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The effects of implicit and explicit security priming on creative problem solving

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Attachment theory is a theory of affect regulation as it occurs in the context of close relationships. Early research focused on regulation of emotions through maintenance of proximity to supportive others (*attachment figures*) in times of need. Recently, emphasis has shifted to the regulation of emotion, and the benefits of such regulation for exploration and learning, via the activation of mental representations of attachment figures (*security priming*). We conducted two studies on the effects of implicit and explicit security priming on creative problem solving. In Study 1, implicit security priming (subliminal presentation of attachment figures' names) led to more creative problem solving (compared with control conditions) regardless of dispositional attachment anxiety and avoidance. In Study 2, the effects of explicit security priming (recalling experiences of being well cared for) were moderated by anxiety and avoidance. We discuss the link between attachment and exploration and the different effects of implicit and explicit security priming.

Keywords: Attachment; Attachment anxiety; Security priming; Creative problem solving.

Attachment theory (Bowlby, 1982) has become one of the most prominent theories in developmental, social, and personality psychology (see Cassidy & Shaver, 2008, for a comprehensive overview). The theory divides human motivation into realms governed by what Bowlby (1982) called innate behavioural systems (e.g., attachment, exploration, care giving). An important early part of the theory was Ainsworth's (Ainsworth, Blehar, Water, & Wall, 1978) idea that exploration (e.g., exploring the physical world, exploring and developing skills of various kinds) was a natural part of the human behavioural repertoire

from early infancy on, and that its optimal functioning depended on a secure attachment relationship between a child and a familiar caregiver, often a parent. Beginning in the 1980s, the theory was extended conceptually and empirically to apply to adolescents and adults (e.g., Hazan & Shaver, 1987). Because the extension was focused largely on romantic attachment, or pair bonding, in couple relationships, the focus on exploration was lost for a time. The purpose of the present paper is to help the field return to the general issue of attachment security as a contributor to creative exploration (see also Feeney & Van Vleet, 2010,

for studies of security and exploration in romantic and marital relationships).

Attachment and emotion regulation

One of the basic assumptions of attachment theory (Bowlby, 1973, 1980, 1982) is that social interactions with significant others (called "attachment figures" in the theory) are internalised in the form of conscious and unconscious mental representations of self and relationship partners ("internal working models of self and others"), which affect close relationships and emotion regulation throughout life (Mikulincer & Shaver, 2007a). To summarise the theory briefly, interactions with attachment figures who are available and supportive in times of need foster the development of both a sense of attachment security ("felt security"; Sroufe & Waters, 1977) and internal working models that are generally positive and optimistic, thereby contributing to self-worth, adaptive emotion-regulation strategies, effective psychosocial functioning, and good mental health (Mikulincer & Shaver, 2007a). When attachment figures are rejecting or unavailable in times of need, felt security is undermined, negative models of self and others are formed, and the likelihood of later emotional problems and maladjustment increases.

When testing this theory in studies of adults, most researchers have focused on a person's "attachment style"—the systematic pattern of relational expectations, emotions, and behaviour that results from a person's attachment history (Fraley & Shaver, 2000). Research, beginning with Ainsworth et al. (1978) and continuing through recent studies by social and personality psychologists (see Mikulincer & Shaver, 2007a, for a review), indicates that attachment styles can be measured in terms of two orthogonal dimensions, attachment-related *anxiety* and *avoidance* (Brennan, Clark, & Shaver, 1998). A person's position on the anxiety (or anxious attachment) dimension indicates the degree to which he or she worries that a partner will not be available in times of need and adopts "hyperactivating" attachment strategies—energetic, insistent attempts to obtain care,

support, and love from relationship partners—as a means of regulating distress (Mikulincer & Shaver, 2003). A person's position on the avoidance (or avoidant attachment) dimension indicates the extent to which he or she distrusts relationship partners' goodwill, strives to maintain behavioural independence and emotional distance from partners, and relies on deactivating strategies, such as suppression of attachment-related thoughts and emotions (Mikulincer & Shaver, 2003). People who score low on both dimensions are said to be secure or to have a secure attachment style.

There is now extensive evidence that lower scores on measures of attachment anxiety and avoidance are associated with more adaptive responses to threats and stressors and more satisfying and stable romantic or marital relationships (see Mikulincer & Shaver, 2007a, for a review). Moreover, dispositional attachment security (i.e., low scores on attachment anxiety and avoidance) is associated with fewer interpersonal problems in general (e.g., Bartholomew & Horowitz, 1991); greater empathy and compassion (Gillath, Shaver, & Mikulincer, 2005); greater willingness to help needy others (e.g., Collins & Feeney, 2000); higher levels of curiosity, cognitive openness, and exploratory behaviour (e.g., Feeney, 2007; Mikulincer, 1997); and lower risk of developing emotional difficulties and psychopathology (e.g., Mikulincer, Florian, & Weller, 1993).

Although the psychological benefits of attachment security may seem to be well established (see Mikulincer & Shaver, 2007a, for a review), the direction of causality is still open to research. Most studies have been based on cross-sectional research designs and on the assumption that attachment security is a stable trait that has persisting effects on other aspects of psychosocial functioning. However, some studies have revealed fluctuations in attachment security following major life transitions and stressful events (e.g., Cozzarelli, Karafa, Collins, & Tagler, 2003; Davila & Sargent, 2003). Moreover, although attachment security is often conceptualised as a single global orientation toward close relationships (i.e., a stable trait), and is often measured as

such (e.g., Brennan et al., 1998), a person's attachment security is rooted in a complex cognitive and affective network that includes many different episodic, context-related, and relationship-specific, as well as fairly general, attachment representations (Mikulincer & Shaver, 2007b). In fact, research shows that a person's sense of attachment security can change, subtly or dramatically, depending on natural or experimentally induced contexts and recent experiences (e.g., Baldwin, Keelan, Fehr, Enns, & Koh Rangarajoo, 1996; Mikulincer & Shaver, 2001).

In light of that fact, we have used well-validated social-cognition research techniques to activate a person's sense of attachment security and then measured the short-term psychological effects of this intervention (e.g., Mikulincer, Gillath, et al., 2001; Mikulincer, Hirschberger, Nachmias, & Gillath, 2001; Mikulincer & Shaver, 2001). These experimental manipulations, which we call "security priming" (Mikulincer & Shaver, 2007b), include subliminal presentation of pictures that suggest attachment-figure availability (e.g., a Picasso drawing of a mother cradling an infant in her arms; a couple holding hands and gazing into each other's eyes); subliminal presentation of the names of people who were designated by participants as security-enhancing attachment figures; guided imagery concerning the availability of an attachment figure; and visualisation of the faces of security-enhancing attachment figures. The effects of these security primes have been compared with the effects of emotionally positive but attachment-unrelated stimuli (e.g., pictures of a large amount of money, the names or faces of acquaintances who are not attachment figures) or emotionally neutral stimuli (e.g., pictures of furniture, neutral words), and the effects of security priming stand out as distinct.

Using these cognitive procedures, we have consistently found that security priming has positive effects on mood, mental health, compassionate and prosocial feelings and behaviours, and tolerance toward out-group members, and this happens even in the case of otherwise insecure or insecurely attached people (e.g., Mikulincer, Hirschberger, et al., 2001; Mikulincer & Shaver,

2001; Mikulincer, Shaver, Gillath, & Nitzberg, 2005; Mikulincer, Shaver, & Horesh, 2006). Positive effects of security priming on self-views and views of romantic partners have also been found (e.g., Baccus, Baldwin, & Packer, 2004; Rowe & Carnelley, 2003, 2006). Rowe and Carnelley (2006) also showed that security priming for three consecutive days has positive effects on people's views of their romantic partners two days later. We therefore believe that even pre-conscious bolstering of a person's sense of attachment security can, at least temporarily, have beneficial effects even if a person is generally insecure with respect to attachment.

Attachment security, exploration, and creativity

In the studies reported here, we wish to extend our examination of the effects of security priming to the realm of exploration and creativity. According to attachment theory (Ainsworth et al., 1978; Bowlby, 1973), attachment insecurities interfere with optimal exploration and learning. People who feel threatened and inadequately protected or supported by their attachment figures find it difficult to explore new objects and environments and acquire new information that may challenge or expand their existing beliefs. In contrast, a sense of attachment security can enhance curiosity, encourage relaxed exploration of new, unusual information and phenomena, and favour the formation of new and flexible cognitive structures. Secure individuals, being confident of their ability to deal with distress while relying, if necessary, on close others, should be able to incorporate new information even at the expense of temporary perplexity or confusion. They realise that perplexity, like other challenging experiences, is short-lived and can lead to greater mastery and broadened perspectives (e.g., Feeney & Van Vleet, 2010; Mikulincer & Shaver, 2007a).

These ideas have received strong support in studies showing that people who score higher on measures of dispositional security also score higher on self-report measures of novelty seeking (e.g., Carnelley & Ruscher, 2000), trait curiosity

(Mikulincer, 1997), and exploratory interest (e.g., Green & Campbell, 2000). More secure adults are also characterised by lower levels of cognitive closure, dogmatic thinking, and intolerance of ambiguity (e.g., Green-Hennessy & Reis, 1998; Mikulincer, 1997). Secure adults are also less likely to make judgements based on early information while ignoring later data, and less likely to judge a group member based only on a generalised notion about the group rather than considering specific information about that particular person (Mikulincer, 1997). In the context of romantic relationships, Feeney and Thrush (2010) found that a romantic or marital partner's availability and supportiveness during a laboratory exploration activity helped people persist longer at the activity while avoiding anxiety. Van Vleet and Feeney (2010) found that spouse availability during the first year of marriage predicted increases in exploration over the subsequent year.

Attachment-related differences in cognitive openness can be observed even in situations that might be expected to encourage relaxed exploration, such as ones that increase a person's level of positive emotion. In a series of three experiments, Mikulincer and Sheffi (2000) offered people various positive experiences (retrieving a happy memory or watching a brief comedy film) or exposed them to a neutral condition, and found that the previously demonstrated beneficial effects of positive mood on creative problem solving (Isen, Daubman, & Nowicki, 1987) were observed only among people who were relatively secure with respect to attachment. These people reacted to a positive mood induction by performing better on a creative problem-solving task. In contrast, avoidant individuals were not affected by positive affect inductions, and anxious ones actually reacted to positive inductions with *impaired* creativity (the opposite of what occurred with secure individuals and the same as what happened in previous studies when a negative rather than a positive mood was induced).

Again, most of these studies relied on cross-sectional, correlational research designs and so could not test for causal effects of attachment security on exploration and cognitive openness. The major goal of the present studies was to examine causal processes by experimentally priming mental representations of attachment security and examining the effect on creative problem solving. Specifically, we conducted two laboratory experiments in which we: (i) measured participants' dispositional attachment orientations (attachment anxiety and avoidance); (ii) subliminally or supraliminally primed mental representations of attachment security or attachment-irrelevant mental representations; and (iii) measured participants' performance on a creative problem-solving task. This allowed us to examine associations between dispositional attachment insecurities and creative problem solving, the causal effects of short-term security priming, and the possible interactions between security priming and dispositional attachment insecurities.

A second goal of the present studies was to compare the effects of implicit, subliminal security priming (Study 1) with the effects of explicit, supraliminal security priming (Study 2). Recent studies have found that emotion regulation can operate at implicit levels, outside of awareness, and without conscious deliberation (e.g., Koole, 2009; Mauss, Bunge, & Gross, 2007; Meyer, Berkman, Karremans, & Lieberman, 2011 this issue). Moreover, attachment studies have found that security priming has positive effects on emotion regulation at both explicit and implicit levels (see Mikulincer & Shaver, 2007b, for a review). However, Mallinckrodt (2007) reported that, although explicit security priming generally had a positive effect on mood, participants who scored relatively high on attachment anxiety reacted less positively to the intervention. We think it is possible that conscious thinking about supraliminal security primes can encourage anxious individuals' habitual tendency to ruminate about love, security, and support, which then causes attention to shift to negative images and feelings that interfere with exploration and problem solving. We explored this possibility in the studies reported here.

STUDY 1

In Study 1, we assessed participants' dispositional attachment anxiety and avoidance, subliminally presented security primes, and assessed their effects on creative problem solving. To heighten the accessibility of mental representations of attachment security, we used a subliminal priming technique developed by Mikulincer Hirschberger, et al. (2001) in which participants were exposed for 20 milliseconds to names of people they had previously described as security-enhancing attachment figures. We compared this condition with two control conditions: (i) subliminal priming with the names of relationship partners who did not serve what attachment theorists call a secure-base function; and (ii) subliminal priming with names of acquaintances who were not emotionally close and did not serve secure-base functions for the participant. Creative problem solving was assessed with the frequently used Remote Associates Test (RAT; Mednick, 1962). Our predictions were as follows:

1. Participants in the security-priming condition would perform better on the RAT than participants in the two control conditions.
2. Participants' scores on attachment anxiety and avoidance would be inversely related to creative problem solving.

We also explored possible interactions between security priming and scores on the two attachment-insecurity dimensions. Although we did not make predictions about these interactions, it seemed possible that the effects of security priming would be independent of the effects of attachment style, as they have been in most previous studies (see Mikulincer & Shaver, 2007b, for a review).

Method

Participants. Seventy-five Israeli undergraduates (53 women and 22 men, ranging in age from 19 to 28 years, *Median* = 22) participated in the study in exchange for credits toward a research participation requirement in one of their psychology courses. Participants were randomly divided into three experimental conditions with 25 participants in each. No significant gender or age differences were found between the three conditions.

Materials and procedure. The study was run in two sessions. In the first session, participants completed the Experiences in Close Relationships scales (ECR; Brennan et al., 1998) during a lecture class. Participants rated the extent to which each item was descriptive of their feelings and behaviour in close relationships on a 7-point scale ranging from 1 = "*not at all*" to 7 = "*very much*". Eighteen items measured attachment anxiety (e.g., "I worry about being abandoned") and 18 items measured avoidance (e.g., "I prefer not to show a partner how I feel deep down"). The reliability and validity of the Hebrew version of the ECR have been demonstrated in many studies (e.g., Mikulincer & Florian, 2000). In the Study 1 sample, Cronbach alphas were high for both the anxiety items (.84) and the avoidance items (.85). Scale scores were computed by averaging item ratings, and the correlation between the two scores was not significant, $r(73) = -.01$, $p < .01$, as intended by the scale designers (Brennan et al., 1998). Higher scores indicate greater anxiety and avoidance.

Three to four weeks later, a different experimenter, blind to participants' attachment scores, contacted participants by phone and invited them to take part in another study. After arriving at the laboratory, participants (escorted through the procedure individually) were informed that the study dealt with social and cognitive abilities. Following these instructions, participants completed three measures, to be used in the priming task, designed to elicit names of attachment figures, other close persons, and acquaintances. The order of these three measures was randomised across participants. In one measure, participants received a list of 100 first names displayed in an Excel worksheet and marked the names of people they knew. In a second measure, participants were asked to type, in an Excel worksheet, the first names of their father, mother, brothers, sisters,

best friends, current and previous romantic partners, grandfathers, and grandmothers.

The third measure was a computerised version of the 6-item WHOTO scale developed by Fraley and Davis (1997), which asked participants to provide the first names of close relationship partners who serve certain attachment-figure functions. Specifically, they were asked to record in a separate Excel worksheet the first names of people to whom they sought proximity and who provide them with a safe haven (security in times of need) and/or secure base (a secure foundation for engaging in other activities, pursuing personal goals, etc.). For each item, participants wrote the first name of the person who best served the targeted function and labelled that person's relational role (e.g., mother, father, friend).

The average number of different attachment figures' names generated by participants while completing the 6-item WHOTO measure was 2.94 ($SD = 0.95$). A close friend was nominated as an attachment figure in 39% of the cases (across all WHOTO items), a romantic partner in 26% of the cases, mother in 16% of the cases, father in 11% of the cases, and other family members in 8% of the cases. No significant association was found between participants' attachment scores and nomination of specific kinds of figures.

Following these questionnaires, participants completed a short delay/filler questionnaire about life habits and were then asked to complete a 20-trial computerised lexical decision task. This task was designed to prime a specific mental representation subliminally while the participant was focusing consciously on reading a string of letters and deciding whether or not it constituted a word. On each trial, the prime was presented for 20 ms, which was not long enough to allow it to be consciously seen, and was then immediately masked with an XXX display and a target letter string. Participants were told that each trial would begin with an "x" in the middle of the screen, on which they should fixate, followed by a mild flash, which they could ignore, and then, after a brief pause, the target letter string. The materials and procedure of this task were identical to those used by Mikulincer Hirschberger, et al. (2001).

We randomly divided participants into three conditions according to the name to be subliminally primed in all 20 trials. In the security-priming condition, the prime was the name of the person who was most frequently mentioned as an attachment figure in the WHOTO measure. (In cases where the top two names appeared equally often, the computer program chose one of them randomly.) In the close-person-priming condition, the prime was the name of a close-relationship partner who was *not* nominated as serving any of the attachment functions mentioned in the WHOTO scale. In the acquaintance-priming condition, the prime was the name of a person known by the participant but not viewed as a close-relationship partner or an attachment figure.

Following the lexical decision task, all participants rated their current mood to provide a check on the affective consequences of the priming procedure and to evaluate an alternative positive-mood explanation of the findings. Specifically, participants rated the extent to which they felt good, happy, bad, and sad. Ratings were made on a 7-point scale ranging from 1 = "*not at all*" to 7 = "*very much*". The Cronbach alpha coefficient for the four items (after reversing the response scales of the negative affect items) was .86, indicating high internal consistency. We therefore computed a mood score by averaging the four items, with higher scores indicating a more positive mood.

All participants then performed a 15-item computerised version of the RAT. This version included 15 triads composed of three words. Participants were asked to generate a word that formed a compound with the other three words (e.g., "common" is the correct response to "sense, courtesy, place"). Triads were selected according to the Bowden and Jung-Beeman (2003) norms for RAT item-difficulty levels. The 15 selected items were of moderate difficulty and were randomly presented via MediaLab software. Each triad appeared on the monitor screen for 15 s, followed by a text box asking the participant to immediately type in an answer (if they did not have one, they typed "no"). Participants were given 1 minute to provide an answer. The

dependent variable was the number of correct responses a participant generated (ranging from 0 to 15).

Results and discussion

A one-way analysis of variance (ANOVA) assessing the effect of Priming Condition (attachment security, close person, acquaintance) on the number of correct RAT responses revealed a significant effect of Priming Condition, $F(2, 72) = 4.32$, $p < .05$. Scheffé post hoc tests revealed that participants in the security-priming condition solved more RAT triads ($M = 5.96$, $SD = 2.13$) than participants in the close-person ($M = 4.36$, $SD = 2.18$) and acquaintance ($M = 4.48$, $SD = 2.12$) priming conditions. No significant difference was found between the close person and acquaintance priming conditions.

To examine the unique and interactive effects of scores on the two attachment dimensions, we conducted a two-step hierarchical regression analysis of RAT response scores. In the first step, security priming (a dummy variable contrasting security priming with the combination of close-person and acquaintance priming) and attachment anxiety and avoidance (Z-scores) were introduced as predictors. The product terms representing the two-way interactions between security priming and each of the attachment scores were introduced in the second step. This regression analysis yielded the expected significant main effect of security priming, $\beta = 0.28$, $p < .01$, even after controlling for the contributions of the insecurity scores. Second, the unique main effect of attachment anxiety was also significant, $\beta = -0.46$, $p < .01$, with higher scores on attachment anxiety predicting worse RAT performance. Neither the main effect of avoidant attachment nor any of the interactions was significant.

To examine the alternative mood explanation, we first conducted a two-step hierarchical regression analysis of the reported mood score, in which it was predicted by security priming, attachment anxiety, avoidance, and their interactions (similar to the regression analysis described above). This analysis revealed a significant main effect of Security Priming, $\beta = 0.24$, $p < .01$, with participants in the security-priming condition reporting a more positive mood than those in the other two priming conditions. No other effects were significant. This finding suggested that mood elevation might be an alternative interpretation of the observed effect of security priming on creative problem solving. However, a two-step hierarchical regression analysis of RAT performance, in which it was predicted by security priming, attachment anxiety, attachment avoidance, and their interactions while controlling for reported mood, continued to yield the significant main effects of security priming and attachment anxiety on creative problem solving, βs of 0.31 and -0.47, ps $< .01$. That is, mood did not explain the effects of security priming on creative problem solving.

Overall, subliminal priming with the names of security-providing attachment figures caused participants to perform better on a creative problem-solving task. Moreover, attachment anxiety was inversely related to creative problem solving and the interactions of the attachment-insecurity dimensions and security priming were not significant. That is, the beneficial effect of security priming on problem solving was observed regardless of dispositional differences in attachment anxiety and avoidance.

STUDY 2

Study 2 was designed to determine whether supraliminal (i.e., conscious) security priming would also improve participants' creative problem-solving performance. For this purpose, we designed a two-session study similar to Study 1. Participants completed the ECR scales and performed the computerised RAT task used in Study 1. The single difference between the two studies was the method of security priming. In Study 2, each participant was asked to think consciously about an actual person who functioned for him or her as a security-providing attachment figure, to visualise this person, and to recall a particular interaction with him or her in which the participant felt supported and

comforted. This supraliminal priming manipulation was compared with a control priming condition: asking the participant to think about a mere acquaintance and recall a particular interaction with him or her. The predictions were identical to those of Study 1.

Method

Participants. Sixty Israeli undergraduates (31 women and 29 men, ranging in age from 20 to 31 years, *Median* = 22) participated in the study in exchange for research credits in a psychology course. Participants were randomly divided into two conditions with 30 participants in each. No significant gender or age differences were found between the two conditions.

Materials and procedure. Like Study 1, Study 2 was run in two sessions. In the first session, conducted during regular class time, participants completed the ECR scales, which once again proved reliable (alpha coefficients of .83 and .91).

Three to four weeks later, a different experimenter, unaware of participants' attachment scores, contacted participants by phone and invited them to take part in an experimental study. After arriving at the laboratory, participants (run individually) were given instructions identical to those in Study 1, were randomly divided into two conditions, and performed a guided imagination task. In the *security-priming* condition, participants were instructed to think of people to whom they turned when they felt distressed or worried. They were then asked to list six of these people's central qualities, to visualise a specific situation in which one of these people actually provided comfort and help when they were feeling distressed or worried, and to write a brief description of the recalled situation and the way they felt during it. In the *acquaintance priming* condition, participants were instructed to think of other students they knew but with whom they did not have a close relationship, list six traits that described these people, visualise a specific lecture they attended with one of these people, and write a description of the recalled situation and their feelings during it. Following the guided imagina-

tion task, participants completed Study 1's 4-item mood scale (Cronbach alpha = .88) and then performed the 15-item computerised version of the RAT described in Study 1.

Results and discussion

To test our predictions, we conducted a two-step hierarchical regression analysis similar to the one conducted in Study 1. This analysis yielded a significant main effect of security priming, $\beta = 0.25$, $p < .05$, with participants in the security-priming condition solving more RAT triads than participants in the acquaintance priming condition. The main effect for attachment anxiety was also significant once again, $\beta = -0.24$, $p < .04$, with higher attachment anxiety scores being associated with poorer RAT performance. Beyond these significant main effects and in contrast with the results of Study 1, the interaction between security priming and attachment anxiety was also significant, $\beta = -0.44$, $p < .01$. The main and interactive effects of avoidant attachment were once again not significant. Simple slope tests examining the nature of the significant interaction revealed that security priming led to better RAT performance among participants scoring low (-1 *SD*) on attachment anxiety, $\beta = 0.69$, $p < .01$, but not among those scoring high ($+1$ *SD*), $\beta = -0.19$, *ns*.

In examining the alternative mood interpretation of the results, a multiple regression analysis revealed that participants in the security-priming condition reported having a more positive mood than participants in the acquaintance priming condition, $\beta = 0.51$, $p < .01$. However, as in Study 1, a regression analysis performed on the RAT scores continued to yield significant main effects of security priming and attachment anxiety, βs of 0.28 and -0.25, ps $< .05$, as well as the significant interaction between security priming and attachment anxiety, $\beta = -0.45$, $p < .01$, even after controlling for mood. Thus, although security priming elevated participants' mood, this elevation could not explain the effects of security priming and attachment anxiety on creative problem solving.

GENERAL DISCUSSION

In two laboratory experiments we addressed questions left unanswered by previous studies on some of the beneficial effects of attachment security. First, previous correlational studies had documented associations between dispositional measures of attachment insecurity and self-report measures of curiosity, exploration, cognitive openness, and creativity. These studies left unanswered the important issue of causal direction, so it was unclear whether boosting attachment security actually fosters relaxed exploration and creative problem solving. Second, in our previous experimental studies (e.g., Mikulincer Hirschberger, et al., 2001), we assessed the effects of security priming on mood, self-esteem, compassion, empathy, and helping, but not on exploratory behaviour. This left unanswered the important question of whether the beneficial effects of security priming extend to curiosity, exploration, and creativity. In general, we wished to examine and understand the effects of what Bowlby (1982) called the attachment behavioural system on the exploration system, two motivational and behavioural systems postulated by Bowlby (1982) and emphasised by Ainsworth (1991).

Across the two experiments reported here, security priming enhanced creative problem solving, and this predicted effect occurred with both subliminal and supraliminal security-priming techniques. Also, in both experiments, self-reported dispositional attachment anxiety was associated with poorer problem solving. However, self-reported avoidant attachment was not associated with creative problem solving. In addition, whereas implicit security priming led to better creative problem solving regardless of variations in dispositional attachment insecurities, explicit security priming improved problem solving only among participants who scored relatively low on attachment anxiety.

Theoretically, these findings, especially when combined with the correlational evidence obtained in previous studies (e.g., Mikulincer, 1997), indicate that a sense of attachment security, whether established in a person's long-term relationship history or augmented by short-term implicit or explicit priming, improves creative problem solving. The two experiments also clearly indicated that mood variations could not explain the findings, even though security priming did improve mood (as has happened in other studies; see, e.g., Mikulincer Hirschberger, et al., 2001), and positive mood can sometimes enhance curiosity and creative problem solving (e.g., Isen et al., 1987).

According to our model of attachment dynamics in adulthood (Mikulincer & Shaver, 2007a), a sense of attachment security allows a redistribution of attention and other resources, away from self-protection and toward attractive attachment-unrelated activities, including exploration, learning, and creative behaviour. This idea and our findings imply that creative problem solving is a somewhat effortful process that requires attentional and cognitive resources and can be interfered with by worries and anxieties as well as other emotional and cognitive demands. However, there is no empirical evidence regarding the amount of attentional and cognitive resources needed for successfully performing the Remote Associates Task, and no evidence regarding the specific cognitive or neural pathways by which attachment-related worries interfere with creative problem solving and feelings of attachment security remove this interference. Further studies should explore these issues and examine whether attentional or cognitive interference is a valid explanation of the observed associations between attachment orientations and creative problem solving.

Beyond the transfer of mental resources from self-protection to attachment-irrelevant activities, three additional mechanisms may contribute to creative problem solving following security priming. First, attachment security may contribute to feelings of self-confidence and self-efficacy (e.g., Shaver & Mikulincer, 2002), which in turn may motivate a person to exert more attentional and problem-solving effort in the Remote Associates Test. Second, security priming may elicit more constructive strategies of distress regulation (Shaver & Mikulincer, 2002), which then allow

a person to deal effectively with tension, worries, hesitancy, and other obstacles to performing well on the RAT. Third, security priming may increase feelings of hope and optimism (Shaver & Mikulincer, 2002), which make it easier to push on in the face of ambiguity and uncertainty and to explore unusual associations.

The present studies also revealed differential effects of the two kinds of attachment insecurity. Whereas attachment anxiety was consistently associated with poorer creative problem solving, avoidant attachment was not related to problem solving. According to Mikulincer and Shaver (2007a), attachment anxiety is associated with affect-regulation strategies that intensify rather than down-regulate distress (e.g., making catastrophic appraisals, ruminating on personal failures and deficiencies). These distress-intensifying strategies are likely to focus attention on vulnerability and self-protection rather than the external problem that needs to be explored and solved. Moreover, anxious individuals may be less motivated in general to invest effort in successful problem solving, because it might thwart their wish to continue feeling needy, expressing needs, and feeling incompetent, which they may deem useful in attracting help and support from other people (Mikulincer & Shaver, 2007a).

In contrast, avoidant attachment is associated with defensive inhibition or suppression of distress. These strategies may reduce distress and allow a person to focus on problem solving, as long as there is not too great an emotional or cognitive "load" in a particular situation. If there is such a load, research shows that the avoidant defences may break down (e.g., Mikulincer, Dolev, & Shaver, 2004), revealing considerable anxiety and self-doubt. Future studies should explore whether the addition of an emotional or cognitive load during the RAT hinders avoidant people's performance even more than it hurts the performance of non-avoidant people.

Our findings regarding scores on avoidant attachment are at odds with previous studies showing that avoidant people are less curious, less tolerant of ambiguity, and less open to new information than less avoidant people (e.g.,

Mikulincer, 1997). The source of this discrepancy may reside in the Remote Associates Test. Although it requires effortful mental searches for unusual associations, it does not generate a great deal of ambiguity or uncertainty because each item has only one correct answer. Future studies should examine whether the lack of performance deficits among avoidant people in the present studies are replicated with creative problem-solving tasks that do not have a single correct answer, that demand fuller expression of one's inner world, and that generate higher levels of ambiguity concerning what constitutes a good performance. In such open-ended, murkier contexts, avoidant individuals may experience greater discomfort and distress and suffer performance deficits similar to those observed here among participants who scored high on attachment anxiety.

In Study 1, the effects of implicit security priming (subliminal exposure to the names of security-enhancing attachment figures) did not depend on dispositional attachment anxiety or avoidance. In Study 2, however, the beneficial effects of explicit security priming (guided imagination of an interaction with a security-enhancing attachment figure) were moderated by dispositional attachment anxiety. In particular, the beneficial effect of security priming on creative problem solving did not occur for participants who scored relatively high on attachment anxiety. Why?

It seems possible that subliminal presentation of the names of security providers activates a network of positive memories and feelings outside of awareness that induce relaxation and allow greater curiosity, focused attention, and useful associations. The guided imagination task, in contrast, may allow an anxious person to think about a situation in which support was provided, but then move from this thought to associated thoughts of insufficient support, questions about the motives behind the support, and so on—in other words, engage in the kinds of rumination that cause attention to shift to negative images and feelings, which in turn interfere with focusing on a problem and generating unhampered associations to it. Future studies should explore this

paradoxical and destructive mental process in greater detail, because it is likely to interfere with potentially positive effects of security inductions in couple interactions and interactions with psychotherapists.

The findings of Study 2 are reminiscent of Mikulincer and Sheffi's (2000) studies in which an explicit positive mood induction led to worse rather than better creative problem solving among people scoring high on anxious attachment. They are also reminiscent of Mikulincer, Shaver, Bar-On, and Ein-Dor's (2010) studies, in which participants who scored high on attachment anxiety reacted to explicit positive primes (e.g., thinking about initiating a loving relationship) with a tendency to avoid closeness and react ambivalently to closeness. (Normally, security and love primes activate a tendency to unambivalently approach closeness.) Taken together, these findings imply that attachment-anxious people turn explicit signals of safety into harbingers of trouble and distress. Perhaps they initially react positively to imagined love and security but then allow conscious deliberation to remind them of the downside of previous experiences that began positively but ended painfully. That is, conscious thinking about what were intended to be security-enhancing interventions may paradoxically generate negative emotions and states of ambivalence that interfere with creativity and exploration. This dysfunctional process might be circumvented by implicit primes because, with that procedure, the anxious person remains unaware of the attachment-related source of his or her positive state of mind.

Before closing, it is important to mention that our studies were conducted with Israeli undergraduates. Future studies should include participants from other nations, age groups, and education levels. This would further establish the generality of our findings. In many of our previous studies we have obtained similar results in the United States and Israel, and similar results when testing representative community samples of adults varying in age and sociodemographic characteristics (e.g., Mickelson et al., 1997), so we expect the results presented here to generalise as

well. In addition, future studies should include other implicit and explicit security-priming techniques (e.g., subliminal exposure to security-related pictures, visualising the face of a security-enhancing attachment figure) and other measures of exploration, creativity, and problem solving. Despite the limitations of the studies reported here, however, we have shown that attachment security, whether dispositional in nature or contextually enhanced, fosters creative problem solving.

Overall, the many different approaches taken by researchers to mapping the beneficial effects of attachment security and security priming strengthen our confidence in the validity of attachment theory, which we believe is an important platform for a positive psychology of human virtues, strengths, creativity, and growth.

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