuals (Klein, 2007; Richards & Blanchette, 2004). This suggests that the use of modified cognitive measures may prove to be a useful research technique for studying the emotional significance of dream imagery to the dreamer.

For this study it was assumed that, since most dreams recalled are REM dreams, a random sample of dreams from a normal population would be strongly representative of REM rather than NREM dreams. However, in order to determine whether REM and NREM dreams differ in quality, as previous research has suggested, a control comparison of REM versus NREM dreams using electroencephalogram (EEG) recordings is necessary to verify with certainty the sleep stage from which dreams have been recalled. Furthermore, while research suggests that REM dreams reflect emotional memory sources, the emotional content of less frequent NREM dreams should also be considered.

For future studies, it would be necessary to demonstrate both that REM dreams reflect emotional memory (using a pre-sleep emotional learning task combined with a modified emotional Stroop task or other measures of emotion), and also to explore the emotional significance of NREM dreams to determine whether there are definitive qualitative differences between REM and NREM mentation. In addition, one further limitation of this method is that the words in dream reports are chosen by the participants rather than the researcher. As a result, world complexity and length could not be controlled for easily. Future studies might alleviate this concern by examining many dreams over a longer period, and matching words from a larger sample of dreams from each participant with free association controls of similar complexity and length.

One further concern regards the validity of the measure while using free association as a control for word familiarity. One might suggest, for example, that conducting free association prior to the experiment may influence the emotional valence of words taken from the dream on during subsequent testing. If this were the case, however, it would be suspected that the free association words would be more emotionally salient than the dream words themselves - in fact, the results here demonstrate precisely the opposite. It is often assumed that free association leads to an increase in emotion or understanding of dream imagery. However, these findings suggest that (in agreement with the idea that REM dreams are a reflection of emotional and/or procedural memory) the dream images themselves are more emotionally salient, while free associations made from those images are "one step away" from the direct reflection of the emotional memory source (and therefore actually less emotionally significant to the dreamer). It is possible that this reflects a transition made during free association from a direct reflection of emotional memory to a more rational or intellectual understanding of dream content. Free associations made based on dream content would therefore not directly reflect emotional memory, but may provide a deeper intellectual (but less emotional) understanding of the content. Finally, while the present approach attempts to overcome traditional limitations in studying emotion, further experimentation should include multiple measures of emotion

that are used in combination to confirm the efficacy of the measure. However, despite the limitations, the methodology discussed herein appears promising in terms of developing new experimental techniques for assessing the link between REM mentation and emotional memory.

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