Effects of secure priming and performance feedback on creativity
EFFECTS OF SECURE PRIMING AND PERFORMANCE FEEDBACK ON CREATIVITY

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The present study assessed the effects of secure priming, referring to attachment security and a sense that the world is safe, and performance feedback on people’s creativity. It was hypothesized that the induced positive mood and motivation would redistribute resources away from self-protection towards self-worthiness and a more exploratory mindset, enabling curiosity, expansive reasoning and creativity. 92 psychology students completed an online experiment with factorial design, followed by assessments of cognitive ability and attachment style. Results provided a significant correlation between cognitive ability and creativity, a close to significant difference in creativity between secure and dismissing attachment, but no significant effects of secure priming or gamification. Methodological limitations that may have reduced the strength of the conditions and the likelihood of detecting significant effects were discussed.

Forrester Consulting (2014) concluded that companies that foster creativity are 3.5 times more likely to achieve revenue growth of 10% or more compared with less creative peers. Creativity is unfortunately very much of an intangible asset, for companies as well as individuals. Culture, settings, personality, as well as tools, techniques and tasks are all important factors to get creativity to flow in aspects of both quality and uniqueness.

Although both secure priming and gamification have become popular in recent decades, none or very few studies access and measure the impact of each condition on creativity, and none that consider the possible integrated effect. The present study set out to explore the effects of secure priming and performance feedback (the use of feedback and interactivity in traditionally non-game contexts is often referred to as gamification, in this case a simple form of gamification) on individuals’ creativity. Of particular interest is the combined psychological effect of secure priming and gamification as it potentially could guide the development of workplace interventions to tune the work-environment in a way that would increase the the level of creativity among employees.

Creativity

Creativity is generally defined as the generating of ideas, insights or problem solutions that are both novel and potentially appropriate, as well as useful or valuable (e.g. Amabile, 1983; Baas, De Dreu, & Nijstad, 2008). In addition to these criteria, Amabile (1983) includes a criterion that the creative thought process should be heuristic (no identifiable or ready path to the solution, rather based on trial and error often in combination with other strategies, like for example dividing problems into subproblems and sub-goals) rather than algorithmic (a predefined set of operations leading to an acceptable response).
While Guilford’s (1950) primary objective was to advocate for a more systematic study of creativity by contemporary psychologists, he did, indeed, also convey an insightful and apprehensive description of different domains and individual qualities that affect the quality and quantity of creativity. At that time, research on creativity was low in intensity, as the common belief was that creativity is related to, and a consequence of, intelligence. If researched upon, the studies were often tied to the creative thought process as such. A typical example of results from this type of research would be Wallas’ (1926, as cited in Rhodes, 1961) four stages of creativity: preparation (reading, observing and asking about a specific subject), followed by incubation (thinking and reasoning on the subject), inspiration (results in insights on the subject) and verification (insights verified to be useful). Guilford (1950) implied that this type of research was superficial, at least from a psychological point of view, and suggested key areas to study in order to get insights on important aspects of being creative. These key areas include personality factors, in particular, and traits like sensitivity to problems; ideational fluency and novelty; flexibility of mind and the ability to analyze, evaluate, reorganize, redefine and synthesize the span of the ideational structure; as well as motivational factors like interest and attitudes.

An important point is Guilford’s (1957) definition of the difference between convergent and divergent thinking, cognitive processes that either result in single correct conclusions or multiple novel, original, and unusual responses. Even though divergent thinking plays a central role in creativity, Guilford postulated both types to be equally important, at least, in non-art applications. While Guilford viewed both types of thinking as related to one’s intellectual abilities, Wallach and Kogan (1965) argued that divergent thinking has structural causes (see neural hyperconnectivity below) and is based on loosely related concepts and associations rather than executive abilities. The works of Wallas, Guilford, Wallach and Kogan and many others were later synthesized by Amabile (1983) into the componential framework of creativity, relating the creative process to domain-relevant skills (domain knowledge and technical skills), creativity-relevant skills (cognitive style and implicit and explicit heuristics for generating novel ideas) and task motivation (attitudes towards the task). Domain-relevant skills constitutes an individual’s complete knowledge from which an idea can be synthesized, creativity-relevant skills determines to which extent an idea will surpass any previous products or responses within the domain and while these two components determines what an individual can do, the third, task motivation, directly affects what he or she will do.

Even if Amabile’s componential framework of creativity pinpoints three different but equally important aspects of “real life creativity”, most creativity research still focuses on the creative skills, specifically the ideational capacity and performance of individuals, often measured in terms of fluency, flexibility, and novelty/originality.

Attachment
The attachment theory by Bowlby (1969, 1973, 1980) relates to psychological growth and how relationship characteristics incorporates into personality, where an individual’s early attachment, the consistency, sensitivity, and quality of care and relationships during infancy and childhood, influences the individual’s later development (Thompson, 2008). The attachment theory is grounded in another more generic theory of internal working models representing interaction patterns between self and others, and can be viewed upon
as an interpretative filter through which individuals build their understanding of new experiences in ways that are consistent with past experiences (Thompson, 2008).

According to Bowlby, all individuals are born with a biological predisposition to attach to a caregiver, a behavior that is rooted in the need of care in order to survive. It is this link between the individual and an attachment figure, the behavioral patterns, and the underlying working models, that is of interest in the attachment theory.

As a child, this relationship is categorized as secure when the child trust itself and the caregiver and insecure when the child lack trust in itself and/or the caregiver (Weinfield, Sroufe, Egeland, & Carlson, 2008). While the secure child’s positive expectation on the caregiver’s availability enables an exploratory behavior, the insecure child’s lack of trust results in strategies to either maximize the caregivers attention, suppress their need of attachment or appear disoriented, altogether limiting attention and leaving less resources available for an exploratory behavior (Weinfield et al., 2008). The latter three behavioral patterns are categorized as insecure-resistant, insecure-avoidant and disorganized.

In adults, attachment is classified according to four attachment styles: secure, preoccupied, dismissing, and fearful; where the three latter are referred to as insecure (Bartholomew, 1990; Bartholomew & Horowitz, 1991). These styles are manifested by the quadrants in two-dimensional space defined by an individual’s model of self and model of others (Bartholomew, 1990) and aligns well with Bowlby’s theory and concept of internal working models encapsulating relationships and interaction patterns through the image of self and others. The model of self range from negative (the self as unworthy, negative self-concept and high anxiety) to positive (the self as worthy of love and attention, positive self-concept and low anxiety) and the model of others range from negative (the others as rejecting, uncaring, distant and high avoidance) to positive (the others as trustworthy, caring, available and low avoidance).

Adult secure individuals tend to have positive expectations on the availability and effectiveness of social support (Ognibene & Collins, 1998, as cited in Mikulincer & Shaver, 2008) while preoccupied individuals often exaggerate their distress and presents themselves as extremely vulnerable to pain and injury in contact with others (Collins & Read, 1994, as cited in Mikulincer & Shaver, 2008), dismissing individuals rely mainly on themselves to deal with threats (Mikulincer & Shaver, 2008) and fearful individuals desire intimacy but as they also distrust others they tend to avoid close involvement that may lead to loss or rejection (Feeney, 2008). The preoccupied, dismissing and fearful styles are regarded as secondary attachment strategies, caused by a damaged emotion regulation, and created by the individuals in order to get “a workable relationship with a consistently distant or unavailable attachment figure” (p. 519), while the primary attachment strategy, adopted by secure individuals, is to seek proximity to a protective, supportive as well as stronger and wiser attachment figure (Mikulincer & Shaver, 2008).

Creativity and attachment
At first glance one would assume that secure individuals would be more creative than insecure individuals, since secure individuals foster interpersonal qualities, confidence, self-efficacy, self-esteem, social skills and the ability to explore the environment (Sroufe, Egeland & Carlson, 1999, as cited in Berlin, Cassidy, & Appleyard, 2008). Secure
individuals are also curious, open to new information, possibilities and perspectives and growth oriented (Mikulincer & Shaver, 2008). Dismissing individuals, on the other hand, often cannot engage in problem solving, since feelings of frustration and defeat, due to ambiguity and confusion, would block their memory access and hinder knowledge structures to be searched and updated (Mikulincer, 1997, as cited in Mikulincer & Shaver, 2008). Moreover, problem solving works against the preoccupied individuals’ urge to remain helpless, vulnerable and weak (Mikulincer & Shaver, 2008).

Yet, if one looks at creative individuals as a group, the picture looks slightly different. Exposure to difficult experiences (severe economical problems) and/or traumatic events (loss of or separation from one or both parents) early in life have in many cases contributed to the development of a higher creative potential (Simonton, 2009), backgrounds that also correspond to anxiety disorders such as panic disorder, social phobia, specific phobia, and generalized anxiety disorder together with the preoccupied attachment style (Cassidy, 1995, as cited in Dozier, Stovall-McClough, & Albus, 2008), and dissociative symptoms such as disturbances in the identity, awareness and cognition, often characterized as frequent day-dreaming and lack of memory for significant past events together with the fearful attachment style (Putnam, 1991, as cited in Dozier et al., 2008).

From a neurological perspective, maltreatment and stress during infancy and childhood result in the same anatomical and structural patterns in the brain’s white matter (Coplan et al., 2010, as cited in Howell et al., 2013), as hypothesized to cause neural hyper-connectivity which in turn results in anxiety, bipolar disorder, schizophrenia as well as increased openness, divergent thinking and creativity (Howell et al., 2013; Jung, Grazioplene, Caprihan, Chavez, & Haier, 2010; McCrea, 2008; Ryman et al., 2014).

Creative individuals are therefore be characterized by impaired filtering of stimuli leading to an increased number of irrelevant associations, which, according to Prentky (1979, 2001), must be balanced by higher logical capacity (aka cognitive ability). This is in line with Carson (2011), who argues that intellectual capacity (IQ) is the cause of division between psychopathology and creativity for individuals with impaired filtering.

Prior studies of creativity in combination with attachment
As described above, many aspects of attachment and different attachment styles are interlaced, at multiple levels, with key aspects of creativity. For example behavior and phenomena, early developmental similarities in neurological structure, and the impaired integration of mental functions.

These comparisons and findings are however course grained and the elusive similarities have not been consistently materialized in the research up to today. A study on attachment style and employee creativity by Kidney (2013) indicates that high levels of attachment anxiety and avoidance (among employees) may predict lower levels of information exchange and creativity. The study indicated small to moderate effect sizes. A meta-analysis on mood and creativity by Baas et al. (2008) showed that overall creative performance was higher in negative mood compared with positive mood; the advantage positive mood had on novelty and fluency was lost on flexibility and the insight capability. There was also an interaction effect of mood and task context, where negative mood
resulted in higher creativity when tasks were serious and problem oriented, while positive mood resulted in higher creativity when tasks were fun and enjoyable. Other studies have not found any statistically significant correlations between any of the attachment styles and creativity (Betty, 2011).

In another line of research, preoccupied and dismissing individuals temporarily increased their ability to solve creative problems when supraliminally induced with the perception and the availability of an attentive attachment figure, for example a drawing of a mother cradling an infant in her arms (Mikulincer, Hirschberger, Nachmias, & Gillath, 2001; Mikulincer, Shaver, & Rom, 2011). This phenomenon can be explained, at least to some degree, by the dynamic model of attachment system activation by Shaver and Mikulincer (2002) and opens up for many interesting experimental conditions. Even though the internal working models of attachment security are quite stable over time, research shows that an individual’s sense of attachment security can temporarily change depending on experimentally or naturally induced recent experiences (Mikulincer et al., 2001). This type of experiments are especially intriguing as they may indicate that these individuals temporarily retain resources that are otherwise locked up in attachment related thought processes, and/or that the curiosity and openness to new information, possibilities and perspectives, as well as the growth-oriented mind, otherwise only held by secure individuals, temporarily becomes adopted by these less secure individuals.

Combined psychological effect of secure priming and gamification

By applying performance feedback (a simple form of gamification) in addition to the secure priming, the positive effect of sensing a secure base, independent of their actual attachment style, may be stretched even further, and increase the individual’s affiliation, engagement, and ultimately his/her creativity. Gamification is defined as the “use of game design elements in non-game contexts” (Deterding, Khaled, Nacke, & Dixon, 2011), and is often realized by adding challenges, feedback, and interactivity to traditionally non-game applications and contexts, such as for example business applications and business processes, in order to engage and motivate employees (Yohannis, Prabowo, & Waworuntu, 2014). Another excellent, but non-work related, example of a gamified application is Facebook. Who has not, during some period in their life, been chasing Facebook likes?

The self-determination theory by Ryan and Deci (2000) is often used as an explanation of the engagement in gamified activities. In essence, gamified activities satisfy fundamental human needs for competence, autonomy and relatedness resulting in intrinsic motivation and positive affect (Przybylski, Rigby, & Ryan, 2010).

In line with this, the prospect of a positive outcome has been found to bolster creativity (Friedman & Förster, 2005). According to the broaden-and-build theory (Fredrickson, 2001), an increase in positive affect results in a behavioral control that is more intuitive and effortless, which broadens cognitive processing and includes more exploratory thoughts and actions. Recent research by Wang, Schneider and Valacich (2015) show that individuals’ creativity is positively associated with perceived competence and that perceived competence interacts with performance feedback. The guiding theory in this research is that these mechanisms will have an impact on creativity-related skills (through
more exploratory thoughts due to broadened cognitive processes) as well as task-motivation (through induced intrinsic motivation).

The present study set out to explore the effect of secure priming and performance feedback on these grounds. Of main interest was whether a sense of secure base and the motivational effects of secure priming and performance feedback enable curiosity and increase openness and acceptance of stimulating ideas with higher originality and with reduced constraints; and ultimately results in more expansive reasoning and higher creativity. It was hypothesized that a) secure priming results in higher levels of creativity compared with neutral conditions, b) performance feedback results in higher levels of creativity compared with a control group with neutral condition and c) the combination of secure priming and performance feedback results in higher levels of creativity than any of the other conditions.

Method

Participants
In total, 145 students at the Department of Psychology at Stockholm University participated in the study and replied to at least one item. After listwise deletion of missing data and filtering out participants who spent less than 25 seconds on each creativity task, analyses were based on data of 92 participants. The threshold of 25 seconds was an effect of the performance feedback implementation, as it operated at intervals of 20 seconds. Age and sex were not collected due to anonymity reasons.

Procedure and material
The study was performed using an online/web-based instrument accessed and runnable in standard web-browsers on most desktops, laptops, tablets and mobile devices. The instrument was developed using PHP (version 5.6.30), MariaDB (version 10.0.30), a Debian (version 8.9) Linux server and approximately 3680 lines of code in JavaScript, HTML, CSS and PHP. During second half of April (late semester), participants were invited to the study through e-mails targeted to students at the Department of Psychology at Stockholm University. Two e-mails were sent out, the second as a reminder one week after the first. Besides introductory information about the study, the e-mails contained a link to an information page on the Internet.

Once at the information page, the participants were informed about the usage of the collected data, confidentiality of the data handling, that their participation was voluntary and that they were free to quit at any time. By clicking on a button to start the experiment, the participants agreed to the specified terms and gave their consent to participate. Students seeking course credits in the research participation system had to complete all parts of the study before they could apply for the credits. In order to get the course credits, participants had to state their name, date of birth and which course or program they was enrolled in.

The online/web-based instrument guided the participants through four different tasks, where the first task was a secure priming task masked as an assessment of aesthetic preferences, the second an assessment of creativity, the third an assessment of cognitive
abilities and the fourth task a self-report questionnaire composed of items derived from the Relationship Questionnaire (RQ; Bartholomew & Horowitz, 1991), presented in randomized order. No time limits were applied and no default answers were set.

Experimental conditions.
The experimental conditions were implemented and indirectly conveyed in first and the second tasks. The assessment of aesthetic preferences was in reality used as secure priming. The participants were supraliminally primed while consciously rating the pleasantness of images picturing either neutral motives (= neutral condition) or attachment-figures in caring and responding situations (= secure priming condition).

During the second task, the assessment of creativity, the participants got either no (= neutral condition) or continuous feedback on their performance in relation to the performance of the average and top performers (= gamification condition). The tone of the performance feedback were dynamically adjusted and depended on the subject’s actual performance in terms of number of ideas and current phase (time between ideas). Participants were randomly and automatically assigned to two the four conditions. Figure 1 provides screenshots of the user interface of the four experimental conditions.
Figure 1. Illustrative screenshots of the user interface of the four experimental conditions. Participants were shown either neutral motives (A) or became supraliminally primed with motives of attachment-figures in caring and responding situations (B) and got either no feedback (C) or became motivated by continuous performance feedback (D).
Adult attachment style was assessed using Bartholomew and Horowitz’s Relationship Questionnaire (RQ; Bartholomew & Horowitz, 1991), transformed into a self-report scale with four three item sub-scales (or dimensions), measuring the subject’s relative fit to the secure, preoccupied, dismissing and fearful attachment styles. All twelve items were rated using a Likert scale ranging from 1 (Inaccurate) to 5 (Accurate). Statements included in the items were for example “I am comfortable depending on others” (secure), “I sometimes worry that others do not value me as much as I value them” (preoccupied), “I am comfortable without close emotional relationships” (dismissing) and “I worry that I will be hurt if I allow myself to become too close to others” (fearful). Index variables were calculated as the mean score of each sub-scale’s items.

In this research the RQ was used as a categorical measure of adult attachment style. The categorization was carried out according to Bartholomew’s guidelines (n.d.), by comparing the standard scores of each subject’s sub-scales, where the sub-scale with the highest standard score determines the subject’s attachment style. Nowadays the recommended usage of the scale, by Bartholomew and other researchers, is primarily as a continuous measure of adult attachment rather than a categorical measurement of attachment style.

Kurdek (2002) elaborates on the reasons for this change in view, and, in essence, it is all about reliability. The reliability of RQ and similar scales is simply too low in order to scientifically be able to map a specific individual to a certain attachment style. However, in this research the categorical measure of adult attachment style is used only to provide some explanatory value in an explorative research. In addition, as the scale is used on an
group level where negative and positive residuals might balance one another rather than
determine on specific individual’s the objections may be reduced even further.

Descriptive statistics including reliabilities are shown in Table 3. The actual distribution of
attachment styles is shown in Table 1.

<table>
<thead>
<tr>
<th>Assigned attachment style</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure</td>
<td>31</td>
<td>33.7</td>
</tr>
<tr>
<td>Preoccupied</td>
<td>17</td>
<td>18.5</td>
</tr>
<tr>
<td>Dismissing</td>
<td>23</td>
<td>25.0</td>
</tr>
<tr>
<td>Fearful</td>
<td>21</td>
<td>22.8</td>
</tr>
</tbody>
</table>

**Creativity.**
The dependent measure was creativity, measured as divergent thinking and assessed with
two subtests of the Wallach-Kogan Creativity Test (WKCT, Wallach & Kogan, 1965),
more specifically a line meaning test with graphical stimuli (“Things the drawing makes
you think of” in combination with an incomplete line drawing) and an alternate uses test
with verbal stimuli (“Different ways to use a cork”). The participants were asked to write
as many ideas as possible in relation to the stimulus. Figure 1, pane C and D, provides
illustrations screenshots of the task’s graphical user interface including the two types of
conditions and the two types of stimulus.

Participants’ responses were scored for fluency, originality and flexibility. Fluency was
calculated as the average number of ideas given in the two subtests, originality as the
average novelty rate of the ideas and flexibility as the average number of distinct semantic
categories each subject’s ideas touched upon, as described by Plucker and Makel (2010).
The latter two measurements were derived from a consolidated list of all the ideas given
by all the participants (in total, 917 ideas), through which each idea was assessed on a 5-
point scale ranging from 1 (not at all novel) to 5 (very novel) as well as mapped into
semantic categories (a new category added if an idea did not fit with an existing category,
the final list of semantic categories contained 79 entries).

An index variable, Creativity, was created by averaging log-transformed Fluency,
Originality and Flexibility measurements. The log-transformation was done in order to
mitigate the skewness of the measurements, an effect of non-normal distribution of
creativity, with a significant few and an insignificant many. Or, as put by Runco and
Sakamoto (1999): “The distribution of creative output is ny no means normal, but
extremely skewed right, with a rather long upper tail”. Jauk, Benedek, Dunst, and
Neubauer (2013) got a skewness of 1.78 for creative achievement.
Table 2. Descriptive statistics for Fluency, Originality, Flexibility and Creativity, where the latter is a log transformed index variable. Bivariate correlations (1-4), mean (M), standard deviation (SD), Skewness and reliability as Cronbach’s alpha (α).

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>M</th>
<th>SD</th>
<th>Skewness</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.98</td>
<td>3.08</td>
<td>2.39</td>
<td>NA</td>
</tr>
<tr>
<td>Originality</td>
<td>0.97**</td>
<td></td>
<td></td>
<td></td>
<td>14.42</td>
<td>10.52</td>
<td>2.47</td>
<td>NA</td>
</tr>
<tr>
<td>Flexibility</td>
<td>0.85** 0.88**</td>
<td></td>
<td></td>
<td></td>
<td>3.54</td>
<td>1.91</td>
<td>1.93</td>
<td>NA</td>
</tr>
<tr>
<td>Creativity</td>
<td>0.97** 0.99** 0.94**</td>
<td></td>
<td></td>
<td></td>
<td>0.73</td>
<td>0.23</td>
<td>0.07</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Note: N = 92, * p < .05, ** p < .01, NA = not applicable

Cognitive ability.

Cognitive abilities was assessed with twelve progressive matrix problems similar to Raven’s progressive matrices (Raven, 1938). The objective to include cognitive ability as a covariate is to control for possible mediating effects of general cognitive ability on creativity - to verify there is an effect of secure priming once the covariate has been accounted for.

A set of twelve matrices were especially developed within the present research as there were no free online tests for cognitive abilities available. The set was developed using Carpenter, Just and Shell’s (1990) analysis of and theory on Raven’s advanced progressive matrices as basis. Carpenter’s et al’s theory indicates that the required capacity in abstraction ability (“the construction of representations that are only loosely tied to perceptual inputs and instead are more dependent on high-level interpretations of inputs that provides a generalization over space and time”, p. 428) and working memory is determined by the number of rules, the complexity of each rule and the actual combination of rules. In this context a rule is an operation on one or more graphical elements, and it its complexity differs depending on type of operation (constant, progression, addition, subtraction, etc) and the pattern of the graphical elements it operates on.

The matrices in the developed set deploys 1 to 5 rules, which corresponds to the range found in found in Raven’s advanced progressive matrices. Thus indicating that the level of difficulty may span, at least in theory, over the same range as Raven’s advanced progressive matrices. However, even though the items were piloted among a small group of family and friends, no normalization or comparison with Raven or other tests have been performed prior to or after the current research. Nonetheless, according to Embretson (1998) psychometric properties of cognitive tests generated from Carpenter et al.’s theory correspond (generally) well with Raven’s matrices.

Result

All statistical analyses were performed in R (version 3.3.3) including the reshape2 (version 2.1.4.2) and psych (version 1.7.5) add-on packages. Descriptive statistics are presented in Table 1, Table 2 and Table 3.
A 2 x 2 between subjects factorial analysis of covariance (ANCOVA) was conducted to compare the main and interaction effects of secure priming and gamification on Creativity, whilst controlling for Cognitive ability. Results showed that Cognitive ability covaried significantly with Creativity, F(1, 87) = 10.42, p < .05. After partialling out the variance associated with Cognitive ability, there were no significant effect of secure priming, F(1, 87) = .06, p > .05, no significant effect of gamification, F(1, 87) = .09, p > .05, and no significant interaction effect between secure priming and gamification, F(1, 87) = .61, p > .05. The result is illustrated in Figure 3.
A 4 x 4 between subjects factorial analysis of covariance (ANCOVA) was conducted to compare the main and interaction effects of experimental conditions (secure priming and gamification) and Attachment style on Creativity, whilst controlling for Cognitive ability. Results showed that Cognitive ability covaried significantly with Creativity, $F(1, 75) = 11.25$, $p < .05$. After partialling out the variance associated with Cognitive ability, there were no significant effect of the experimental conditions, $F(3, 75) = .27$, $p > .05$, a close to significant effect of Attachment style, $F(3, 75) = 2.72$, $p = .05$, and no significant interaction effect between experimental conditions and Attachment style, $F(9, 75) = 1.20$, $p > .05$. A Tukey’s HSD post-hoc test indicated that the secure individuals were more creative than the dismissing individuals in the combined condition of no secure priming and no performance feedback. The result is illustrated in Figure 4.
Figure 4. Results of an ANCOVA testing main and interaction effects of the experimental conditions (secure priming, NP = no priming/neutral and Priming = secure priming, and gamification, NF = no feedback/neutral and Feedback = continuous performance feedback) and Attachment style.

Power calculations indicate that the sample size should be at least 21 participants per group and 84 participants in total for an ANOVA with 4 groups and an effect size of 0.37 and a desired power of 0.8, based on Kidney (2013) results of $r^2$ equal to 0.12 for creativity and 0.14 for attachment style, thus indicating effect sizes in the range of 0.37-0.40. For an ANOVA with 16 groups the corresponding power calculations indicate that the sample size should be at least 10 participants per group and 160 participants in total. However, as attachment style differs in prevalence, indicatively shown by the distribution among American students, 41%, 13%, 18% and 28% for the secure, preoccupied, dismissing and fearful attachment styles (Konrath, Chopik, Hsing, & O’Brien, 2014), respectively, the sample should be increased to 310 participants in order to engage (at least and/or approximately) 40 (4 x 10) students with a preoccupied attachment style.

Discussion

The purpose of the present research was to examine the effect of secure priming and performance feedback (a simple form of gamification) in order to test whether the sense of
secure base and the motivational effects of performance feedback enable curiosity and more expansive reasoning through reduced constraints, increased openness, and acceptance of stimulating ideas with higher originality and ultimately leading to higher levels of creativity.

The result of the experiment, illustrated in Figure 3, did, however not, support the initially set hypotheses. Secure priming did not result in higher levels of creativity compared with the neutral conditions, nor did the applied version of performance feedback or the interaction of the two. This means that the effectiveness of the theories may be less salient in real life settings (this research) as compared with lab-environments. Especially in combination with indistinct experimental condition, which in itself may cause a substantial reduced effect.

The result for the second and more exploratory part of the experiment is illustrated in Figure 4. Here the aim was to investigate possible differences in creativity, both generically and in terms of the applied experimental conditions, between individuals with different attachment styles. The result indicate a close to statistically significant difference in creativity between (participants with different) attachment styles, no statistically significant difference between experimental conditions and no statistically significant interaction effect of attachment style and experimental condition. However, as the two groups were constituted of only 4 and 7 participants each, the result is most likely a random occurrence due to the combination of the non-normal distribution of a high creative ability among participants and too few participants - hence, an obvious case of too low statistical power.

Table 4. Descriptive statistics, share with more than 2 to 8 ideas within each attachment style group.

<table>
<thead>
<tr>
<th>Attachment style</th>
<th>&gt;2 ideas</th>
<th>&gt;4 ideas</th>
<th>&gt;6 ideas</th>
<th>&gt;8 ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secure</td>
<td>97%</td>
<td>71%</td>
<td>22%</td>
<td>16%</td>
</tr>
<tr>
<td>Preoccupied</td>
<td>94%</td>
<td>41%</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>Dismissing</td>
<td>87%</td>
<td>43%</td>
<td>17%</td>
<td>0%</td>
</tr>
<tr>
<td>Fearful</td>
<td>95%</td>
<td>48%</td>
<td>24%</td>
<td>10%</td>
</tr>
</tbody>
</table>

The tendency shown in Table 4, with the creative few among the Secure and Fearful groups, is interesting as it corresponds with a finding by Fransson, Granqvist, Bohlin, and Hagekull (2013). In an effort to relate attachment styles with the Big Five personality dimensions, both the fearful (disorganized) and the secure attachment styles correlated positively with openness, which in turn is known to correlate with creativity [ref]. The only other statically significant correlations in the study by Fransson et al. (2013), were a positive correlation between the secure attachment style and extraversion and a negative correlation between the fearful attachment style (disorganized) and conscientiousness. This could imply that the secure attachment style is beneficial also in terms of creativity - as in most other situations. It could also imply that the fearful attachment style is interlinked with higher creativity through neural hyperconnectivity due to childhood trauma. The counterargument to this is that the correlations between the different attachment styles and Creativity is very weak, thus possibly indicating a non existing
The significant correlation between Cognitive ability and Creativity (see Table 3) aligns well with research by Jauk et al. (2013), where IQ explained 17-32% of the variance in creativity. In this research it explained only 11%, tough. The lower variance in this research could possibly be explained by a high(er) IQ among students studying psychology. In a study specifically searching for potential IQ related thresholds for creativity, Jauk et al. (2013) found three. At an IQ of 85, 100, and 120, which mapped to the abilities to generate multiple ideas (fluency), at least two original ideas and multiple original ideas, respectively. While IQ explained 31% of the variance for individuals with an IQ below 85, it only explained 17% for those below 104 and 7% for those above 104.

The distribution of attachment styles (see Table 1) resembles the results for american students', also measured with RQ, with the distribution of 49% secure, 17% preoccupied, 12% dismissing and 22% fearful in 1988 and 41% secure, 13% preoccupied, 18% preoccupied and 28% fearful in 2011 (Konrath et al., 2014).

Limitations

The reliability of the RQ scale (with alpha values between .53 and .76, see Table 3) have been touched upon earlier, but deserves to be mentioned once again. One plausible explanation for this is that the items had rather complicated wordings, often with two concatenated statements in each item. In some case the statements were also reverse coded. The reported reliability was however in line with earlier research, with ranges from .50 to .72 (Kurdek, 2002). The distribution of Secure, Preoccupied, Dismissing and Fearful attachment styles should thus not be fully trusted (Kurdek, 2002), and one should try to avoid making categorical comparisons based on self-report scales (Bartholomew, n.d.; Kurdek, 2002). With exploratory research as a possible exemption.

All information in relation to the present research, e-mails, information page and instrument, were written in English. The use of English may have negatively impacted the participants' understanding on some or all of the items. In addition, it may have negatively impacted the participants' motivation to generate and enter/write ideas, and hence explain the substantial attrition of participants at that specific task (a loss of 145-101 = 44 participants). On the positive side, though, is that there were no translation issues as all included scales and tests were originally created in English.

Analysis of the data show that nine of the participants (101-92 = 9) rushed through the experiment in less than 10 minutes and thus participated mainly with the objective to get course credits rather than making a fair result. This would most likely not occur in a more controlled lab environment.

The environment in which the participants performed the experiment was not a controlled environment, which also applies to their actual status (calm, in a hurry, etc), as all participants participated at their own discretion. There was also no control of the the device used to run the experiment on, and the priming effect on a mobile device is most likely substantially smaller than on a laptop or stationary computer. These types of tests should preferably be performed in controlled environments. One the other hand, one may
question the ecological validity of lab-controlled experiments. The real life situation is likely to be more complex and the benefit of secure priming is weak or even none. Similar to the result in the present research.

Flexibility and originality in the creativity assessment were rated by a single rater. Even if the rating was performed as objectively as possibly, the result might be biased. This type of rating should preferable be preformed by at least two raters. Or using a program on a computer, as proposed by Bossomaier, Harré, Knittel, and Snyder (2009).

The number of participants was low. There are probably multiple causes for this. The timing of the survey late in the semester (end-of April) may for example have reduced the nume of potential participants substantially. There might also have been a general fatigue or reluctance to participate in online surveys. Very few would have participated without the need of course credits in the research participation system. And even though the instrument could have been plagued with technical issues (as the time for alpha and beta testing were short), the author did not get any reports of any problems to run the experiment, which in-itself is good. Independently of the actual causes, the number of individuals in each group was far below the calculated threshold of 10 participants per condition and 40 participants in each attachment style, which makes the result sensitive to individual results. The statistical power was thus substantially reduced compared with the anticipated number/strength.

In research by Norman, Lawrence, Iles, Benattayallah, and Karl (2015), secure priming was performed using 48 pictures of people in caregiving situations, which was substantially more than the six images used in the present research. The mean time each of these images were looked at was 6 seconds ($M = 6$ seconds, $SD = 4$), thus the whole secure priming was done in (on average) 36 seconds. Most likely was the the performance feedback also too insignificant with its single line of feedback.

Considerations for future studies
The reliability of the Relationship Questionnaire’s (transformed into a scale) sub-scales ranged from poor to acceptable. Based on Kurdek’s (2002) confirmatory factor analyses of Griffin and Bartholomew’s (1994) updated Relationship Scales Questionnaire one should be able to increase the reliability simply by making a better selection of items.

All assessments and tasks should preferably be time bound. Each subject should preferably actively see each image in the secure priming task for longer periods. The creativity tests must also be time-bound, the average-time in the present research were slightly below 4 minutes ($M = 238$ seconds, $SD = 186$) for the first task and slightly below 2 minutes ($M = 116$ seconds, $SD = 100$) for the second task. The time measures were highly skewed (skewness = 1.38, aggregated value for the first and second task). That in itself is not too bad. However, participants who spent less than 25 seconds on each creativity task ($M = 11$ seconds, $SD = 5$) have been filtered out.

Secure priming is very much about attenuating amygdala activation in threatening situations (Norman et al., 2015). What if the assessed situation was not social nor threatening, but instead done solitarily and characterized by anonymity (participants knew they would not be judged upon their result) as in the present research. Could that have
lead to a reduction of secure priming’s psychological effect? Independently, the environment should preferably be controlled for and not, as in the present research, be up to the participants’ own discretion. And if it is not possible, as for online surveys, one could as an alternative at least add a few questions in the questionnaire and collect data about the actual test environment and the participants’ actual arousal level.

A research scope as wide is in the present research should preferably be implemented and verified as a sequence of separate research studies before being integrated into a complex design. A proposal for a step-wise, modular and more feasible approach would be: One study for the development and verification of progressive matrices including comparison with existing Raven matrices and normalization. One study to verify the effect of secure priming in situation characterized by solitarily and anonymity. One study to verify the effect of secure priming on mobile devices, and ensure the right level of secure priming, maybe 48 pictures are required, as in the research by Norman et al. (2015). One study to ensure the right level of gamification, to update one text line with different status messages is most likely not enough, the participants must be engages in a much higher degree (clicking or somehow responding to feedback). If possible, it would be very interesting to study of neural hyperconnectivity caused by less fractional anisotropy in relation to attachment and creative.

Concluding remarks
The present results can not be used to determine whether the effects of secure priming and gamification exist or not. Nevertheless, the research findings and the developed instrument provides a good foundation for further studies within this domain as well as in and adjacent research domains. For example, what are the effects of attachment on trust, information sharing, and group creativity, not to mention management practice and leadership expectations and perceptions? Even the smallest improvement in settings, management, culture, personality, as well as tools, techniques and tasks may matter greatly when it comes to spur creativity and innovation.

References


