Revisiting Mednick’s (1962) Theory of Creativity with a Composite Measure of Creativity: The Effect of Stimulus Type on Word Association Production

ABSTRACT

S.A. Mednick (1962) proposed a theory of creativity suggesting that highly creative individuals can produce more word associations to a stimulus than less creative individuals. Numerous studies have supported this theory using the Remote Associates Test (RAT) as the measure of creativity. Additionally, some studies have suggested that high-frequency words elicit more word associations overall than low-frequency words, and concrete words elicit more associations overall than abstract words. The current study further investigated Mednick’s theory by (a) creating controlled lists of stimuli that can better uncover how word type (abstract versus concrete) and word frequency (high versus low) affect the number of word associations produced to a stimulus, (b) including several creativity tasks besides the RAT, and (c) examining the role of other factors in creative thinking, including intelligence and verbal fluency. Participants first completed a word association task with four different types of words (i.e., high-frequency concrete, low-frequency concrete, high-frequency abstract, and low-frequency abstract), and then completed a variety of tasks, including several creativity tasks. Participants were categorized as highly creative or less creative based on a composite measure of the creativity tasks. Highly creative individuals produced more associations overall, supporting Mednick’s theory. Furthermore, high-frequency stimuli resulted in higher overall associative responses compared to low-frequency stimuli, but contrary to previous research, no differences emerged for concrete versus abstract stimuli. There was also no difference in intelligence scores between the two creativity groups, and only a marginally significant difference in verbal fluency scores.

Keywords: creative thinking, word associations, word frequency, word type.

Creative thinking is a skill needed in all fields and professions to produce meaningful and novel ideas. Mednick (1962) proposed that the process of creative thinking involves the combining of associative elements into new and useful combinations, and that highly creative individuals should be better able to combine associative elements as compared to less creative individuals. From this idea, Mednick proposed that the organization of an individual’s associative elements will influence whether or not an individual produces a creative solution. Focusing specifically on word associations, Mednick suggested that highly creative individuals should be able to produce more word associations to a stimulus because the organization of their associative hierarchy is “flatter.” For example, if given the stimulus “table,” a highly creative individual may respond with a moderately strong first response, allowing the individual to come up with other, less dominant responses as well, creating a flat curve over time. In contrast, a less creative individual may have an extremely strong first response, preventing the individual from reaching other, more remote word associations, creating a steep associative hierarchy. Therefore, a flatter associative hierarchy would be necessary to produce creative solutions. To operationalize his ideas of creativity, Mednick created the Remote Associates Test (RAT), in which a participant is presented with three remote associative elements (e.g., rat, blue, and cottage) and is asked to find a fourth word that could connect and combine the three remote words together (solution: cheese). In theory, highly creative individuals should score higher on the RAT than less creative individuals, because they should be able to reach and combine more remote elements, leading them to the RAT solution.
TESTS OF MEDNICK’S THEORY

Mednick, Mednick, and Jung (1964) tested out Mednick’s (1962) theory of creative thinking by administering both the RAT and a word association task to participants. They first administered the RAT to participants four months in advance, and then split the participants into high, medium, and low creativity groups based on their scores. Then, the participants came back to the laboratory to complete the word association task. In this task, participants were presented with a word (e.g., food) and were asked to respond with as many words that come to mind in a two-minute period (e.g., meal, dinner, chicken...). Consistent with Mednick’s (1962) theory, Mednick et al. (1964) found that the high creativity group produced more word associations during the two-minute period as compared to the low creativity group. Furthermore, the participants produced more word associations to higher frequency words as compared to lower frequency words, but this did not interact with creativity level. Other studies have also found that high-frequency words elicit more responses than low-frequency words in a word association task (e.g., Cofer & Shevitz, 1952) and that this does not seem to depend on creativity level (e.g., Piers & Kirchner, 1971).

Desiderato and Sigal (1970) followed up on Mednick et al.’s (1964) results by examining whether word type (concrete versus abstract) affects the number of responses produced during a word association task. Similar to Mednick et al.’s procedure, they split participants into high and low creativity groups based on their RAT scores, and then administered a word association task. Participants were presented with concrete (e.g., flower) and abstract (e.g., thought) words and were asked to respond with any words that come to mind in a three-minute period. Consistent with Mednick’s (1962) theory, the high creativity group produced more word associations overall as compared to the low creativity group. Moreover, concrete words elicited more responses than abstract words, but this did not interact with creativity levels. These findings have also been supported by other studies (Lambert, 1955; Piers & Kirchner, 1971).

Most of the previous literature investigating Mednick’s (1962) theory has focused on separating individuals into high creative and low creative groups (or recruiting high and low creative groups), and assessing some type of word association behavior. However, other studies have examined Mednick’s theory in more direct ways. For example, Benedek and Neubauer (2013) directly tested the relationship between associative abilities and divergent thinking by using four different associative tasks and several creativity tasks. According to Mednick (1962), creative thinking consists of the ability to combine remote elements together. If this is supported, associative abilities should then predict performance on creativity tasks. Consistent with Mednick’s theory, Benedek and Neubauer found that associative abilities explained approximately half of the variance in divergent thinking in the study.

Benedek and Neubauer (2013) conducted a more direct test of Mednick’s (1962) theory by specifically examining participants’ associative hierarchies. They split participants into high and low creativity groups using a composite creativity score and then mapped associative hierarchies for each group. Consistent with Mednick’s (1962) theory, the highly creative group showed significantly higher associative fluency as compared to the less creative group. However, in contrast to Mednick’s (1962) theory, there were no significant differences in the actual associative hierarchies between the high and low creativity groups. Therefore, associative fluency behavior appears to differ with creativity levels, but the steepness of associative hierarchies may not underlie this finding.

Kenett et al., (2014) followed up by using a novel approach to examine the organization of semantic networks in high versus low creative individuals. Kenett et al. reasoned that if creative individuals do have a flatter associative hierarchy, then they should also have a more flexible semantic memory organization. That is, highly creative individuals may be able to search for associates through a highly condensed and connected semantic network, allowing them to reach more remote associates as compared to less creative individuals. Consistent with Mednick’s theory, Kenett et al., (2014) found differences in the semantic network organization between high and low creative individuals, including the finding that less creative individuals have a more spread out and less connected semantic network as compared to high creative individuals.

CURRENT STUDY

Mednick’s (1962) theory has been supported numerous times in the literature; however, there are some methodological details in many of the studies reviewed above that need to be addressed to better understand the theory. First, a free association task is often used in studies investigating Mednick’s theory, but the words chosen as stimuli are rarely controlled. For example, in Mednick et al.’s (1964) original test of the theory, the researchers did not control for whether the stimuli were abstract or concrete words. Other studies followed up on this and controlled for abstract versus concrete words, but did not control for whether
the words were emotional or not (e.g., Desiderato & Sigal, 1970; Piers & Kirchner, 1971). None of the above studies, even more recent studies (e.g., Benedek & Neubauer, 2013) mention controlling for other factors, such as word length or imageability. Without controlled lists of stimuli, it is not fully clear how the stimuli affect word association responses. The first aim of the current study was to revisit whether word type (abstract versus concrete) and word frequency (high versus low) affect word associations by creating a controlled list of stimuli that could be used for the word association task. Specifically, the current study used four word lists (high-frequency concrete, low-frequency concrete, high-frequency abstract, and low-frequency abstract) and controlled for word length, number of orthographic neighbors, and imageability. Emotion and emotion-laden words were also omitted from all four lists.

Second, it was pointed out by Benedek and Neubauer (2013) that most of the support for Mednick’s theory uses only the RAT as a creativity task, which is problematic for two reasons. First, the validity of the RAT has previously been questioned (see Lee, Huggins, & Therriault, 2014), and second, the RAT was developed to operationalize Mednick’s (1962) theory stating that word associations underlie creative thinking. Therefore, using the RAT to split participants into high and low creativity groups to test Mednick’s theory may be a confound. Benedek and Neubauer (2013) instead used a variety of creativity tasks instead of the RAT to create a composite measure of creativity, which was then used to split participants into high and low creativity groups. The second aim of the current study was to use a variety of creativity tasks in the current context to examine Mednick’s (1962) theory, similar to Benedek and Neubauer (2013). Unlike Benedek and Neubauer, however, the current study also included the RAT in the variety of creativity tasks, given that most of the previous research examining Mednick’s theory used the RAT. A composite creativity measure was created from three creativity tasks: the RAT, the Alternate Uses Task (AUT), and the Runco Ideational Behavior Scale Short Form (RIBS-S), all of which will be described in detail in the method section. The participants were split into high, medium, and low creativity groups based on their creativity score.

Lastly, it is also important to examine potential links between creativity and other factors in the context of Mednick’s theory. For example, the potential link between creativity and personality factors, such as psychoticism, has previously been examined (see Merten, 1993). Merten and Fischer (1999) found that compared to a control group, creative individuals scored higher on the psychoticism dimension of the Eysenck Personality Questionnaire EPQ (Eysenck, & Eysenck, 1975), but no different on any of the other personality dimensions. Additionally, compared to individuals with schizophrenia, the creative participants produced more original responses in the free word association task overall, but could also successfully inhibit these original responses when asked to respond with a word that no one else would respond with. In contrast, the participants with schizophrenia were not able to engage in this inhibition, suggesting that the link between creativity and psychoticism is separate from a link with psychopathology. The last aim of the current study was to examine other factors besides personality that may influence creativity levels. For example, some previous studies have suggested a potential link between creativity and intelligence (e.g., Silvia, 2015; Silvia, Beaty, & Nusbaum, 2013) whereas other studies have suggested a slim or null link between the two measures (e.g., Alloway, Southard, Frankenstein, & Guess, 2017; Kim, 2005). The current study included the Raven’s Standard Progressive Matrices Test (SPM) to assess the relationship between non-verbal intelligence scores and creativity.

A verbal fluency task (Silvia et al., 2013) was also included to assess the relationship between verbal ability and creativity level. The verbal fluency task in the current study required participants to respond with as many words as possible that fit within the prompt (e.g., respond with words that end in “TION”). Previous research has suggested that when creativity tasks depend on fluency (e.g., how many creative responses a participant can produce to a stimulus), creative thinking can resemble typical verbal fluency ability (Nusbaum & Silvia, 2011). Therefore, creativity and verbal fluency may be confounded, depending on how creativity is measured. The verbal fluency task in the current study was added to examine this potential issue. The current study used a composite creativity measure, so it was expected that creativity level would not be confounded with verbal fluency.

In summary, the current research significantly expands upon the published work examining word associations in Mednick’s theory by using highly controlled lists of stimuli in the word association task, which has not been utilized in the previous research. This allows us to better assess the role of word frequency and concreteness on word associations, as compared to previous research that used word lists with potential confounds. Furthermore, the current research expands the test of Mednick’s theory by using a composite creativity measure that includes the RAT, which allows us to assess if Mednick’s theory can extend to other creativity measures. Overall, following previous research, it was hypothesized that highly creative individuals...
should produce more word associations as compared to less creative individuals, even with using a composites creativity measure. Furthermore, based on previous research, it was hypothesized that concrete words should elicit more responses than abstract words in the associative fluency task, and high-frequency words should elicit more responses than low-frequency words, without any interactions with creativity level.

METHOD

PARTICIPANTS

Eighty undergraduate student participants (50 female, 30 male) from the University at Albany, State University of New York participated in exchange for research credit in an introductory psychology course. All participants were native English speakers and reported normal or corrected-to-normal vision. The age of the participants ranged from 18 to 22 years ($M = 18.81, SD = .98$).

TASKS

Word Association Task

The word association task used in the current study was a continuous free association task, in which participants were asked to freely generate as many associates to a stimulus as possible. Forty nouns were selected as the stimuli. Using the English Lexicon Project (HAL Frequency, Balota et al., 2007), half of the nouns were categorized as high frequency ($M = 10.31, SD = .80$, ranging from 9.03 to 11.65) and half of the nouns were categorized as low frequency ($M = 7.64, SD = 1.16$, ranging from 5.36 to 8.88). The high- and low-frequency words differed significantly in frequency, $t(38) = 8.50, p < .001, d = 2.69$. Using the concreteness rating of the MRC Psycholinguistic Database (Coltheart, 1981), half of the nouns were categorized as abstract ($M = 347.95, SD = 63.40$, ranging from 204.00 to 467.00) and half of the nouns were categorized as concrete ($M = 501.50, SD = 62.95$, ranging from 353.00 to 587.00). The concrete and abstract words differed significantly in concreteness, $t(38) = 7.69, p < .001, d = 2.43$. These word groupings were used to create four lists of stimuli that preserved these distinctions in word frequency and concreteness (i.e., high-frequency concrete, low-frequency concrete, high-frequency abstract, and low-frequency abstract, see Table 1 for frequency and concreteness values). All four lists were equated on imageability and word length using the MRC Database, and on the number of orthographic neighbors using the English Lexicon Project (Balota et al., 2007). Emotion and emotion-laden words were excluded from all four lists. See Appendix A for the complete lists.

Each of the 40 nouns was presented by a computer using E-Prime 2.0 (Psychology Software Tools, Pittsburgh, PA) for one minute each. The participants were instructed that they would have one minute per word to type all words that come to mind, and they should press “enter” between each response. They were told that the responses should be single words, not phrases or sentences. Before completing the 40 trials, the participants were given an example (i.e., “summer”: beach, sea, warm, swim, sandals... ) and a practice trial (“hair”). Then, participants completed the 40 trials. Participants were given the opportunity to take a break after every ten items. The entire task lasted approximately 45 minutes.

Creativity Tasks

RAT

Ten compound remote associate problems were taken from Bowden and Jung-Beeman (2003). All ten of the selected items were reported by Bowden and Jung-Beeman as previously solved within 30 seconds by more than 70% of participants. For each problem, three words were presented on the computer screen (e.g., aid, rubber, and wagon), and participants had 30 seconds to type in a solution (band). The participants...
were instructed specifically to generate a solution word that forms a word pair with each of the three words. The participants were first given an example (fountain, baking, pop; solution: soda) and a practice trial (eight, skate, stick; solution: figure) before completing the actual trials. After 30 seconds per trial, the computer advanced to the next problem whether a response was given or not. All problems were presented during the study by a computer using E-Prime 2.0, in the same way as the words were presented in the word association task. See Appendix B for the complete list of items.

AUT

The Alternate Uses Form B Test Booklet (Guilford, Christensen, Merrifield, & Wilson, 1978), obtained from Mind Garden and Inc. (2019), was used for the AUT. The AUT measures divergent thinking, which is thought to be an indicator of creativity (e.g., Runco & Acar, 2012). The AUT booklet contained six total items (e.g., shoe) with instructions for the participants to list as many as six alternate uses for each item (e.g., use shoe as a planter). The AUT booklet was administered to participants on paper. Participants had four minutes total to complete the first three items, and an additional four minutes to complete the second three items.

RIBS-S

The RIBS-S (part of the Runco Creativity Assessment Battery, Runco, 2011) was administered to participants. The RIBS-S is a short form of the original Runco Ideational Behavior Scale (RIBS) and is highly correlated to the original RIBS (Runco et al., 2013). Therefore, the short form was used to decrease the time of the overall experiment. The RIBS-S includes 20 phrases such as “I have ideas for arranging or rearranging the furniture at home” and participants were asked to indicate how often the phrase describes their thinking (0 = never, 1 = approximately once a year, 2 = once or twice each month, 3 = once or twice each week, 4 = just about every day, and sometimes more than once each day). According to Runco, the scale is thought to be associated with divergent thinking. It was administered to participants on paper, with unlimited time for completing the scale.

Scoring the Creativity Tasks

The RAT was scored for accuracy, as each item had only one correct solution. The RIBS-S was scored by totaling the responses for each question to come up with a total creativity score out of 76, with a higher score indicating a higher level of creativity. The AUT was scored in two different ways. First, the number of appropriate responses that was generated for each item was totaled, following the instructions included in the manual (Guilford et al., 1978). A response was considered inappropriate if it was not physically possible (e.g., “wear as a ring” for shoe), if it was too vague (e.g., “use to make something” for shoe), or if the response was the item’s typical use (e.g., “wear on foot” for shoe). The total number of responses for each of the six items was then totaled, to come up with a grand total of AUT responses.

Second, the creativeness of the AUT responses was rated. Two trained research assistants rated all responses for each item on a creativity scale of 1-5 (1 = not at all creative, 2 = slightly creative, 3 = moderately creative, 4 = creative, and 5 = highly creative). The research assistants did not rate each individual response for each item, but rather they rated the creativity level of all responses to each item, using the “snapshot” method (see Silvia, Martin, & Nusbaum, 2009, for a discussion of the validity of the method). For example, if a participant wrote three different alternate uses for the item “shoe,” all three responses were given a creativeness rating, instead of each individual response. The research assistants were instructed to take into account three facets of creativity with their ratings: uncommonness, remoteness, and cleverness (taken from the instructions of Silvia et al., 2008). Cohen’s k, a statistical measure of interrater reliability for two raters, was run to determine agreement between the two raters. Cohen’s k ranges from 0 to 1, with 0 indicating that agreement is equivalent to chance and 1 indicating perfect agreement. The raters showed significant agreement on all six items of the AUT, with each item above the .21 benchmark for fair agreement (1: k = .36, p < .001; 2: k = .37, p < .001; 3: k = .50, p < .001; 4: k = .41, p < .001; 5: k = .31, p < .001; 6: k = .24, p = .001; Landis & Koch, 1977). Therefore, the ratings from the two research assistants were averaged, and the average ratings from all six items were totaled to come up with a total score of AUT creativity.

Forming Creativity Groups

Following the procedures of Benedek and Neubauer (2013), all of the creativity tasks in the current study were combined to form a composite measure of creativity that was then used to split participants into high
and low creativity groups. Specifically, the RAT, the RIBS-S, and both measures of the AUT (total responses and creativeness) were z-standardized and averaged to create a composite creativity score. Similar to Benedek and Neubauer, participants were then split into creativity groups by labeling the participants with the highest 33% of creativity scores as the high creative group and the participants with the bottom 33% of creativity scores as the low creative group (n = 27 in both groups, low creativity group: 9 male students, 18 female students; high creativity group: 11 male students, 16 female students). The age of the participants in the low creativity group ranged from 18 to 22 years (M = 18.82, SD = 1.15) and in the high creativity group ranged from 18 to 21 years (M = 18.82, SD = .92). The participants with creativity scores in the middle were not analyzed further in the current study.

The high and low creativity groups differed significantly in all creativity measures (RAT: high creativity group M = 68.50%, low creativity group M = 42.60%, t(52) = 5.26, p < .001, d = 1.43; RIBS-S: high creativity group M = 47.85, low creativity group M = 38.63, t(52) = 3.75, p < .001, d = 1.02; AUT Fluency: high creativity group M = 20.30, low creativity group M = 9.31, t(52) = 7.67, p < .001, d = 2.08; AUT Creativeness: high creativity group M = 13.78, low creativity group M = 7.54, t(52) = 10.14, p < .001, d = 2.76) including the composite creativity measure (high creativity group M = .67, low creativity group M = -.72, t(52) = 15.55, p < .001, d = 4.23).

Raven’s SPM

The Raven’s SPM, a non-verbal test measuring fluid intelligence (Raven, Court, & Raven, 1998), was obtained from Pearson (n.d.). The test consists of five sets of 12 questions each, with each question requiring participants to fill in a missing element of a pattern. The test was administered to participants on paper, and a time limit of 20 minutes was given to each participant. After 20 minutes, the experimenter asked the participant to hand in the paper, regardless of whether or not the test was completed.

Verbal Fluency Measure

Five prompts were taken from Silvia et al. (2013) to assess verbal fluency (e.g., “Type words that end with -TION”). Participants were instructed to type as many words as they could in the allotted one-minute time period. They were instructed to press “enter” in between each response. All prompts were presented during the study by a computer using E-Prime 2.0, in the same way as the words were presented in the word association task.

PROCEDURE

Individually tested participants first gave informed consent and then were seated at a computer to complete the word association task. Following the word association task, the participants completed the RAT, the AUT, the RIBS-S, the Raven’s SPM, and the verbal fluency measure. The order of these five tasks was counterbalanced using a Latin Square. After all the tasks were completed, the participants were debriefed and given credit for the experimental session. The entire session lasted approximately two hours. See Appendix C for the complete procedure.

RESULTS

TASKS

Descriptive statistics, internal consistency estimates (calculated with Cronbach’s α), and intercorrelations for each of the tasks in the study are presented in Table 2. It should be noted that two of the tasks were estimated to have low internal consistency (i.e., the verbal fluency task and the RAT). However, this could be related to the small number of items in each of the tasks. In general, Cronbach’s α tends to be small with fewer items in the task (Vaske, Beaman, & Sponarski, 2016). Future work should increase the number of items in the task and examine this finding further.

TEST OF MEDNICK’S THEORY

A 2 (Creativity Level: High vs. Low) × 2 (Word Frequency: High vs. Low) × 2 (Word Type: Concreate vs. Abstract) mixed-factor ANOVA was conducted on the number of word association responses, with the first factor being between-participants and the second two factors being within-participants. See Table 3 for a breakdown of the mean number of responses. Mednick’s theory was supported from the significant main effect of Creativity Level, F(1,52) = 7.33, p = .009, η² = .12. Specifically, the highly creative individuals (M = 11.46) produced more overall word associations as compared to less creative individuals (M = 8.93).
There was also a significant main effect of word frequency, $F(1, 52) = 93.25, p < .001, \eta^2 = .64$, demonstrating that high-frequency words ($M = 10.88$) elicited more responses overall as compared to low-frequency words ($M = 9.50$). However, there was no significant main effect of word type, $F(1,52) = .15, p = .698, \eta^2 = .00$. Abstract ($M = 10.22$) and concrete words ($M = 10.17$) elicited an equivalent number of responses. None of the interactions were significant. To further assess these results, a Bayes factor analysis (e.g., Rouder, Morey, Speckman, & Province, 2012) was conducted using JASP (Version 0.11.1; JASP Team, 2019). A computed Bayes Factor showed that the best model is a model with main effects of word frequency and creativity level, with no main effect of word type and no interactions. Specifically, this model is 3.27 times more likely than a model also containing the main effect of word type. According to Van Doorn et al., (2019), a Bayes Factor above 3 can be considered moderate evidence for the best model. This model was also more likely than any other models containing an interaction (all Bayes factors $> 3$).

### INTELLIGENCE AND WORD FLUENCY

An independent samples t-test was conducted on the Raven’s SPM scores between the high and low creativity groups. The Raven’s SPM was scored for accuracy (i.e., the percentage of correct responses achieved in 20 minutes). There was no significant difference in accuracy between the two groups (high creativity $M = 72.22\%$, low creativity $M = 69.01\%$), $t(52) = .74, p = .465, d = .20$, suggesting that in the current study, intelligence scores did not differ by creativity level. To further assess the non-significant result, a Bayes factor analysis was conducted using JASP, in the same way as above. This produced a Bayes factor of 0.34, which can be considered weak to moderate evidence for the null hypothesis (Van Doorn et al., 2019).

Similarly, an independent samples t-test was conducted on the verbal fluency measure between the high and low creativity groups. The verbal fluency measure consisted of the total number of appropriate responses to each prompt. There was a marginally significant difference in scores between the two groups, $t(52) = 1.85, p = .070, d = .50$. Specifically, the highly creative individuals created marginally more responses overall ($M = 8.19$) as compared to the less creative individuals ($M = 7.19$). However, a Bayes factor analysis was conducted, and a Bayes factor of 1.10 was produced. This can be considered only weak evidence for the alternative hypothesis (Van Doorn et al., 2019). It should be noted that the Bayes Factor is close to 1, which would suggest equal support for the null and alternative hypotheses.

### TABLE 2. Descriptives, Internal Consistency Estimates ($\alpha$), and Intercorrelations

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>$\alpha$</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 AUT Creativeness</td>
<td>10.71</td>
<td>3.37</td>
<td>.84</td>
<td>.65***</td>
<td>.19</td>
<td>.12</td>
<td>.15</td>
<td>.26*</td>
<td>.30**</td>
</tr>
<tr>
<td>2 AUT Fluency</td>
<td>14.63</td>
<td>6.72</td>
<td>.88</td>
<td>.25*</td>
<td>-.01</td>
<td>.21</td>
<td>.13</td>
<td>.46**</td>
<td></td>
</tr>
<tr>
<td>3 Word Fluency</td>
<td>7.75</td>
<td>1.86</td>
<td>.39</td>
<td>.24*</td>
<td>.05</td>
<td>.09</td>
<td>.44**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Raven’s SPM</td>
<td>.73</td>
<td>.15</td>
<td>.82</td>
<td>.03</td>
<td>.22*</td>
<td>.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 RIBs</td>
<td>44.60</td>
<td>9.78</td>
<td>.77</td>
<td>-.10</td>
<td>.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 RAT</td>
<td>.55</td>
<td>.22</td>
<td>.26</td>
<td>.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Word Association$^a$</td>
<td>9.73</td>
<td>3.27</td>
<td>.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* = $p < .05$, ** = $p < .01$, *** = $p < .001$. $^a$ Word Association was averaged across high/low frequency and abstract/concrete. $^b$ Internal consistency estimates were calculated using Cronbach’s alpha ($\alpha$).

### TABLE 3. Number of Word Associations in the Associative Fluency Task Broken Down by Creativity Level, Word Type, and Word Frequency. The Number in Parentheses is the Standard Deviation

<table>
<thead>
<tr>
<th></th>
<th>Low-Frequency Concrete</th>
<th>High-Frequency Concrete</th>
<th>Low-Frequency Abstract</th>
<th>High-Frequency Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Creative</td>
<td>10.67 (4.16)</td>
<td>12.18 (3.66)</td>
<td>11.01 (3.78)</td>
<td>11.96 (3.74)</td>
</tr>
<tr>
<td>Low Creative</td>
<td>8.11 (3.16)</td>
<td>9.71 (3.12)</td>
<td>8.21 (3.36)</td>
<td>9.69 (3.25)</td>
</tr>
</tbody>
</table>
Revisiting Mednick’s (1962) Theory of Creativity

Mednick’s (1962) theory of creativity states that creative thinking involves the combining of associative elements into new and useful combinations. To test this theory, previous research (e.g., Mednick et al., 1964) labeled participants as highly creative or less creative based on RAT scores, and then compared performance on a word association task between the highly creative individuals and less creative individuals. The typical finding supporting Mednick’s theory is that highly creative individuals tend to produce more word associations than less creative individuals, suggesting that they have a stronger ability to reach remote associative elements. The current study assessed Mednick’s theory with three specific aims: (1) to further investigate how word frequency and word type affect the number of responses produced in the word association task, (2) to use a variety of creativity tasks besides the RAT, and (3) to see how other factors, such as intelligence and word fluency, relate to creativity.

To investigate the first aim, the current study used four controlled word lists for the word association task that varied in frequency and word type. Consistent with previous research (e.g., Cofer & Shevitz, 1952), high-frequency words in the current study elicited more overall word association responses as compared to low-frequency words. Similar to Piers and Kirchner (1971), this did not interact with creativity level, suggesting that this difference in word frequency exists regardless of creativity level. Surprisingly, in contrast to previous research (e.g., Desiderato & Sigal, 1970), concrete words did not elicit more overall word association responses as compared to abstract words in the current study. This difference compared to previous research could be due to our word lists being more controlled. For example, we equated imageability between the concrete and abstract word lists, which previous research did not do, to our knowledge. For example, ark is a concrete word (concreteness = 561) and revolution is an abstract word (concreteness = 378) but both are similar in imageability ratings (ark imageability = 517, revolution imageability = 513). It could be that the difference between concrete and abstract words found previously was actually a difference in imageability.

One last potential reason for the null finding could be low statistical power. It is possible that eliminating the middle creativity group from all of the analyses resulted in a sample size that was too small to detect a significant difference in concreteness. However, using G*Power 3.1.9.6 (Faul, Erdfelder, Lang, & Buchner, 2007), we determined that the power to detect a moderate effect (i.e., Cohen $f = 0.25$), should it exist, was $> 0.90$. Furthermore, the Bayes Factor analyses that we provide earlier in the manuscript support our null finding.

For the second aim, we used three different creativity tasks: the RAT, the AUT, and the RIBS-S. As mentioned earlier, the RAT has been criticized for being the sole creativity task in previous studies, given that the RAT was developed to operationalize Mednick’s theory (Benedek & Neubauer, 2013). We created a composite creativity measure including the RAT, to see if Mednick’s theory would still be supported when the RAT was not the sole creativity task. Indeed, Mednick’s theory was supported in the current study, suggesting that the theory is supported with other creativity tasks besides the RAT, as well. This finding is consistent with Benedek and Neubauer who also used a composite creativity measure and found that highly creative individuals still elicit more word association responses overall as compared to less creative individuals.

The third aim was investigated by including the Raven’s SPM and the verbal fluency measure. There is a long-standing debate about whether or not intelligence levels and creativity levels are related, which may in part be related to the participants’ intelligence levels. It has previously been suggested that a correlation between intelligence and creativity only emerges when intelligence levels are below a particular threshold, typically an IQ of 120 (i.e., the threshold hypothesis, see Jauk, Benedek, Dunst, & Neubauer, 2013). Therefore, the lack of correlation between intelligence and creativity in the current study may be due to our current sample demonstrating above-average intelligence. However, threshold hypothesis is still highly debated
(Kim, 2005; Weiss, Steger, Schroeders, & Wilhelm, 2020), and it is not yet clear if the correlation between intelligence and creativity disappears with an above-average intelligence sample. Furthermore, the average score of our current participants on the Raven’s SPM was 73%, which may not be high enough to pass the somewhat arbitrary threshold defined in threshold theory, though the exact threshold has also been debated (Jauk et al., 2013).

The debate surrounding intelligence and creativity levels may also depend on the tasks used to measure both intelligence and creativity. We used a composite score to measure creativity and the Raven’s SPM to measure intelligence, and we found no significant differences in intelligence between the high and low creativity groups. Our results contradict findings from other previous articles suggesting a link between the two measures, but it is worth noting that these articles have used other methods to estimate and assess the relationship between creativity and intelligence (e.g., Nusbaum & Silvia, 2011; Silvia, 2008). In contrast, our results are in line with Furnham and Bachtar (2008), who found no relationship between creativity (measured in several different ways) and intelligence. Future research should continue to address what types of creativity tasks are related to intelligence levels, and how a composite creativity measure fits within the creativity and intelligence debate.

The verbal fluency measure was added to the current study to assess previous claims that verbal fluency resembles creative thinking too closely (see Silvia et al., 2013). Specifically, it has not always been clear in the past if certain creativity tasks are simply measuring verbal fluency ability. There was only a marginally significant difference in verbal fluency performance between the high and low creativity groups in the current study, but a significant difference in all of the creativity tasks between the high and low creativity groups, suggesting that the creativity measure is estimating more than verbal fluency ability. This is likely because the current study used a variety of creativity tasks, including both fluency and creativeness for the AUT. Previous research suggesting that verbal fluency underlies creative thinking often uses only fluency scores as a measure of creativity (see Silvia et al.), which may be the reason for this issue. A composite measure of creativity may better estimate creative thinking and more easily separate it from verbal fluency ability.

As a limitation, it could be argued that the current study is merely measuring motivation instead of creativity. That is, the highly creative individuals may have scored higher on the creativity tasks and produced more word associations simply because they were motivated to try harder as compared to the less creative individuals. However, the fact that there was no difference between the two groups on the Raven’s SPM and only a marginally significant difference between verbal fluency scores suggests that this is not likely. If the results of the current study were simply due to motivation or amount of effort, the highly creative individuals would have likely scored significantly higher on both the Raven’s SPM and verbal fluency measure as well as the creativity and associative fluency measures.

Overall, consistent with past research, the current study supported Mednick’s (1962) theory in that highly creative individuals elicited more word associations as compared to less creative individuals. The current study also added new findings to the previous literature. First, it showed concrete words did not elicit more word associations as compared to abstract words, which is a discrepant finding with previous literature, but this may be because the current word lists were equated on imageability. Second, it showed that Mednick’s theory could be supported using a composite of the RAT, AUT, and the RIBS-S. Lastly, it showed no difference in intelligence levels between high and low creativity groups with the current study’s procedures and tasks, and only a slight non-significant difference in verbal fluency between high and low creativity groups.

For future research, a chained word association task may provide even more information for the link between creativity and word associations than the continuous word association task used in the current study. In a chained association task, participants are given a stimulus (e.g., plate) and asked to produce a chain of responses, in which the previous response becomes the new stimulus (see Benedek, Konen, & Neubauer, 2012). For example, if a participant responds “food” to the stimulus “plate,” “food” becomes the new stimulus for the next response (e.g., “dinner”), which then becomes the new stimulus for the next response, and so on (e.g., “plate”: food, dinner, table, chair). Levin (1978) suggested that a chained word association task is more strongly related to creativity than a continuous word association task, because chained responses can bring participants to more remote elements than a continuous word association task (e.g., the chain above starts with “plate” and ends on “chair”). According to Mednick (1962), highly creative individuals should be better able to reach more remote elements than less creative individuals. Therefore, a chained association task may be useful for assessing how well participants can reach remote elements. Future research should examine chained versus continuous word association tasks within Mednick’s theory of creativity.
REFERENCES


JASP Team. (2019). JASP (Version 0.11.1) [Computer software].


Deana Vitrano, Jeanette Altarriba, University at Albany, State University of New York

Deniz Leblebici-Basar, Istanbul Technical University

Correspondence concerning this article should be addressed to Deana Vitrano, Department of Psychology, University at Albany, State University of New York, 1400 Washington Ave. Albany, NY 12222. E-mail: vitrano.deana@gmail.com

**AUTHOR NOTE**

The data that support the findings of this study are available from the corresponding author upon reasonable request.

**APPENDIX A**

**STIMULI FOR THE WORD ASSOCIATION TASK**

<table>
<thead>
<tr>
<th>Low-Frequency Concrete</th>
<th>High-Frequency Concrete</th>
<th>Low-Frequency Abstract</th>
<th>High-Frequency Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ark</td>
<td>Story</td>
<td>Ego</td>
<td>Contribution</td>
</tr>
<tr>
<td>Colony</td>
<td>Column</td>
<td>Infinity</td>
<td>Memory</td>
</tr>
<tr>
<td>Cabinet</td>
<td>Construction</td>
<td>Twilight</td>
<td>Opportunity</td>
</tr>
<tr>
<td>Ruler</td>
<td>Device</td>
<td>Perception</td>
<td>Height</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Office</td>
<td>Heredity</td>
<td>Strength</td>
</tr>
<tr>
<td>Medal</td>
<td>Foundation</td>
<td>Childhood</td>
<td>Revolution</td>
</tr>
<tr>
<td>Participant</td>
<td>Personnel</td>
<td>Pact</td>
<td>Week</td>
</tr>
<tr>
<td>Alchemist</td>
<td>Animal</td>
<td>Botany</td>
<td>Reaction</td>
</tr>
<tr>
<td>Preposition</td>
<td>Brain</td>
<td>Genius</td>
<td>Growth</td>
</tr>
<tr>
<td>Inhabitant</td>
<td>Creature</td>
<td>Rotation</td>
<td>Evening</td>
</tr>
</tbody>
</table>
APPENDIX B
ITEMS AND SOLUTIONS FOR THE RAT

<table>
<thead>
<tr>
<th>Remote Associate Items</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rocking/wheel/high</td>
<td>Chair</td>
</tr>
<tr>
<td>Fish/mine/rush</td>
<td>Gold</td>
</tr>
<tr>
<td>Sleeping/bean/trash</td>
<td>Bag</td>
</tr>
<tr>
<td>Loser/throat/spot</td>
<td>Sore</td>
</tr>
<tr>
<td>Print/berry/bird</td>
<td>Blue</td>
</tr>
<tr>
<td>Cracker/fly/fighter</td>
<td>Fire</td>
</tr>
<tr>
<td>Dew/comb/bee</td>
<td>Honey</td>
</tr>
<tr>
<td>Cream/skate/water</td>
<td>Ice</td>
</tr>
<tr>
<td>Basket/eight/snow</td>
<td>Ball</td>
</tr>
<tr>
<td>Safety/cushion/point</td>
<td>Pin</td>
</tr>
</tbody>
</table>

APPENDIX C
PROCEDURES OF THE CURRENT STUDY

<table>
<thead>
<tr>
<th>Task: Word Association Task</th>
<th>Creativity Tasks</th>
<th>Verbal Fluency Task</th>
<th>Intelligence Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Free Association Task</td>
<td>RAT</td>
<td>AUT</td>
<td>RIBS-S</td>
</tr>
<tr>
<td>Task: Type words that come to mind</td>
<td>Find a word that can connect all three words</td>
<td>Come up with alternate uses for the item</td>
<td>Indicate how often each of the phrases describes your thinking</td>
</tr>
<tr>
<td>Items: 40 items 60 seconds each (10 HF concrete, 10 LF concrete, 10 HF abstract, 10 LF abstract)</td>
<td>10 items, 30 seconds each</td>
<td>6 items, 8 minutes total</td>
<td>20 items, unlimited time</td>
</tr>
<tr>
<td>Example: Animal: (dog, pig, pet…) skate/eight/stick (figure) Shoe (use as a planter) “I have ideas for rearranging the furniture.” (0-4 scale) “Type words that end with -TION” (vacation, production…)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. The word association task was always administered to participants first. The order of the rest of the tasks was counterbalanced using a Latin Square.
HF, High frequency, LF, low frequency.