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I hereby declare that this PhD dissertation is my original work

and it has been written by me in its entirety.

I have duly acknowledged all the sources of information

which have been used in this dissertation.

This PhD dissertation has also not been submitted for any degree in any university previously.

Sean Lee Teck Hao

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Abstract

Although creative ideation requires deviating sufficiently from conventional thoughts, people tend to fixate on highly salient and accessible concepts when responding to idea generation tasks. Surmounting such a default tendency then, is crucial to generating creative ideas. Bridging creative cognition with self-regulation research, I hypothesized that inhibitory control over such a default response may require self-regulatory resources. This would suggest that interventions that increase people's self-regulatory resources may also boost their creativity. However, results from Study 1 did not support this hypothesis. Specifically, there was no significant difference between ego-depleted versus non-depleted participants in terms of inhibitory control over salient concepts (assessed by the newly developed Concept Inhibition Task; CIT) or creative performance. Interestingly, post-hoc findings suggest a moderating relationship between ego-depletion status and inhibitory control, such that higher inhibitory control was associated with increased creativity only for non-depleted participants; the association was otherwise null for depleted participants. Study 2 replicated the null findings of Study 1 and did not support the utility of glucose consumption – an established ego-replenishing intervention – in increasing the creative performance of ego-depleted individuals. Study 3 examined the effectiveness of mindfulness meditation – an established self-regulation boosting intervention – in elevating people's creativity. Results revealed no significant difference in inhibitory control and creativity between participants who meditated versus those who listened to music (a comparable control group) after a ten-day intervention period. Although improvements to both inhibitory control and creativity were found when comparing baseline to post-intervention levels, such improvements

were not unique to those who meditated. Interestingly, Study 3 showed that inhibitory control was positively associated with creativity at both pre- and post-intervention assessments, whereas the association was null for Study 2 where most participants were subjected to ego-depletion. Together, these three studies suggest that self-regulatory resources may not exert a direct impact on inhibitory control over salient concepts and generating creative ideas. Instead, self-regulatory resource levels may modulate the relationship between inhibitory control and creativity, such that only non-depleted individuals may reap creative benefits from inhibiting salient concepts. For ego-depleted individuals, inhibitory control over salient concepts appear to be inconsequential towards their creative performance. This post-hoc finding is explained by considering the dual pathway theory of creative idea generation (Nijstad et al., 2010). Implications and future directions are discussed.

CONTENT

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Chapter 1: Introduction

To sustain a competitive edge in today's ever-expanding and volatile economy, people are expected to be productive and creative at the same time (Hartley, 2004; Piirto, 2011; Trilling & Fadel, 2009). Despite research highlighting a negative association between workload and creativity (Amabile, 1998; Amabile et al., 2002), employees often find themselves in situations where they have to juggle between completing multiple tasks and generating creative ideas within their respective domains of work (Burke, 2009; Elsbach & Hargadon, 2006; González et al., 2004; Peters et al., 2009). How then, may employees facing such competing demands maintain an optimal level of creativity? While most studies till date have focused on factors that individuals may have limited control over, such as reducing time pressure or garnering managerial support (Amabile, 1998; Mayfield, 2009), this paper examines facilitating self-regulation as a more autonomous way of managing such creative demands.

Self-regulation refers to an individual's capacity in altering or overriding his or her prepotent responses, which include behaviors, thoughts, and even emotions (Baumeister, 2002, 2014). It differs from mere self-control in that self-control pertains narrowly to conscious short-term efforts in altering one's behavior (Baumeister, 2002). The process of self-regulation entails the monitoring of one's current state in relation to a certain goal or standard, and mobilizing regulatory resources to modulate one's responses when disparity exists (Bandura, 1991; Baumeister, 2002; Baumeister & Heatherton, 1996). Because this process is posited to tap on an exhaustible pool of self-regulatory resources, performance on a task requiring self-regulation suffers when one had already engaged in a prior task that also requires self-regulation (i.e., ego-depletion; Baumeister, 2002; Baumeister, Bratslavsky, Muraven, & Tice, 1998).

It is reasonable to argue that self-regulation is involved in the process of creative ideation when individuals are required to exert inhibitory control over a natural tendency to fixate upon highly salient and accessible semantic concepts in order to generate creative ideas. Specifically, research has shown that individuals are predisposed to rely on the most salient and retrievable concepts in their semantic memory when tasked to generate ideas; surmounting such a prepotent response to access less salient concepts requires the effortful exertion of inhibitory control (Beaty & Silvia, 2012; Gilhooly et al., 2007; Ward et al., 2000). Yet, there is a knowledge gap in this link between creative idea generation and self-regulation given that no prior research has examined this proposition.

The notion of self-regulation is especially pertinent in today's workplace where most tasks require the regulation of behaviors, thoughts, and emotions, such as persisting on long and arduous projects, putting off familial concerns to prioritize work, and suppressing emotions to meet certain job-related emotional display requirements (Bianchi & Milkie, 2010; Diefendorff et al., 2011; Prem et al., 2016; Quinn et al., 2012; Repenning et al., 2001). Such exercising of self-regulation would then drain self-regulatory resources that may be needed for creative endeavors. These arguments, if empirically supported, would provide new insights into why increased work demands are harmful toward employees' creative capacity. They would also illuminate the possibility that self-regulation interventions may help maintain or even promote creativity among strained employees.

In this light, the theoretical significance of studying self-regulation in the context of creative idea generation is twofold. First, the self-regulation literature elucidates nuanced factors regarding the overriding of prepotent response tendencies in order to close the gap between the current state and future desirable state. These factors include inhibitory control, impulse strength,

and self-regulatory resource capacity (Baumeister & Heatherton, 1996; Hagger, Wood, Stiff, & Chatzisarantis, 2010; Muraven & Baumeister, 2000). Bridging these two streams of research could offer new perspectives to unpack the processes underlying creative idea generation and to possibly inform the future development of creativity-supporting interventions. Second, a wealth of interventions has already been developed and empirically validated in the field of self-regulation. Ranging from consuming glucose-containing food (e.g., Gailliot & Baumeister, 2007a) to inculcating certain mindsets (e.g., Savani & Job, 2017), these interventions aim to preserve one's self-regulatory resources and maintain high performance levels for tasks requiring self-regulation. These existing interventions can potentially aid employees in meeting job-relevant creative demands while coping with cognitively depleting work tasks.

In the current research, three studies are proposed to a) empirically ascertain the role of self-regulation in the domain of creative idea generation (Study 1), and b) examine the effectiveness of self-regulation interventions in improving one's creativity (Studies 2 and 3). Specifically, glucose consumption, which has been shown to be able to replenish one's self-regulatory resources (Gailliot et al., 2007), will be examined as a potential intervention in buffering against a fall in creativity levels following the engagement of an ego-depleting task (Study 2). Next, mindfulness meditation, which has been shown to be able to enhance people's overall self-regulatory capacity (Vago & David, 2012), will be examined as a potential intervention in enhancing creativity levels by heightening individuals' inhibitory control ability (Study 3).

Chapter 2: Self-Regulation and Creative Idea Generation

As discussed, self-regulation pertains to an individual's capacity in altering or overriding his or her prepotent responses, which include thoughts, behaviors, and emotions (Baumeister, 2002, 2014). Involving both unconscious and conscious cognitive processes, self-regulation entails the monitoring of one's current state in relation to a certain goal or standard, and mobilizing regulatory resources to modulate one's responses when disparity exists (Bandura, 1991; Baumeister, 2002; Baumeister & Heatherton, 1996).

The fundamental, primary goal of creative idea generation is to produce ideas that are highly novel (Sternberg & Lubart, 1999). The generation of such ideas arise from the exploration of remotely associative elements or concepts within one's semantic memory (Mednick, 1962; Moran, 2009). In other words, in order to generate creative ideas, individuals have to transcend highly salient and accessible concepts in order to consider and integrate concepts that are only loosely associated. This is based on the established semantic network model of cognition, which states that the human brain acquires and retains knowledge in the form of associative elements, wherein all knowledge are represented by a network of related concepts within semantic memory (Brachman, 1977; Frederiksen, 1975; Lambon Ralph et al., 2007).

For example, one's knowledge of "dog" may be represented by associative concepts such as "furry", "four-legged", "bark", "loyal", and "mammal". Depending on their relative accessibility or saliency in one's semantic memory, each concept's semantic distance from the core knowledge representation (e.g., dog) differs, with loosely associated ones being farther away (Jiang & Conrath, 1997; Rips et al., 1973). For example, when one thinks of "dog", concepts such as "bark" would typically come to one's mind rather than "mammal"; as such,

"mammal" is considered the more remote concept that is semantically farther to "dog" as compared to "bark".

Importantly, based on the theory of spreading activation, automaticity of activation is greater for concepts positioned at shorter semantic distances (e.g., "bark") from the target representation (e.g., "dog") than for concepts positioned at further semantic distances (e.g., "mammal"); hence, the farther a semantic concept is, the greater the cognitive effort is required to activate and access it (Collins & Loftus, 1975; den Heyer & Briand, 1986). This explains why "bark" readily comes to one's mind, whereas "mammal" requires exerting substantive cognitive effort before it comes to mind when thinking about "dog". In order to generate highly creative ideas, one needs to transcend common, readily accessible concepts and effortfully activate those that are semantically more distant and only loosely associated with the target knowledge domain (Mednick, 1962).

Because common concepts require substantially less cognitive effort (if any at all) to activate, people are more likely to focus and rely on such concepts when generating ideas. Indeed, research has demonstrated the existence of a prepotent tendency of fixating on salient and accessible concepts which results in the generation of uncreative ideas. Studies have consistently observed a serial order effect whereby people typically start out by producing common, uncreative ideas and only gradually switch to generating more creative ideas over time, with some never ever managing to generate novel ideas at all (Beaty & Silvia, 2012; Christensen, Guilford, & Wilson, 1957; Gilhooly et al., 2007; Silvia, 2008; Ward et al., 2000). Further, studies have also shown that concepts activated by examples results in people fixating on these example concepts when generating ideas (Smith, 2003; Smith, Ward, & Schumacher, 1993). Such a prepotent tendency restricts creative exploration and goes against the goal of generating novel

ideas. Hence, inhibitory control over such a tendency is necessary for catalyzing creativity, as based on the three major perspectives of creativity below.

Path-of-Least-Resistance Theory

The path-of-least-resistance theory states that people tend to retrieve a basic exemplar from semantic memory to guide creative idea generation, resulting in the consideration of only highly salient properties and concepts (Ward, 1994; Ward, 1995; Ward, Dodds, Saunders, & Sifonis, 2000). For example, when tasked to generate creative designs for a table, an individual is likely to retrieve the basic exemplar of a table consisting of four legs and a flat top and start generating ideas with this normative form in mind. As a result, ideas generated would largely center around this norm of four legs and a flat top, thereby limiting the creative exploration of alternative forms (e.g., single-legged, wide base table). To generate creative ideas, inhibitory control over such a natural inclination is required so that one would not be bounded by such normative concepts (Ward, 1994; Ward, 1995; Ward et al., 2000).

Executive Switching Theory

The theory of executive switching states that people tend to generate ideas from the most readily accessible knowledge categories (Beaty & Silvia, 2012). Individuals will limit creative exploration to such categories until they can no longer produce ideas relying on those categories (Beaty & Silvia, 2012). For instance, when tasked to generate creative ideas to improve the quality of education in a university, people are likely to start generating ideas from a salient knowledge category such as “lecturer” (e.g., improve their hiring process or send them for further training). Only with effortful cognitive control would one be able to switch to a less salient category, such as “technology”, and instigate more creative ideas (Nusbaum & Silvia, 2011; Unsworth, 2010).

Creative Idea Generation Strategies

The perspective of creative idea generation strategies postulates that people have a tendency to adopt a simple memory-retrieval strategy during the ideation process, whereby pre-existing ideas and solutions are used as a template to generate new ideas (Gilhooly, Fioratou, Anthony, & Wynn, 2007). For instance, when people are asked to generate creative uses for the object "table", they would be inclined to recall existing uses of a table (e.g., to put things on) and to generate ideas centering around such existing uses (e.g., using it as a stool to sit on). To catalyze greater levels of creativity, inhibitory control over such a natural inclination is required to facilitate the adoption of more abstract-based strategies, such as by thinking about an object in terms of its parts and materials (Gilhooly et al, 2007). This would effectively facilitate the consideration of remotely associated concepts, such as by reflecting on the observation that a table's legs are long and cylindrical such that it may be used as a rolling pin, thus catalyzing the production of creative thoughts.

While these theories diverge on the specific characterizations of salient concept activation (e.g., conjuring an exemplar, recalling pre-existing uses), they converge upon the notion that people tend to rely and fixate on what is mentally most salient and readily accessible to them when tasked to generate ideas. Importantly, they all specify that inhibitory control is required to break away from the pull of salient semantic concepts in order to engage in creative exploration. One quasi-experimental study, in particular, empirically illustrated the potential involvement of inhibitory control in creative idea generation. Edl, Benedek, Papousek, Weiss, and Fink (2014) showed that increased creative performance on the Torrance Tests of Creative Thinking exhibited by design students (versus non-design students) was significantly mediated by higher levels of general cognitive inhibitory control ability (assessed via the Stroop task). Together, prior

research consistently supported the theorizing that people's prepotent tendency of fixating on highly accessible concepts can impede their generation of creative ideas. The exertion of inhibitory control over such an automatic tendency is thus key in boosting creative ideation. Yet, despite its clear relevance to self-regulation, no study till date has systematically examined creative idea generation in relation to self-regulation.

Recall that self-regulation pertains to the modulation of cognitive, behavioral, and emotive prepotent tendencies. Conceivably, people's automatic tendency to fixate on highly accessible concepts is a cognitive prepotent tendency. According to the self-regulation literature, all prepotent tendencies possess a certain level of strength, such that an effortful exertion of an equal or greater strength is required to assume control and modulate them (Baumeister & Heatherton, 1996; Muraven & Baumeister, 2000). This effortful exertion of control is fueled by a limited pool of self-regulatory resources. When such resources are strained, it would prevent people from mustering a sufficiently strong magnitude of control to overcome the strength of the impulse (i.e., self-regulation failure; Hagger, Wood, Stiff, & Chatzisarantis, 2010). Hence, I propose that individuals with strained self-regulatory resources would be less able to exert inhibitory control over their natural reliance on salient concepts, thereby hampering their creativity. This hypothesis will be examined in Study 1.

Chapter 3: Improving Creativity by Facilitating Self-Regulation

As discussed earlier, most job-related tasks that employees face require self-regulation (Bianchi & Milkie, 2010; Diefendorff et al., 2011; Prem et al., 2016; Quinn et al., 2012; Repenning et al., 2001). Engaging in such tasks depletes self-regulatory resources that, I propose, are needed for creative ideation. If it is empirically supported that creative idea generation requires self-regulatory resources, how then could employees sustain their creative capacity while facing an overwhelming amount of depleting work tasks? I propose that interventions which improve people's self-regulatory capacity might help. In this research, I examine two of such established interventions: glucose consumption and mindfulness meditation.

Glucose Consumption

Glucose serves as the primary source of energy for the human brain, which is unlike most other parts of our body where energy derived from amino acids and lipids can substitute for glucose (Fox et al., 1988; Mergenthaler et al., 2013). Research has shown that the exertion of self-regulation is cognitively demanding and results in a noticeable dip in blood glucose levels (Gailliot et al., 2007; Gailliot & Baumeister, 2007). This reduces blood glucose available for the brain's use, crippling one's self-regulatory capacity on a subsequent task (Betz et al., 1975; Gailliot et al., 2007; Gjedde & Crone, 1981). The consumption of glucose restores one's blood glucose levels for optimal brain functioning and has been shown to significantly improve self-regulatory capacity on a subsequent task requiring self-regulation (Gailliot et al., 2007; Gailliot & Baumeister, 2007). Study 2 will examine then, if consuming glucose might improve the creative performance of individuals with strained self-regulatory resources.

Mindfulness Meditation

Mindfulness entails both present-centered awareness and self-awareness, in that full attention is paid to what is occurring in the present with high awareness and clarity of intentions and volition (Reb & Atkins, 2015). In other words, a mindful individual would not only strive to register a present phenomenon with full awareness, but would also endeavor to prevent oneself from acting on prepotent, automatic impulses (Baas et al., 2014; Kabat-Zinn et al., 1985; Vago & David, 2012).

Fostering mindfulness via practicing mindfulness meditation has been shown to improve people's self-regulatory capacity. Mindfulness meditation entails present-centered attention, such that an individual strives to register a present phenomenon with full awareness, otherwise known as "bare attention" (Kabat-Zinn et al., 1985; Vago & David, 2012). It draws its roots from Theravada Buddhism where the notion of bare attention is crux to its teachings and practices (Bodhi, 2011). During mindfulness meditation, practitioners strive to be cognizant of all present bodily sensations and to acknowledge but not effortfully suppress intrusive thoughts, gently shifting their attention to their breaths to let such thoughts pass by (Baas et al., 2014). Through repeated practice over time, this builds awareness of one's normally automatic thought processes and fosters volitional control over these processes, thereby improving self-regulatory capacity (Cook-Cottone, 2015; Mrazek et al., 2013; Raffone et al., 2007; Tang et al., 2007; Vago & David, 2012).

More recently, research has shown a positive association between one's mindfulness levels and creative performance (Baas et al., 2014; Lebuda et al., 2016). In an attempt to elucidate its underpinning mechanisms, researchers examined the state of mindfulness via five facets: observe (ability to sustain attention on different stimuli), act with awareness (ability to be cognizant of one's thoughts and behaviors), describe (ability to verbalize feelings and beliefs),

non-react (ability to be passive regardless of present experiences), and non-judge (ability to be non-evaluative of present experiences; Agnoli, Vanucci, Pelagatti, & Corazza, 2018; Baas et al., 2014). Among the five facets, act with awareness is the only facet that was consistently found to be positively related to creativity across two research conducted thus far on mindfulness facets and creativity (Agnoli et al., 2018; Baas et al., 2014). This suggests that mindfulness meditation may improve one's creativity by facilitating awareness of one's thoughts and actions.

As promoting a sense of awareness of automatic thought processes and fostering volitional control over these processes is crux in boosting self-regulatory capacity via mindfulness meditation (Tang et al., 2015; Tapper, 2018), I argue that the main mechanism via which mindfulness mediation boosts creativity is through improving self-regulation. Bridging these two streams of research, I propose that in the context of creative ideation, this means that a greater awareness of the prepotent tendency of automatically relying and fixating on highly accessible, salient semantic concepts could facilitate the mobilization of self-regulatory resources to modulate such a tendency and lead to higher levels of creativity. Hence, Study 3 aims to a) empirically validate the effectiveness of mindfulness meditation practice in elevating people's creativity using a full experimental approach, and b) examine if such an effect is brought about specifically by improving their self-regulatory capacity to exert inhibitory control over highly salient and accessible concepts, thereby shedding light on its underlying mechanisms.

Chapter 4: Study 1

Purpose of Study

Study 1 aims to examine whether the depletion of self-regulatory resources would hamper the generation of creative ideas. Research on self-regulation has consistently shown that performance on tasks requiring self-regulation suffers if one has already engaged in another task that require self-regulation (i.e., ego-depleted; Baumeister et al., 1998; Baumeister & Heatherton, 1996). As such, if individuals' creativity is undermined after an experimental induction of ego-depletion (i.e., depletion of self-regulatory resources), this would suggest that the process of generating creative ideas requires self-regulatory resources. To examine this, a full experimental design was adopted whereby participants were randomly assigned either to an ego-depleted condition or a non-depleted control comparison condition. I hypothesize that participants assigned to the ego-depleted condition would exhibit significantly lower levels of creativity as compared to those assigned to the non-depleted condition.

Importantly, the proposed mediating mechanism of inhibitory control over the tendency of fixating upon highly salient and accessible semantic concepts will also be directly examined. For this purpose, a new reaction time task that adopts elements of the Stroop task was developed. The Stroop task is a commonly used measure of general inhibitory control, which operates under the assumption that humans are predisposed to deriving meaning from reading words rather front colors (e.g., Egner & Hirsch, 2005; Enticott, Ogloff, & Bradshaw, 2006; West & Alain, 2000). In the task (cf. Stroop, 1935), participants are presented with words that name a certain color (e.g., "red"), but these words are themselves printed in either a color congruent with the name of the color (e.g., the word "red" is printed in red; a congruent trial) or printed in a color incongruent with the name of the color (e.g., the word "red" is printed in blue; an incongruent trial). The

respondent's task is to indicate the actual printed color of the word, not the color it names, by pressing a designated key on the keyboard (e.g., Hartanto & Yang, 2016). Longer reaction times (RT) on trials presenting words with printed colors that differ from the colors named (i.e., incongruent trials) are taken to be indicative of poorer inhibitory control (Gailliot & Baumeister, 2007b; Inzlicht et al., 2006; Job et al., 2010; Tice et al., 2007; Webb & Sheeran, 2003).

This new reaction time task, named the concept inhibition task (CIT), entails presenting participants with target words of everyday household objects similar to those used in the Unusual Uses Task (UUT; Gilhooly et al., 2007; Nusbaum & Silvia, 2011), such as "key", "brick" and "pencil". These target words (e.g., "pen") are flanked by two of its associated concepts, with one being a closely associated concept (e.g., "writing") and another being a comparatively more remote concept (e.g., "fiddling"). Respondents are told that the flanking words are concepts that others have said to come to their minds when thinking about the target word. They are then instructed to always select the less commonly associated concept (i.e., more remote concept) of the two presented. Based on the premise of the Stroop task, I propound that participants would have to exercise inhibitory control over their automatic tendency of being drawn to and fixating on the more salient and accessible semantic concepts in order to select the more remotely associated concept. Hence, longer RTs taken to select the less commonly associated concepts are taken to be reflective of poorer inhibitory control over such a prepotent tendency.

The flanking words used for the CIT were derived from a pilot study. A total of 113 participants (38 males and 75 females) aged 18 to 31 years old (M = 21.7, SD = 2.0) from the Singapore Management University (SMU) participated in the pilot study. Participants were presented with the common household objects of "pencil", "button", "eyeglasses", "pen", "key", and "brick", and were asked to spend three minutes to freely list the concepts that came to their

mind for each household object. After rank ordering the frequency of listed concepts, on average, 18 of the most frequently listed single words and 18 of the least frequently listed single words were randomly paired for each target object, producing 110 trials (10 practice, 100 actual).

Since the CIT draws closely from the premise of the Stroop task, and that the Stroop task is one of the most commonly used measures of general inhibitory control (Gailliot & Baumeister, 2007b; Inzlicht et al., 2006; Job et al., 2010; Tice et al., 2007; Webb & Sheeran, 2003), I sought to demonstrate concurrent validity of the CIT with the Stroop task. A total of 63 participants (12 males and 51 females) aged 19 to 26 years old (M = 20.9, SD = 1.4) from SMU, who were not involved in the prior pilot study, participated in the validation study. A standard Stroop task consisting of 10 practice trials (with feedback), 50 congruent trials (without feedback), and 50 incongruent trials (without feedback) was administered. Both crucial parameters of average RT on correct responses for incongruent trials (Inzlicht et al., 2006) and accuracy in terms of number of incorrect responses for incongruent trials (Pallak, Pittman, Heller, & Munson, 1975) were examined.

The CIT consisting of 10 practice trials (with feedback) and 100 actual trials (without feedback) was administered before the Stroop task. Similarly, both average RT on correct responses and number of incorrect responses were assessed. Consistent with established RT task protocol (Sriram & Greenwald, 2009), for both tasks, a "+" symbol appeared in the middle of the screen for 400ms between each trial. Results of the validation study are summarized in Table 1. As illustrated, the average RT on correct responses in the CIT was significantly positively correlated with that in the Stroop task. Likewise, the number of incorrect responses in the CIT was also significantly positively correlated with that in the Stroop task. These results support the

concurrent validity of the CIT with the established Stroop task (Greca & Stone, 1993; Kosten et al., 1983).

Table 1. *Correlations between the CIT and Stroop Task.*

Variables	1	2	3	4
1. Concept Inhibition Task (CIT) – Average RT	–			
2. Concept Inhibition Task (CIT) – Number of Incorrect Responses	.04	–		
3. Stroop Task – Average RT	.57**	.26*	–	
4. Stroop Task – Number of Incorrect Responses	-.09	.29*	.12	–

*$p < .05$; **$p < .01$

To recap, I hypothesize that the detrimental effects of ego-depletion on creativity would be significantly mediated by decreased inhibitory control over the prepotent tendency of fixating upon highly salient, closely associated semantic concepts as assessed by the CIT. Study 1 tested this hypothesis.

Measures

Manipulation check. A 2-item manipulation check was administered following the ego-depletion manipulation to ascertain its efficacy. Consistent with past studies (e.g., Muraven, Shmueli, & Burkley, 2006), participants were asked to rate from a scale of 1 (*not at all*) to 7 (*very much*), on the items of "how much were you fighting against an urge on that task?" and "how much did you have to control yourself on that task?" Cronbach's α was .668.

Creativity. Creativity was assessed via the pasta naming task (Dijksterhuis & Meurs, 2006; Marsh et al., 1999). First, participants were provided with examples of pasta names (lasagne, spaghetti, fettuccini, and rigatoni). Then, they were given four minutes to generate as

many creative one-word pasta names as they could for a new type of pasta that was allegedly to be introduced to the market soon. As with past studies that have administered this task (e.g., IJzerman, Leung, & Ong, 2014), all pasta names generated were then categorized into one of four categories: 1) names that have a similar beginning and a similar ending to any of the examples given (e.g., "lasaccini"), 2) names that have a similar beginning but a different ending to any of the examples given (e.g., "fettupo"), 3) names that have a different beginning but a similar ending to any of the examples given (e.g., "totuccini"), and 4) names that have both a different beginning and ending to the examples given (e.g., "potsipano").

Creativity was scored from one to three[1]. Pasta names that fell into Category 1 were given a score of one, those that fell into Categories 2 or 3 were given a score of two, and those that fell into Category 4 were given a score of 3. Also, pasta names that were exactly the same as existing pasta names, but were not part of the list of examples, were also given the lowest creativity score of one (e.g., linguine). Effectively, these scores indicate the extent to which participants creatively generated pasta names beyond the conventional pasta naming system, with the lowest score of one indicating that participants did not generate anything new on their own and have completely relied on existing materials. Scores were then averaged across all pasta names generated for each participant, with higher scores indicating higher levels of creativity. Number of pasta names generated (i.e., creative fluency) was also recorded for each participant.

[1] Using an alternative proportion scoring system devised by IJzerman et al. (2014) yielded similar results when responses of existing pasta names that were not part of the example list were manually penalized to a value of 0

Convergent thinking ability. A 10-item Remote Associates Test (RAT) published by Cengage (*The Remote Associates Test*, n.d.) was used to assess participants' convergent thinking ability. Each item consists of a set of three seemingly unrelated words, and the task is to come up with a fourth word that can relate to all three words. An example item is: "attorney", "self", and "spending". The answer to this is "defense". As my proposition regarding the relationship between self-regulation and creativity pertains mainly to divergent thinking ability (i.e., inhibitory control over salient concepts to creatively explore multiple remote semantic concepts; Gilhooly et al., 2007), the inclusion of the RAT in the study would test the discriminant validity of the hypothesized effect to apply to only divergent thinking but not convergent thinking.

Inhibitory control. Inhibitory control over salient concepts was measured using the CIT. The task consisted of ten practice trials (with feedback) and 100 actual trials (without feedback), with each trial containing a target word of an everyday household object positioned in the middle of the screen (e.g., "pen"), flanked by both a closely associated concept (e.g., "writing") and a more remote concept (e.g., "fiddling") positioned either at the top left or top right side (relative position randomly determined) of the screen. Participants were told that the flanking words are concepts that come to people's mind when thinking about the target word. They were then instructed to select the less commonly associated concept (i.e., more remote concept) by pressing a designated key. Following established protocols of operationalizing inhibitory control in RT tasks, accuracy in terms of the number of incorrect responses was first compared between participants of the two conditions to establish that no significant difference in accuracy was present. Next, RT on correct responses was used to operationalize inhibitory control (Khng & Lee, 2014). Longer RTs on correct responses are indicative of poorer inhibitory control.

Covariates. Based on the recommendations of past studies on ego-depletion and self-regulation (e.g., Dang et al., 2019; Tsai & Li, 2019; Vohs et al., 2011), the covariates of fatigue, action orientation, lay theory of willpower, and trait self-control were measured in this study. Fatigue was assessed with a 3-item scale adopted from Tsai and Li (2019) and Vohs et al. (2011), action orientation was measured using the 12-item Demand-Related Action Orientation subscale (Jostmann & Koole, 2007), lay theory of willpower was measured using a 6-item scale developed by Job et al. (2010), and trait self-control was measured using the 13-item Brief Self-Control Scale (Tangney, Baumeister, & Boone, 2004). Additionally, the experience of positive and negative affect (i.e., PA and NA) was assessed and accounted for using the 20-item Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) due to their established association with both ego-depletion (Tice et al., 2007) and creativity (Amabile et al., 2005). Cronbach's α were .833, .723, .866, .844, .904, and .772 respectively. All scale items and scoring instructions can be found in Appendix A.

Procedure

120 participants (25 males and 95 females), age ranging from 18 to 26 years old (M_{age} = 21.1 years, SD_{age} = 1.7 years), were recruited from the SMU subject pool system. These participants identified themselves ethnically as Chinese (97; 80.8%), Malay (4; 3.3%), Indian (7; 5.8%), and "other" (12; 10.0%). Their declared primary majors include: Social Sciences (91; 75.8%), Law (7; 5.8%), Business (5; 4.2%), Economics (5; 4.2%), Marketing (5; 4.2%), Political Science (2; 1.7%); Accountancy (2; 1.7%), and "undeclared" (2; 1.7%). Participants were randomly assigned to one of two conditions: ego-depleted condition (N = 62) or non-depleted condition (N = 58). Participants were awarded one study credit for completing the study. All relevant descriptive statistics are shown in Table 2.

Table 2. *Descriptive Statistics of Demographic and Studied Variables.*

	N	*M*	*SD*	*Range*
Age	120	21.10	1.74	18-26
Sex (% male)	120	20.80%		
Creativity Score	120	2.21	0.48	1.00-2.92
Number of Pasta Names Generated	120	17.53	10.32	2-58
RAT Score	120	1.40	1.42	0-6
RT on Correct Responses (ms)	120	2540.08	607.94	1201.72-3847.22
Number of Incorrect Responses	120	19.03	13.44	6-80
Fatigue	120	3.76	1.54	1.00-7.00
Action Orientation	120	5.43	2.89	0-12
Lay Theory of Willpower	120	2.35	0.86	1.00-6.00
Trait Self-Control	120	3.02	0.65	1.15-4.85
PA	120	2.44	0.82	1.00-4.60
NA	120	1.44	0.45	1.00-3.00

The target sample size of 120 was derived from an a priori power analysis conducted using G*Power by specifying a mean difference test with an estimated effect size of $d^{+} = 0.62$, $\alpha = 0.05$, and power = 0.95. As no prior study has examined the relationship between self-regulation/ego-depletion and creativity, this estimated effect size was obtained from a meta-analysis conducted by Hagger et al. (2010), wherein the average effect size of the ego-depletion effect on performance across a wide range of tasks was calculated to be $d^{+} = 0.62$.

Participants were first presented with the *e*-crossing task, a well-established ego-depletion manipulation procedure (Baumeister et al., 1998; Job et al., 2010). An online variant of the task adopted from Muraven, Shmueli, and Burkley (2006) and Tsai and Li (2019) was used. For the first 5 minutes of the task, all participants (regardless of assigned condition) were tasked to type word for word a printed text document (a long and detailed report of an airplane accident). All participants were instructed to leave out all instances of the letter "e" from their copied text. For the next 5 minutes of the task, participants assigned to the ego-depleted condition were instructed to follow a new complex rule that sporadically required them to inhibit the previously learnt response pattern. Specifically, they were now instructed to include in their copied text (i.e., not leave out) letter "e"s that were either right next to or one letter away from a vowel. All other instances of the letter "e" still had to be left out of their copied text. Participants assigned to the non-depleted condition were simply told to continue leaving out all instances of the letter "e" from their copied text. Additionally, to be consistent with the paradigm detailed by Baumeister et al. (1998), legibility of the text document provided to participants in the ego-depleted condition was intentionally compromised by lowering the print resolution and black tone level of the text document. The manipulation check items, fatigue measure, and PANAS measure were administered upon completion of the task.

Participants completed the CIT next. They were told that a target word referencing an everyday object would appear in the middle of the computer screen, which would be accompanied by two other words at the top left and top right corner, each representing a concept that comes to people's mind when thinking about the target word. They were instructed to always select the less commonly associated concept (i.e., more remote concept) of the two presented. Consistent with past RT tasks, participants pressed the 'e' key on the keyboard to select the left

flanker word and the ‘i' key to select the right flanker word (e.g., Greenwald et al., 2009). The relative position (i.e., left or right side) of the commonly associated concept and the less commonly associated concept was randomized across trials. Participants were told to keep their index fingers atop the “e” and “i" keys for the entire task duration and to respond as quickly and accurately as they can.

Upon completion, participants worked on the pasta naming task where they generated as many creative pasta names as they could within four minutes. Next, participants completed the RAT. Finally, they completed the covariate measures of action orientation, lay theory of willpower, and trait self-control and provided basic demographic information (e.g., age, gender, etc.) before being thanked and debriefed.

Results

Main analyses. To assess the efficacy of the ego-depletion manipulation, an independent samples *t*-test was conducted on participants’ average score on the 2-item manipulation check. Results revealed that there was no significant difference in average scores between participants assigned to the ego-depleted condition (M = 5.41, SD = 1.15) and the non-depleted condition (M = 5.06, SD = 1.40), $t(110.63) = -1.49$, $p = .139$, Cohen's $d = 0.27$. Repeating the analysis on the individual items, although there was no significant difference in response to the item “how much were you fighting against an urge on that task?” between the two conditions (ego-depleted condition: M = 5.02, SD = 1.51; non-depleted condition: M = 5.00, SD = 1.67), $t(114.89) = -0.06$, $p = .956$, Cohen's $d = 0.01$, there was a significant difference in response to the item “how much did you have to control yourself on that task?” between the two conditions (ego-depleted condition: M = 5.81, SD = 1.19; non-depleted condition: M = 5.12, SD = 1.50), $t(108.47) = -2.77$, $p = .007$, Cohen's $d = 0.51$. This suggests that while the online *e*-crossing task procedure may

have induced similar levels of urge-fighting among participants of both conditions, participants in the ego-depleted condition perceived having exerted more self-control on the task than did those in the non-depleted condition.

On the basis of this partial support for the success of the ego-depletion manipulation procedure, an independent samples *t*-test was then conducted on participants' creativity scores. Results revealed that there was no significant difference in creativity scores between participants in the ego-depleted condition (M = 2.20, SD = 0.47) and those in the non-depleted condition (M = 2.22, SD = 0.50), $t(115.75) = 0.25$, $p = .805$, Cohen's $d = 0.04$. These results remained non-significant after controlling for the measured covariates. There was also no significant difference in the number of pasta names generated between the two conditions, $t(107.76) = 0.14$, $p = .888$, Cohen's $d = 0.03$.

Notwithstanding, a mediation analysis was conducted using the SPSS PROCESS macro (Model 4; Hayes, 2017) to examine if participants' level of inhibitory control would mediate a relationship between ego-depletion status and creativity. First, an independent samples *t*-test was conducted on the number of incorrect responses in the CIT to ensure that accuracy was similar for both conditions. Results showed that both conditions were similarly accurate in the CIT, $t(109.36) = 1.47$, $p = .144$, Cohen's $d = 0.27$. A dummy variable for condition (0 = non-depleted condition, 1 = ego-depleted condition) was then created and specified as the predictor. Inhibitory control operationalized as RT on correct responses in the CIT was specified as the mediator, and creativity score was specified as the outcome variable.

Results showed that the dummy condition variable was not significantly associated with RT on correct responses, $B = 65.92$, $SE = 111.36$, 95% CI [-154.60, 286.44], $t = 0.59$, $p = .555$, which in turn was also not significantly associated with participants' creativity score, $B = -0.001$,

SE = 0.002, 95% CI [-0.004, 0.002], *t* = -0.64, *p* = .525. A bootstrap estimation approach conducted with 5,000 samples (Shrout & Bolger, 2002) indicated that the indirect path was non-significant, *B* = -0.07, *SE* = 0.25, 95% C.I. = [-0.76, 0.31]. These results remained non-significant after controlling for the measured covariates. Similarly, all results remained non-significant when the outcome variable was specified as the number of pasta names generated.

Supplementary analyses. Post-hoc analyses were conducted on participants' convergent thinking ability as measured by the RAT. Conducting an independent samples *t*-test revealed that there was no significant difference in the number of correct responses in the RAT between participants in the ego-depleted condition (*M* = 1.52, *SD* = 1.48) and those in the non-depleted condition (*M* = 1.26, *SD* = 1.36), *t*(117.97) = -0.92, *p* = .356, Cohen's *d* = 0.18, even when time spent on the RAT was controlled for, *F*(1, 117) = 1.04, *p* = .310, η_p^2 = .009. Similarly, conducting a simple linear regression analysis revealed that RT on correct responses in the CIT (i.e., inhibitory control) was also not associated with the number of correct responses in the RAT, *B* = 0.0002, *SE* = 0.0002, 95% CI [-0.0003, 0.001], *t* = 0.74, *p* = .458, even when time spent on the RAT was controlled for, *B* = 0.00004, *SE* = 0.0002, 95% CI [-0.0003, 0.0005], *t* = 0.19, *p* = .852. There was no significant difference in time spent on the RAT between participants of the two conditions, *t*(108.56) = 0.38, *p* = .702, Cohen's *d* = 0.07.

Post-hoc moderation analyses were then conducted using the SPSS PROCESS macro (Model 1; Hayes, 2017) to examine if the a priori hypothesized relationships may have been masked by a moderating variable. Firstly, moderation analyses were conducted on the hypothesized direct relationship between condition (0 = non-depleted condition, 1 = ego-depleted condition) and creativity scores. However, no measured variable was found to exert a significant moderating effect. Next, moderation analyses were conducted on the hypothesized

relationship between condition and RT on correct responses in the CIT. Similarly, none of the measured variables was found to exert a significant moderating effect.

Finally, moderation analyses were conducted on the hypothesized relationship between RT on correct responses in the CIT and creativity scores. Interestingly, condition was found to exert a significant moderating effect, $B = 0.0003$, $SE = 0.0001$, 95% CI [<0.001, 0.001], $t = 2.08$, $p = .040$. Decomposing this interaction effect via simple slopes analysis, a significant, negative relationship between RT on correct responses in the CIT and creativity scores for non-depleted participants was found, with $B = -0.0002$, $SE = 0.0001$, 95% CI [-0.0004, <0.00001], $t = -2.04$, $p = .044$. There was no significant association between RT on correct responses in the CIT and creativity scores for ego-depleted participants, $B = 0.0001$, $SE = 0.0001$, 95% CI [-0.0001, 0.0003], $t = 0.92$, $p = .361$. This interaction effect is illustrated in Figure 1. No other measured variable was found to exert a moderating effect.

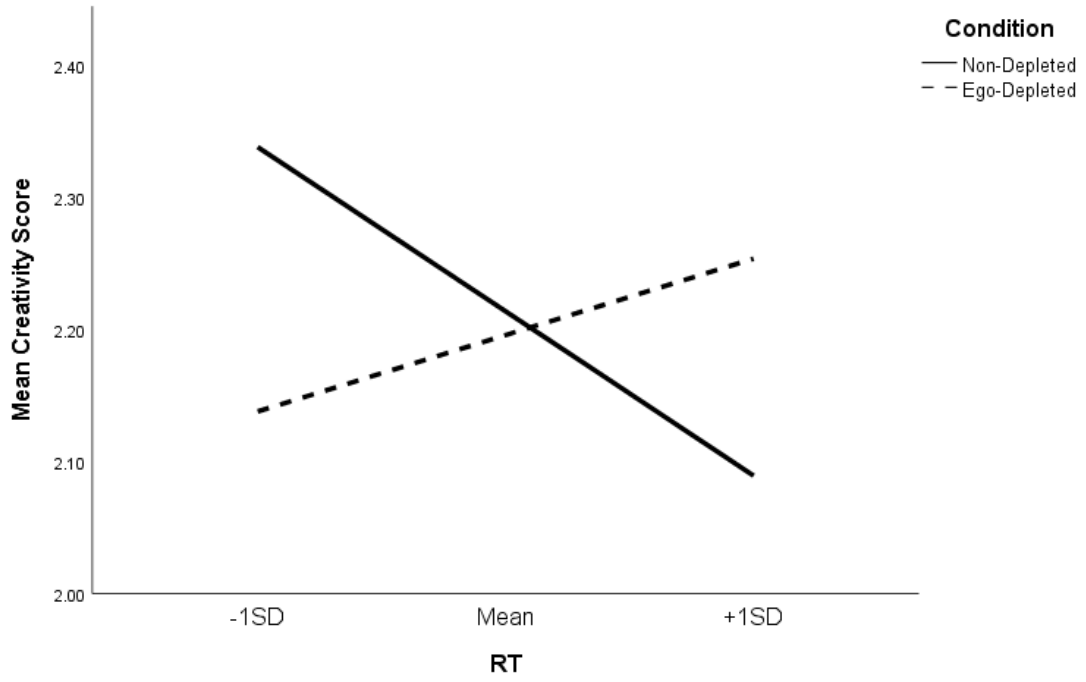

Figure 1. Simple slopes (i.e., unstandardized coefficients) of RT on correct responses in the CIT predicting creativity scores for non-depleted versus ego-depleted condition.

Discussion

Findings from Study 1 suggest that ego-depletion does not exert a substantive impact on one's inhibitory control over salient concepts or one's creativity. Furthermore, these findings suggest that one's inhibitory control over salient concepts does not necessarily translate into creative gains, as measured by the pasta naming task. A potential explanation for these null findings is that the ego-depletion manipulation was not sufficiently efficacious in depleting one's self-regulatory resources to produce an effect. As seen in the results section, only partial support for the efficacy of the ego-depletion manipulation was obtained. Specifically, participants from the two conditions only significantly differed in their response to one of the two manipulation check items. Hence, it is possible that the observed null effects could be attributable to the somewhat unsuccessful manipulation of ego-depletion, in that those assigned to the ego-depleted condition may not have experienced sufficient levels of decline in their self-regulatory resources to drive an effect.

Interestingly, however, an interaction effect between condition and inhibitory control was found, such that the hypothesized positive association between inhibitory control and creativity was observed only for those assigned to the non-depleted condition. This suggests that better inhibitory control over salient concepts results in increased creativity only for those non-depleted individuals whose self-regulatory resources were not compromised. Assuming that the partially effective ego-depletion manipulation substantively drove this effect, it suggests that when one's self-regulatory resources are drained to a certain extent, one would no longer be able to reap creative benefits of inhibiting salient concepts. In other words, while eroding one's self-regulatory resources does not result in direct decreases in inhibitory control or creativity, it renders one unable to benefit creatively from their ability to exert inhibitory control over salient

concepts. Specifically, inhibitory control over salient concepts becomes inconsequential towards creative performance when individuals experience ego-depletion. Nonetheless, as these findings were the result of post-hoc analyses, Study 2 aimed to replicate and validate these findings.

Chapter 5: Study 2

Purpose of Study

The initial purpose of Study 2 was to assess the effectiveness of glucose consumption, an established ego-replenishing intervention (Gailliot et al., 2007; Gailliot & Baumeister, 2007), in buffering a decline in inhibitory control and creative performance among ego-depleted individuals. However, in light of Study 1's findings, Study 2 sought to conceptually replicate Study 1 using a more efficacious, traditional ego-depletion manipulation and a different creativity task. This can ensure that Study 1's findings are not attributable to efficacy issues of the ego-depletion manipulation and/or task-specific features. The secondary aim of Study 2 was then to examine the potential effect of glucose consumption on inhibitory control over salient concepts and creative performance.

Participants were randomly assigned to one of four conditions: ego-depletion with sugar candy condition (depleted-sugar), ego-depletion with non-sugar candy control condition (depleted-non-sugar), ego-depletion with no candy control condition (depleted-no candy), and non-depletion condition (non-depleted). Comparing inhibitory control and creativity levels between the depleted-no candy and non-depleted conditions presents a conceptual replication of Study 1. Comparisons between the depleted-sugar versus depleted-non-sugar and depleted-no candy conditions would test the potential ego-replenishing and creativity-boosting effects of glucose consumption.

Participants in the depleted-sugar condition consumed the Werther's Original butter-flavored sugar candy, whereas those in the depleted-non-sugar condition consumed the non-sugar variant of the same candy, which was artificially sweetened with Acesulfame K. Acesulfame K elicits a similar taste of sweetness as sugar but cannot be metabolized by the human body (von

Rymon Lipinski, 1985). I included a non-sugar candy control in addition to a no-candy control because some studies have suggested that it may not be glucose that induces an ego-replenishing effect, but rather the taste of sweetness itself (e.g., Hagger & Chatzisarantis, 2013; Miller, Bourrasseau, & Blampain, 2013). Having these two conditions allows for a closer examination of whether it is an increase in blood glucose levels or the mere sensation of sweetness that induces any ego-replenishing effect observed.

Previous studies have typically used sugary drinks to increase blood glucose levels (e.g., Gailliot et al., 2007). However, as noted by Gailliot et al. (2007), it takes time for ingested glucose to be absorbed into the bloodstream; possibly taking 20 minutes or longer depending on each individual's physiological conditions (Busch, 2017). Research has shown that sublingual administration of glucose (i.e., placing of glucose-containing tablet under the tongue) provides significantly better absorption efficiency that is comparable to that of intravenous administration (e.g., Barennes, Valea, Nagot, Van de Perre, & Pussard, 2005). As such, to maximize absorption efficiency and minimize the impact of individual differences in glucose absorption rates, participants in the depleted-sugar condition were given sugar candies to consume by placing it under their tongue (i.e., sublingual administration) for five minutes. For consistency, participants in the depleted-non-sugar condition were instructed to do the same with their non-sugar candy.

A pilot test was conducted on 84 participants (28 males and 55 females) from SMU (21 to 28 years old; $M = 23.4$, $SD = 1.7$) to ascertain that the Werther's Original butter-flavored sugar candy is effective in replenishing self-regulatory resources. Participants were randomly assigned to either a sugar candy condition ($N = 42$) or a non-sugar candy condition ($N = 42$). Ego-depletion was induced by having participants watch a long and boring video (e.g., Stucke & Baumeister, 2006); an 18-minute pre-recorded lecture consisting almost entirely of monologues.

Self-regulatory capacity was measured by the amount of time (in seconds) participants were willing to spend on an anagram task consisting of some items that are impossible to solve (i.e., task persistence; e.g., Vohs et al., 2014). To ensure that participants would duly sustain their attention on the long video, they were led to believe that they would be quizzed on the video's contents.

Participants assigned to the sugar candy condition consumed the Werther's Original butter-flavored sugar candy before engaging in the anagram task, whereas participants assigned to the non-sugar candy condition consumed the non-sugar, artificially sweetened version of the candy. It was found that participants who had consumed the glucose-containing sugar candy persisted significantly longer on the anagram task (M = 320.97, SD = 146.54) as compared to those who had consumed the non-sugar candy (M = 241.02, SD = 128.84), $t(82) = 2.66$, $p = .010$, $\eta_p^2 = .079$. These results indicate that the sugar candy administered is effective in replenishing one's self-regulatory resources.

In Study 2, following the experimental induction of ego-depletion, participants assigned to the depleted-sugar condition were provided with a piece of Werther's Original butter-flavored sugar candy; those assigned to the depleted-non-sugar condition received the non-sugar version of the candy; those assigned to the depleted-no candy condition did not receive any candy and were instructed to rest instead. Participants assigned to the non-depleted condition did not undergo the experimental induction of ego-depletion and did not receive any candy.

As with Study 1, inhibitory control over the tendency of fixating on highly salient and accessible semantic concepts was assessed using the concept inhibition task (CIT). Creativity was assessed using a different creative idea generation task developed by de Dreu et al. (2008). As mentioned, this is to ensure that Study 1's findings are not attributable to task-specific

features. Further, besides novelty/originality of ideas generated, this creativity task allows for the assessment of practicality and categorical flexibility – two other important creativity-related outcomes (Murray et al., 1990; Sternberg & Lubart, 1999), thereby allowing for a more nuanced understanding of the potential effects of ego-depletion on creativity.

Measures

Manipulation check. Efficacy of the ego-depletion manipulation was assessed using the same 2-item scale as in Study 1. Cronbach's α was .654.

Creativity. Creativity was assessed via an established creative idea generation task developed by de Dreu et al. (2008). The task required participants to generate as many ideas as they could in four minutes to improve the university's quality of education, which is described as deteriorating due to increasing student intake. As with past studies (e.g., de Dreu et al., 2008; Diedrich et al., 2015), the ideas generated were rated in terms of how novel they were on a scale of 1 (*not novel at all*) to 5 (*extremely novel*). Creativity score was computed by averaging novelty ratings across all ideas generated by each participant.

In addition, practicality and categorical flexibility were assessed as per past studies (de Dreu et al., 2008; Nijstad et al., 2010; Shaw & DeMers, 1986). For practicality, ideas were rated on a scale from 1 (*not practical at all*) to 5 (*extremely practical*). Practicality score was computed by averaging practicality ratings across all ideas generated by each participant. Categorical flexibility was scored in terms of the number of unique categories that could characterize each of the ideas generated by each participant (see Appendix B for the established list of categories provided by de Dreu et al., 2008). The sheer number of ideas generated (i.e., creative fluency) was also recorded for each participant.

A total of 1,083 ideas were generated by participants of this study. Using established guidelines of rating creative ideas (Silvia et al., 2008), all ideas were first alphabetically sorted before being randomized and divided among judges. This prevents the confounding of judges' ratings by a given participant's ideational fluency and/or a given idea's serial position in a set of ideas (Silvia et al., 2008). The 1,083 ideas generated were randomly divided among eight independent judges, with 20 overlapping ideas for the assessment of inter-rater reliability. Inter-rater reliability was assessed in terms of absolute agreement. Results were generally indicative of acceptable agreement among the judges (i.e., ICC > .40; Carod-Artal Francisco Javier et al., 2009; Zaiontz, n.d.) for novelty (ICC(2,1) = .419; ICC(2,8) = .852), practicality (ICC(2,1) = .501; ICC(2,8) = .889), and categorization (ICC(2,1) = .514; ICC(2,8) = .894). For these 20 overlapping items, the average was taken for novelty and practicality ratings, while mode was taken for categorization. All ratings were then matched to the respective participant's responses before being aggregated accordingly.

***Convergent thinking ability*.** The same 10-item Remote Associates Test (RAT) administered in Study 1 was used to assess participants' convergent thinking ability.

Inhibitory control. The same CIT administered in Study 1 was used to assess inhibitory control over the prepotent tendency of fixating on salient and highly accessible semantic concepts.

Covariates. As with Study 1, the potential covariates of fatigue, action orientation, lay theory of willpower, trait self-control, positive affect (PA), and negative affect (NA) were accounted for in Study 2. Cronbach's α were .839, .654, .857, .824, .905, and .769 respectively.

Procedure

One hundred and thirty participants (26 males and 104 females), age ranging from 18 to 27 years old (M_{age} = 20.8 years, SD_{age} = 1.6 years), were recruited from the SMU subject pool system. These participants identified themselves ethnically as Chinese (104; 80.0%), Malay (5; 3.8%), Indian (13; 10.0%), and "other" (8; 6.2%). Their declared primary majors are as follows: Social Sciences (107; 82.3%), Political Science (8; 6.2%), Business (5; 3.8%), Economics (3; 2.3%), Law (2; 1.5%), Marketing (2; 1.5%), Finance (1; 0.8%), Accountancy (1; 0.8%), and "undeclared" (1; 0.8%). Individuals with a medical history of blood-sugar related health issues such as diabetes, hyperglycemia, or hypoglycemia were not allowed to participate. Consistent with previous studies (e.g., Gailliot et al., 2007), all participants were instructed not to consume any food or beverage (besides plain water) three hours prior to the study. Participants were randomly assigned to one of four conditions: depleted-sugar (n = 32), depleted-non-sugar (n = 33), depleted-no candy (n = 33), and non-depleted (n = 32). Participants were awarded one study credit for completing the study. All relevant descriptive statistics can be found in Table 3.

Table 3. *Descriptive Statistics of Demographic and Studied Variables.*

	N	*M*	*SD*	*Range*
Age	130	20.83	1.56	18-27
Sex (% male)	130	20.00%		
Creativity Score	130	2.67	0.61	1.63-4.67
Practicality Score	130	3.03	0.43	2.00-4.67
Categorical Flexibility	130	3.75	1.29	1.00-7.00
Number of Ideas Generated	130	8.32	3.84	1-22
RAT Score	130	0.97	1.03	0-4

RT on Correct Responses (ms)	130	2623.28	653.85	1265.50-5096.04
Number of Incorrect Responses	130	17.06	8.48	6-72
Fatigue	130	4.44	1.46	1.33-7.00
Action Orientation	130	5.60	2.55	0-12
Lay Theory of Willpower	130	2.33	0.90	1.00-5.00
Trait Self-Control	130	2.90	0.61	1.38-4.38
PA	130	2.05	0.73	1.00-3.80
NA	130	1.33	0.39	1.00-2.90

The target sample size was derived from an a priori power analysis conducted using G*Power by specifying an Analysis of Variance (ANOVA) test of 4 groups with an estimated effect size of $\eta_p^2 = 0.12$, $\alpha = 0.05$ and power = 0.95. This estimated effect size was obtained from a meta-analysis conducted by Hagger et al. (2010), where the average ego-replenishing effect of glucose consumption on general task performance was calculated to be $\eta_p^2 = 0.12$.

All participants first completed the *e*-crossing task. As the manipulation check for the online version of the task adopted in Study 1 yielded equivocal results, this study employed the traditional pen-and-paper method for the *e*-crossing task. The difference between the pen-and-paper version and the online version used in Study 1 is that participants were tasked to cross out the letter “e” on the physical document itself rather than to type the text on the computer and to leave out the letter “e” from the copied text. All procedures and instructions given were otherwise identical. After the *e*-crossing task, participants responded to the same manipulation check items and fatigue measure.

Next, participants in the depleted-sugar condition were provided with a piece of Werther's Original butter-flavored sugar candy. They were instructed to place the candy underneath their tongue for five minutes before proceeding to the next task. Participants in the depleted-non-sugar condition were provided with the artificially sweetened version of candy. To maintain consistency, they were also told to place the candy underneath their tongue for five minutes. Participants in the depleted-no candy condition and non-depleted condition did not receive any candy and were simply instructed to rest for five minutes. A cover story was provided to all participants stating that the study aimed to examine the effects of eating versus resting on people's cognitive resources and creativity.

Following candy consumption/resting, participants responded to the PANAS measure. They then completed the CIT followed by the creative idea generation task and the RAT. Finally, they completed the covariate measures of action orientation, lay theory of willpower, and trait self-control and provided basic demographic information (e.g., age, gender, etc.) before being thanked and debriefed.

Results

Main analyses. To assess the efficacy of the ego-depletion manipulation, a planned linear contrast analysis was conducted on participants' average score on the 2-item manipulation check. Three dummy variables were created to represent the four conditions (see Table 4), with the non-depleted condition being the effective reference category. Results showed that participants in all ego-depleted conditions (i.e., depleted-sugar, depleted-non-sugar, and depleted-no candy) reported significantly higher scores on the manipulation check items as compared to those assigned to the non-depleted condition, with $B = 0.84$, $SE = 0.35$, 95% CI [0.148, 0.153], $t = 2.40$, $p = .018$ for dummy variable 1, $B = 1.22$, $SE = 0.35$, 95% CI [0.53, 1.90], $t = 3.49$, $p = .001$

for dummy variable 2, and $B = 0.91$, $SE = 0.35$, 95% CI [0.22, 1.60], $t = 2.62$, $p = .010$ for dummy variable 3. This indicates that the *e*-crossing task procedure was effective at inducing ego-depletion.

Table 4. *Dummy Variable Coding, with Non-Depleted as Reference Category*

	Dummy Variable 1	Dummy Variable 2	Dummy Variable 3
Depleted-Sugar	1	0	0
Depleted-Non-sugar	0	1	0
Depleted-No Candy	0	0	1
Non-Depleted	0	0	0

An omnibus Analysis of Variance (ANOVA) was then conducted to compare creativity scores of participants among the four conditions. Results revealed that there was no significant difference in creativity scores among the four conditions, $F(3, 126) = 0.39$, $p = .764$, $\eta_p^2 = .009$. Notwithstanding, an a priori planned pairwise comparison test was conducted to compare creativity scores of participants in the depleted-no candy condition ($M = 2.72$, $SD = 0.51$) versus those assigned to the non-depleted condition ($M = 2.74$, $SD = 0.73$). Results revealed that there was no significant difference in creativity scores between the two conditions, with $p = .894$, 95% CI [-0.28, 0.32] when a Least Significant Difference (LSD) test was conducted, and $p > .999$, 95% CI [-0.39, 0.43] when Bonferroni correction was applied. These results remained non-significant after controlling for the measured covariates. There was also no significant difference in practicality scores, $F(3, 126) = 0.07$, $p = .977$, $\eta_p^2 = .002$, categorical flexibility,

$F(3, 126) = 0.42$, $p = .737$, $\eta_p^2 = .010$, or the number of ideas generated, $F(3, 126) = 0.17$, $p = .916$, $\eta_p^2 = .004$, among the four conditions.

A mediation analysis was then conducted using the SPSS PROCESS macro (Model 4; Hayes, 2017) to examine if participants' level of inhibitory control over salient concepts, operationalized as RT on correct responses in the CIT, would mediate a relationship between the depleted-no candy versus non-depleted condition and participants' creativity scores. Firstly, I conducted an independent samples *t*-test on the number of incorrect responses in the CIT to ensure that accuracy was similar for both conditions. Results showed that both conditions were similarly accurate in the CIT, $t(61.31) = -0.89$, $p = .379$, Cohen's $d = 0.22$. In fact, an ANOVA test revealed that there was no significant difference in accuracy among all four conditions, $F(3, 126) = 0.35$, $p = .791$, $\eta_p^2 = .008$.

Next, the same three dummy variables representing the four conditions (Table 4) were entered, with dummy variable 3 specified as the predictor and the other two dummy variables accounted for as covariates. Results revealed that predictor dummy variable 3 (effectively "0" for non-depleted condition and "1" for depleted-no candy condition) was not significantly associated with RT on correct responses in the CIT, $B = -56.89$, $SE = 161.15$, 95% CI [-375.81, 262.03], $t = -0.35$, $p = .725$. RT on correct responses was also not associated with participants' creativity scores, $B = <0.0000$, $SE = 0.0001$, 95% CI [-.0001, .0002], $t = 0.31$, $p = .757$. A bootstrap estimation approach conducted with 5,000 samples (Shrout & Bolger, 2002) indicated that the indirect path was non-significant, $B = -0.002$, $SE = 0.01$, 95% C.I. = [-0.03, 0.03]. These results remained non-significant after controlling for the measured covariates. Repeating this analysis using a dummy variable which coded "1" for both depleted-non-sugar and depleted-no candy conditions and "0" for other conditions, and a dummy variable which coded "1" for depleted-

sugar condition and "0" for other conditions controlled for (i.e., non-depleted as effective reference category), yielded null results as well.

Repeating the above mediation analysis with practicality score, categorical flexibility, and the number of ideas generated specified as outcome variables in separate models, I found that while dummy variable 3 was not significantly associated with RT on correct responses in the CIT, RT on correct responses was, in turn, negatively associated categorical flexibility (marginal significance), B = -0.0003, SE = 0.0002, 95% CI [-0.001, <0.0000], t = -1.89, p = .061. RT on correct responses was not significantly associated with practicality scores B = <0.0000, SE = 0.0001, 95% CI [-0.0001, 0.0002], t = 0.62, p = .534, or the number of ideas generated, B = -0.001, SE = 0.001, 95% CI [-0.002, 0.0004], t = -1.30, p = .195. All three indirect paths tested using the bootstrap estimation approach were non-significant. All findings held after controlling for the measured covariates.

A planned linear contrast analysis was then carried out to compare creativity scores between participants assigned to the depleted-sugar condition versus those assigned to all other ego-depletion conditions (i.e., depleted-non-sugar and depleted-no candy). A new set of dummy variables was created to represent the four conditions (see Table 5), with the depleted-sugar condition being the effective reference category now. Regressing these dummy variables on participants' creativity scores, I found that there was no significant difference in creativity scores between those assigned to the depleted-sugar condition and those assigned to the other conditions, with B = -0.04, SE = 0.15, 95% CI [-0.34, 0.26], t = -0.25, p = .800 for dummy variable 1, B = 0.08, SE = 0.15, 95% CI [-0.22, 0.39], t = 0.54, p = .591 for dummy variable 2, and B = 0.10, SE = 0.15, 95% CI [-0.20, 0.41], t = 0.67, p = .506 for dummy variable 3. These results held even after controlling for the measured covariates. Repeating this analysis with a

dummy variable which coded "1" for depleted-non-sugar and depleted-no candy conditions and "0" for other conditions, and a dummy variable which coded "1" for non-depleted condition and "0" for other conditions controlled for (i.e., depleted-sugar as effective reference category), yielded null results as well.

Table 5. *Dummy Variable Coding, with Depleted-Sugar as Reference Category*

	Dummy Variable 1	Dummy Variable 2	Dummy Variable 3
Depleted-Sugar	0	0	0
Depleted-Non-sugar	1	0	0
Depleted-No Candy	0	1	0
Non-Depleted	0	0	1

Finally, a mediation analysis was conducted using the SPSS PROCESS macro (Model 4; Hayes, 2017) to examine if inhibitory control would mediate a relationship between the depleted-sugar condition versus the other ego-depletion conditions (i.e., depleted-non-sugar and depleted-no candy) and participants' creativity scores. Specifying the dummy variable which coded "1" for depleted-non-sugar and depleted-no candy conditions and "0" for other conditions as predictor, with the dummy variable which coded "1" for non-depleted condition and "0" for other conditions controlled for, results revealed that participants in the depleted-sugar condition had longer RTs on correct responses (marginal significance), B = -250.30, SE = 140.07, 95% CI [-527.47, 26.87], t = -1.79, p = .076. RT on correct responses, however, was not in turn associated with participants' creativity scores, with B = 0.0001, SE = 0.0001, 95% CI [-.0001, .0002], t = 0.39, p = .698. A bootstrap estimation approach conducted with 5,000

samples (Shrout & Bolger, 2002) indicated that the indirect path was non-significant, B = -0.01, SE = 0.02, 95% C.I. = [-0.06, 0.03]. All relationships tested were non-significant after controlling for the measured covariates.

Supplementary analyses. Post-hoc analyses were conducted on participants' convergent thinking ability as measured by the RAT. Conducting an ANOVA test revealed that there was no significant difference in the number of correct responses on the RAT among the four conditions, $F(3, 126) = 1.12$, $p = .343$, $\eta_p^2 = .026$, even when time spent on the task was controlled for, $F(3, 125) = 0.90$, $p = .441$, $\eta_p^2 = .021$. Similarly, conducting a simple linear regression analysis revealed that RT on correct responses in the CIT was not associated with the number of correct responses on the RAT, B = -0.0002, SE = 0.0001, 95% CI [-0.0004, 0.0001], t = -1.10, p = .273, even when time spent on the RAT was controlled for, B = -0.0001, SE = 0.0001, 95% CI [-0.0004, 0.0001], t = -1.03, p = .306. There was no significant difference in time spent on the RAT among the four conditions, $F(3, 126) = 0.58$, $p = .630$, $\eta_p^2 = .014$.

Post-hoc moderation analyses were then conducted using the SPSS PROCESS macro (Model 1; Hayes, 2017) to examine if any of the null findings may have been masked by a moderating variable. The first set of moderation analyses was conducted on the hypothesized relationship between the depleted-no candy condition versus non-depleted condition and participants' creativity scores. Interaction terms were created by multiplying a potential moderator being tested with each of the three dummy variables that represent the four conditions, with non-depleted condition being the effective reference category (Table 4). These interaction terms were then specified as predictors alongside the potential moderator and original dummy variables. No measured variable was found to exert a significant moderating effect. Repeating this analysis using a dummy variable which coded "1" for both depleted-non-sugar and depleted-

no candy conditions and “0” for other conditions, and a dummy variable which coded “1” for depleted-sugar condition and “0” for other conditions controlled for (i.e., non-depleted as effective reference category), yielded null results as well.

Next, moderation analyses were conducted on the hypothesized relationship between depleted-no candy condition versus non-depleted condition and RT on correct responses in the CIT. Similarly, none of the measured variables was found to exert a significant moderating effect. Repeating this analysis using the dummy variable which coded “1” for both depleted-non-sugar and depleted-no candy conditions and “0” for other conditions, and the dummy variable which coded “1” for depleted-sugar condition and “0” for other conditions controlled for (i.e., non-depleted as effective reference category), yielded null results as well.

Moderation analyses were also conducted on the hypothesized relationship between RT on correct responses for the CIT and creativity scores. No measured variable, including condition assessed using the three dummy variables (Table 4) and three interaction terms created by multiplying each dummy variable with RT, was found to exert a significant moderating effect (Figure 2).

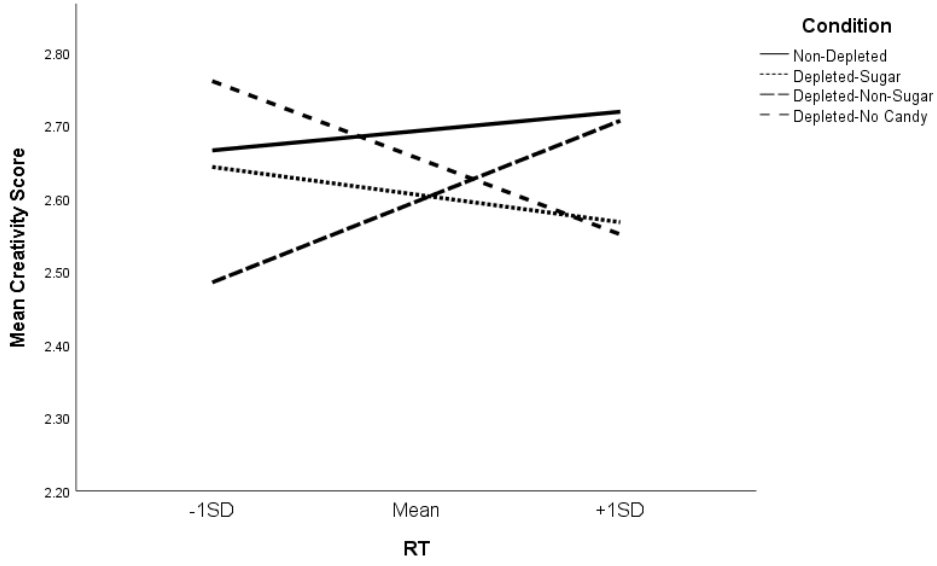

Figure 2. Simple slopes (i.e., unstandardized coefficients) of RT on correct responses for the CIT predicting creativity scores for the four distinct conditions, with null statistical significance for all relationships depicted.

The second set of moderation analyses was conducted on the hypothesized relationship between the depleted-sugar condition versus those assigned to all other ego-depletion conditions (i.e., deplete-non-sugar and deplete-no candy) and creativity scores. Interaction terms were created by multiplying a potential moderator being tested with each of the three dummy variables that represent the four conditions, with depleted-sugar condition being the effective reference category (Table 5). None of the measured variables was found to exert a significant moderating effect, with all interaction terms being statistically non-significant. Repeating this analysis with the dummy variable which coded "1" for depleted-non-sugar and depleted-no candy conditions and "0" for other conditions, and the dummy variable which coded "1" for non-depleted condition and "0" for other conditions controlled for (i.e., depleted-sugar as effective reference category), yielded null results as well.

Finally, moderation analyses were conducted on the hypothesized relationship between the depleted-sugar condition versus those assigned to all other ego-depletion conditions (i.e., depleted-non-sugar and depleted-no candy) and RT on correct responses in the CIT using the same set of three dummy variables (Table 5). None of the variables measured significantly moderated these relationships. Repeating this analysis with the dummy variable which coded "1" for depleted-non-sugar and depleted-no candy conditions and "0" for other conditions, and the dummy variable which coded "1" for non-depleted condition and "0" for other conditions controlled for (i.e., depleted-sugar as effective reference category), yielded null results as well.

Discussion

Study 2 replicated the null effects of ego-depletion on inhibitory control over salient concepts and creativity, as well as the null association between inhibitory control and creativity as observed in Study 1. This is despite evidence of successful ego-depletion manipulation and the usage of a different creativity task. Such corroborating results further underscore the notion that, contrary to my theorization, self-regulatory resources may not be needed in the process of inhibiting salient concepts and generating creative ideas. However, Studies 1 and 2 only examined if a reduction in self-regulatory resources would undermine inhibitory control and creativity. To ascertain with confidence that self-regulation is indeed inconsequential to inhibitory control and creativity, a follow-up study is required to examine the other end of the spectrum as well – whether improving one's self-regulatory capacity would also result in a null effect (Study 3).

Regarding the association between inhibitory control over salient concepts and creativity, post-hoc analyses conducted in Study 1 uncovered a moderating effect of condition on the relationship between inhibitory control and creativity. Specifically, it was found that inhibitory control was only positively associated with creativity for non-depleted individuals; it was unassociated with creativity for ego-depleted individuals. In Study 2, where the majority of participants were subjected to ego-depletion induction, it was observed that inhibitory control was not associated with creativity, although it was found to be positively associated with categorical flexibility, albeit at marginal statistical significance. This suggests that while participants with higher inhibitory control may have been able to explore more semantic concepts and categories, it did not result in significantly more creative ideas. This lends some support to the postulation discussed in Study 1, that ego-depleted individuals are seemingly

unable to leverage on their inhibitory control ability over the pull of salient concepts to generate creative ideas.

It should be cautioned that the abovementioned findings held even for those assigned to the non-depletion condition (i.e., the effect was not moderated by condition, unlike Study 1). One explanation is that the sample size of non-depleted participants (n = 32) was disproportionately smaller than those who underwent ego-depletion induction (n = 98), resulting in insufficient statistical power to discern a moderation effect (Schmidt et al., 2014; Wahlsten, 1991). Further, statistical studies have shown that such a stark imbalance in sample sizes between conditions can artificially induce statistical dependency, resulting in a false correlation between the imbalanced conditions (Landsheer & van den Wittenboer, 2015). Nonetheless, Study 3, which is conducted solely on non-depleted participants, would allow for the validation of this postulation. Specifically, if an unconditional, significant association between inhibitory control and creativity is observed in Study 3, it would lend credence to the notion that non-depleted individuals are able to leverage on the creative benefits of inhibitory control over salient concepts.

Lastly, an unexpected effect was observed whereby ego-depleted participants who consumed the glucose-containing candy seemed to have exhibited poorer inhibitory control as compared to other ego-depleted participants who did not; this effect was found to be marginally significant. This is contrary to past research on the self-regulation boosting effects of glucose consumption (e.g., Gailliot et al., 2007), suggesting that glucose consumption may undermine one's inhibitory control instead. However, given that this effect was found to be marginally significant and was rendered null after controlling for the measured covariates, further studies are first needed to replicate and validate this finding before any firm conclusions can be drawn.

Chapter 6: Study 3

Purpose of Study

Studies 1 and 2 examined whether depleting individuals' self-regulatory resources would hamper their inhibitory control over salient concepts and creativity, which have both yielded null findings in that regard. This present study sought to examine the other end of the spectrum – whether boosting one's self-regulatory capacity instead might improve inhibitory control over salient concepts and creativity. Covering both ends of the spectrum would provide a much more comprehensive understanding with regards to the involvement (or lack thereof) of self-regulation in creative ideation.

Study 3 examined if mindfulness meditation, which has been shown to improve one's self-regulatory capacity (Cook-Cottone, 2015; Tang et al., 2007), could improve individuals' inhibitory control over salient concepts and creativity. Participants were randomly assigned to either a mindfulness meditation condition or a music listening control comparison condition. Those assigned to the mindfulness meditation condition underwent daily mindfulness meditation sessions for 10 days using empirically validated, pre-recorded audio guides developed by *Headspace* (Lim et al., 2015; Mani et al., 2015). Those assigned to the music listening condition underwent daily music listening sessions for 10 days consisting of a randomized playlist of music from the genres of pop, rock, and electronic.

The secondary aim of Study 3 is to validate the postulation that inhibitory control would result in creative gains for non-depleted individuals. Without inducing ego-depletion on any participant of this study, an unconditional, positive association between inhibitory control and creativity is expected. In this study, inhibitory control was assessed using the same CIT administered in Studies 1 and 2. Creativity was assessed using the established chocolate design

task, where participants were tasked to generate a new revolutionary chocolate design (Ong & Leung, 2013). This task was selected as it allows for both an objective and subjective assessment of creativity. With Study 1's creativity task (pasta naming task) based on objective criteria scoring and Study 2's creativity task (quality of university education task) based on subjective novelty rating, this task will allow me to assess creative performance using both objective and subjective scoring of the creative responses. Details of the scoring procedures will be provided in the following section.

Measures

Manipulation check. Effectiveness of the 10-day mindfulness intervention was assessed using the established 39-item Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006, 2008). The FFMQ measures people's mindfulness levels in terms of the following facets: observe (e.g., "when I'm walking, I deliberately notice the sensations of my body moving"), describe (e.g., "I'm good at finding words to describe my feelings"), act with awareness (e.g., "it seems I am "running on automatic" without much awareness of what I'm doing", reverse coded), non-judge (e.g., "I criticize myself for having irrational or inappropriate emotions", reverse coded), and non-react (e.g., "I perceive my feelings and emotions without having to react to them"). Participants in both conditions were asked to rate the extent each statement was true for them during the 10-day intervention period, on a scale of 1 (*never or very rarely true*) to 5 (*very often or always true*). Cronbach's α were .873 (overall), .826 (observe), .930 (describe), .906 (act with awareness), .925 (non-judge), and .801 (non-react). Analyses were conducted at both the overall mean score, which indexes overall mindfulness levels, and at each facet's aggregated scores. The full questionnaire and scoring instructions can be found in Appendix C.

Engagement level. Following Lim et al.'s (2015) paradigm, participants indicated their levels of engagement in each mindfulness/music listening session with two items, "how tired were you during the session?" (reverse coded) and "how attentive were you during the session?" (1 = *not at all* to 10 = *extremely*). Cronbach's α was .289.

Baseline mindfulness. Prior to the 10-day mindfulness meditation/music listening session, participants completed an established parallel version of the FFMQ – the 39-item Kentucky Inventory of Mindfulness Skills (KIMS; Baas et al., 2014; Baer et al., 2004; Baum et al., 2010). KIMS assesses people's mindfulness levels in terms of the following facets: observe (e.g., "I pay attention to sensations, such as the wind in my hair or sun on my face"), describe (e.g., "I can easily put my beliefs, opinions, and expectations into words"), act with awareness (e.g., "I drive on "automatic pilot" without paying attention to what I'm doing"), and accept without judgement (e.g., "I tell myself that I shouldn't be feeling the way I'm feeling", reverse coded). As demonstrated by past studies, the facet of "accept without judgement" in KIMS is equivalent to the aggregated scores of the "non-judge" and "non-react" facets of the FFMQ (e.g., Baas et al., 2014). Participants rated the extent to which each statement was generally true for them, on a scale of 1 (*never or very rarely true*) to 5 (*very often or always true*). Cronbach's α were .805 (overall), .816 (observe), .890 (describe), .790 (act with awareness), and .851 (accept without judgement). Analyses were conducted at both the overall mean score, which indexes overall mindfulness levels, and at each facet's aggregated scores. The full questionnaire and scoring instructions can be found in Appendix C.

Assessing baseline mindfulness levels before the 10-day intervention allowed for missing data analysis to be conducted (i.e., to examine if systematic differences in mindfulness exist between those who dropped out midway and those who stayed on).

Creativity. Creativity was assessed via the chocolate design task adopted from Ong and Leung (2013) after the 10-day mindfulness meditation/music listening intervention. Participants were tasked to generate a new chocolate design within eight minutes. They were instructed to draw the design on a piece of paper and write down any descriptive captions. Consistent with past studies that have administered this task (e.g., Leung et al., 2017), each participants' generated design was scored based on eight criteria. Independent judges awarded one point if the design meets one rating criterion, with a maximum total creativity score of eight points. The exact task instruction and details of the eight evaluation criteria can be found in Appendix D.

Participants' chocolate design drawings, along with their descriptive captions, were scanned as image files and randomly distributed among seven independent judges, with five images being rated by all judges in order to assess inter-rater reliability. These judges were tasked to score each participant's chocolate design based on the provided scoring criteria and to provide their independent novelty ratings using a scale of 1 (*not novel at all*) to 5 (*extremely novel*). Inter-rater reliability was assessed in terms of absolute agreement. Results were generally indicative of acceptable agreement (i.e., ICC > .40; Carod-Artal Francisco Javier et al., 2009; Zaiontz, n.d.) among the judges for both criteria scoring (ICC(2,1) = .621; ICC(2,8) = .920) and novelty rating (ICC(2,1) = .869; ICC(2,8) = .979). For the five designs commonly rated by all the judges, mode was taken for criteria scores and average was taken for novelty ratings.

***Baseline creativity*.** Prior to the 10-day mindfulness meditation/music listening sessions, participants completed a short creativity task – the Unusual Uses Task (UUT; Gilhooly et al., 2007; Nusbaum & Silvia, 2011). This baseline creativity measure before the onset of intervention is needed for missing data analysis (i.e., to examine if systematic differences in creativity exist between those who dropped out midway and those who stayed on).

In the UUT, participants generated as many creative uses as they could for the common household object of "paperclip" (an object not presented in the CIT) within three minutes. A total of 1,088 ideas were generated. Similar to Study 2, all ideas were first alphabetically sorted before being randomized and divided among 11 independent judges, with 20 ideas being independently rated by all judges to measure inter-rater reliability. The judges provided novelty ratings for each idea using a scale of 1 (*not novel at all*) to 5 (*extremely novel*). Inter-rater reliability was assessed in terms of absolute agreement. Results were generally indicative of acceptable agreement (i.e., ICC > .40; Carod-Artal Francisco Javier et al., 2009; Zaiontz, n.d.) among the judges (ICC(2,1) = .440; ICC(2,8) = .846). For the 20 commonly rated ideas, the average was taken among ratings provided by the judges. All ratings were then matched to the respective participant before being aggregated accordingly.

***Convergent thinking ability*.** The same 10-item Remote Associates Test (RAT) administered in Studies 1 and 2 was used to measure convergent thinking ability. Five randomly selected items were administered before the 10-day intervention, while the remining five were administered after the 10-day intervention.

Inhibitory control. The participants completed the same CIT administered in Studies 1 and 2 for measuring inhibitory control over the prepotent tendency of fixating on salient and highly accessible semantic concepts. The CIT was administered before and after the 10-day intervention (trials randomized for each administration).

Covariates. As with Studies 1 and 2, the potential covariates of action orientation, lay theory of willpower, trait self-control, positive affect (PA), and negative affect (NA) were assessed and controlled for in this study. Cronbach's α were .801, .853, .836, .897, and .900

respectively. Fatigue was not a covariate because this study did not involve ego-depletion manipulations.

Procedure

Due to attrition, a total of 111 participants were recruited to achieve the target sample size of 30 per condition. Regular practitioners of any form of meditation were not allowed to participate. The target sample size was determined by an a priori power analysis conducted using G*Power by specifying a mean difference test with an estimated effect size of $d = 0.451$, $\alpha = 0.05$, and power = 0.95. The estimated effect size was derived from a meta-analysis conducted by Lebuda et al. (2016) on the relationship between mindfulness and creativity.

Out of the 111 participants, who were randomly assigned to either the mindfulness meditation condition ($n = 57$) or music listening condition ($n = 54$), 38 participants missed at least one mindfulness meditation/music listening session and were dropped from the study midway. This resulted in a final sample size of 73 participants (10 males and 63 females), age ranging from 18 to 29 years old ($M_{age} = 20.8$ years, $SD_{age} = 2.2$ years), with 31 participants in the mindfulness meditation condition and 42 participants in the music listening condition. These participants identified themselves ethnically as Chinese (55; 75.3%), Malay (3; 4.1%), Indian (7; 9.6%), and "other" (8; 11.0%). Their declared primary majors are as follows: Social Sciences (59; 80.8%), Economics (6; 8.2%), Political Science (3; 4.1%), Marketing (2; 2.7%), Information Systems (1; 1.4%), Law (1; 1.4%), and "undeclared" (1; 1.4%). Participants were awarded five study credits for completing the study. All relevant descriptive statistics of the final sample can be found in Table 6. Due to an unexpected technical issue, two baseline and one post-intervention CIT data points were not saved successfully on the computer's hard drive.

Table 6. *Descriptive Statistics of Demographic and Studied Variables.*

	N	*M*	*SD*	*Range*
Age	73	20.78	2.16	18-29
Sex (% male)	73	13.70%		
Creativity Score (Novelty Rating; Baseline)	73	1.93	0.46	1.00-3.17
Creativity Score (Novelty Rating; Post-Intervention)	73	2.85	1.20	1.00-5.00
Creativity Score (Criteria Counting)	73	2.67	1.39	1.00-6.00
RAT Score (Baseline)	73	0.64	0.77	0-3
RAT Score (Post-Intervention)	73	0.97	1.01	0-3
RT on Correct Responses (ms; Baseline)	71	2142.82	551.46	1125.62-3863.28
Number of Incorrect Responses (Baseline)	71	19.82	11.16	5-72
RT on Correct Responses (ms; Post-Intervention)	72	2027.37	502.23	684.6-3425.66
Number of Incorrect Responses (Post-Intervention)	72	17.63	8.41	5-56
Action Orientation	73	5.62	3.26	0-12
Lay Theory of Willpower	73	2.49	0.87	1.00-5.00
Trait Self-Control	73	2.97	0.63	1.46-4.85
PA	73	2.61	0.75	1.10-4.40
NA	73	1.83	0.72	1.00-3.80

Missing data analyses were conducted to ensure that those who completed versus dropped out did not differ systematically on key variables. Firstly, a binary logistic regression analysis was conducted, whereby a condition dummy variable which coded "1" for mindfulness meditation condition and "0" for music listening condition was regressed onto a completion status dummy variable which coded "1" for completed and "0" for dropped. Results showed that those assigned to the mindfulness meditation condition were significantly more likely to drop out, $B = -1.08$, $SE = 0.42$, $p = .011$.

Next, an independent samples *t*-test conducted on baseline mindfulness levels revealed that there was no significant difference between those who dropped out and those who stayed on, $t(85.35) = -0.59$, $p = .557$, Cohen's $d = 0.12$. Repeating this analysis at each facet of mindfulness (observe, describe, act with awareness, and accept without judgement) yielded null results as well. There was also no significant difference in baseline creativity scores between those who dropped out and those who completed the study, $t(76.95) = 0.50$, $p = .618$, Cohen's $d = 0.09$. However, those who dropped out exhibited significantly lower inhibitory control as indicated by longer RTs on correct responses in the CIT, $t(65.58) = 2.66$, $p = .010$, Cohen's $d = 0.55$. While there were between-group differences in accuracy in the CIT, $t(99.74) = -2.95$, $p = .004$, Cohen's $d = 0.56$, this finding held even when accuracy was controlled for, $F(1, 104) = 4.49$, $p = .037$, $\eta_p^2 = .041$.

The entire study lasted for 12 days. On the first day, participants reported to the psychology lab to complete baseline measures of their mindfulness level (KIMS), inhibitory control over salient concepts (CIT), and creativity (UUT). Participants were then randomly assigned to either the mindfulness meditation condition or music listening condition and were individually briefed on the instructions and procedure before being dismissed.

From the second to eleventh day (i.e., 10 days), participants assigned to the mindfulness meditation condition completed an online 10-minute audio guided mindfulness meditation session each day at their convenience. These audio clips were derived from the 10-day basic mindfulness meditation course on *Headspace*, which were uploaded onto a private YouTube account visible only to the participants assigned to this condition. Doing so permitted the disabling of all media controls, which serves to prevent participants from skipping or fast-forwarding the audio clip, and the verifying of session completion by stitching an audible unique verification code at the end of each clip. All participants were required to input the code into an online survey form along with their unique subject ID after each session. This online survey form also contained the 2-item engagement level measure.

Participants assigned to the music listening condition listened to 10 minutes of music each day instead. Each audio clip consisted of three different musical pieces: one pop, one rock and one electronic genre (order randomized), randomly drawn from the Google Top Chart playlist. Similarly, these audio clips were uploaded onto a private YouTube account visible only to the participants assigned to this condition, with all media controls disabled and an audible unique verification code stitched to the end of each clip. Likewise, participants had to input the code into an online survey form along with their unique subject ID and to complete the 2-item engagement level measure after each session.

On the twelfth and final day, participants reported back to the psychology lab to complete measures of their positive and negative affect (PANAS; instructed to report based on their experiences during the past 10 days), mindfulness level (FFMS), inhibitory control over salient concepts (CIT; trials randomized from before), and creativity (chocolate design task). For the chocolate design task, participants were given eight minutes to come up with a creative

chocolate design by drawing on a piece of A4 paper and providing descriptive captions about the design. A scenario prompt was given, which is attached in Appendix D. Next, participants completed the RAT before completing the covariate measures of action orientation, lay theory of willpower, and trait self-control. Participants then provided basic demographic information (e.g., age, gender, etc.) before being thanked and debriefed.

Results

Main analyses. To assess the efficacy of the 10-day mindfulness meditation intervention program, an independent samples *t*-test was first conducted on participants' post-intervention mindfulness levels, as measured using the FFMQ. Results, however, revealed that there was no significant difference in average post-intervention mindfulness levels between participants assigned to the mindfulness meditation condition (M = 3.15, SD = 0.41) and the music listening condition (M = 3.06, SD = 0.44), $t(67.30) = -0.91$, $p = .368$, Cohen's $d = 0.21$. Repeating this analysis at the facet level also revealed that there was no significant difference between both conditions on any of the facets (observe, describe, act with awareness, non-judge, and non-react). These results remained non-significant after controlling for the measured covariates.

Next, an independent samples *t*-test was conducted on participants' self-reported engagement levels during their respective 10-day online sessions, derived by averaging their responses over 10 days. Results showed that there was no significant difference in overall engagement levels during the 10-day intervention sessions between participants assigned to the mindfulness meditation condition (M = 6.58, SD = 1.18) and the music listening condition (M = 6.35, SD = 1.33), $t(68.68) = -0.79$, $p = .431$, Cohen's $d = 0.18$. Repeating this analysis at the item level yielded null results as well. This indicates that participants of both conditions were similarly engaged in their respective online sessions.

Notwithstanding the null manipulation check result, further tests were conducted to examine the a priori hypotheses. Firstly, a set of analyses was conducted to examine if participants between the two conditions differed significantly in their post-intervention creativity scores. Because creativity scores derived through criteria counting are count-based data, they were analyzed using Poisson regression (Coxe et al., 2009; Hutchinson & Holtman, 2005). Specifying a dummy variable which coded "1" for mindfulness meditation condition and "0" for music listening condition as a predictor, results revealed that there was no significant difference in creativity scores derived through criteria counting between the two conditions, $B = 0.19$, $SE = 0.14$, 95% CI = [-0.09, 0.47], Wald $\chi^2 = 1.77$, $p = .184$. Similarly, conducting an independent samples *t*-test on creativity scores derived through novelty rating revealed no significant difference between the conditions, $t(58.78) = -0.13$, $p = .898$, Cohen's $d = 0.03$. These results remained non-significant after controlling for the measured covariates.

Mediation analyses were then conducted to examine if participants' levels of post-intervention inhibitory control over the prepotent tendency to fixate on highly salient, closely associated semantic concepts would mediate a relationship between mindfulness meditation versus music listening and creativity. I first conducted an independent samples *t*-test on the number of incorrect responses on the CIT (post-intervention) to ensure that accuracy was similar for both conditions. Results showed that both conditions were similarly accurate in the CIT, $t(64.82) = -0.87$, $p = .390$, Cohen's $d = 0.21$.

Next, a Poisson-based mediation analysis was conducted on creativity scores derived through criteria counting. A dummy variable which coded "1" for mindfulness meditation condition and "0" for music listening condition was specified as the predictor, while RT on correct responses in the CIT was specified as the mediator and creativity score derived through

criteria counting was specified as the outcome variable. Results revealed that the dummy variable was not associated with RT on correct responses in the CIT, B = -6.31, SE = 120.38, 95% CI [-246.41, 233.79], t = -0.52, p = .958. RT on correct responses was also not associated with participants' creativity scores derived through criteria counting, B = 0.00003, SE = 0.0001, 95% CI [-0.0002, 0.0003], Wald χ^2 = 0.05, p = .831. These results remained non-significant after controlling for the measured covariates.

A mediation analysis was then conducted on creativity scores derived through novelty rating using the SPSS PROCESS macro (Model 4; Hayes, 2017). The same dummy variable was specified as the predictor, RT on correct responses as the mediator, and novelty ratings as the outcome variable. Results revealed that although the dummy variable was not associated with RT on correct responses in the CIT, B = -6.31, SE = 120.38, 95% CI [-246.41, 233.79], t = -0.52, p = .958, RT on correct responses was, in turn, found to be significantly, negatively associated with creativity scores derived through novelty rating, B = -0.001, SE = 0.0003, 95% CI [-0.001, <-0.0001], t = -2.02, p = .047. A bootstrap estimation approach conducted with 5,000 samples (Shrout & Bolger, 2002) indicated that the indirect path was non-significant, B = 0.004, SE = 0.07, 95% C.I. = [-0.14, 0.17]. These results above held even after controlling for the measured covariates. A follow-up moderation analysis conducted confirmed that the negative association between RT on correct responses and creativity scores derived through novelty rating was not dependent on condition (Figure 3), B = -0.0001, SE = 0.0006, 95% CI = [-0.001, 0.001], p = .851.

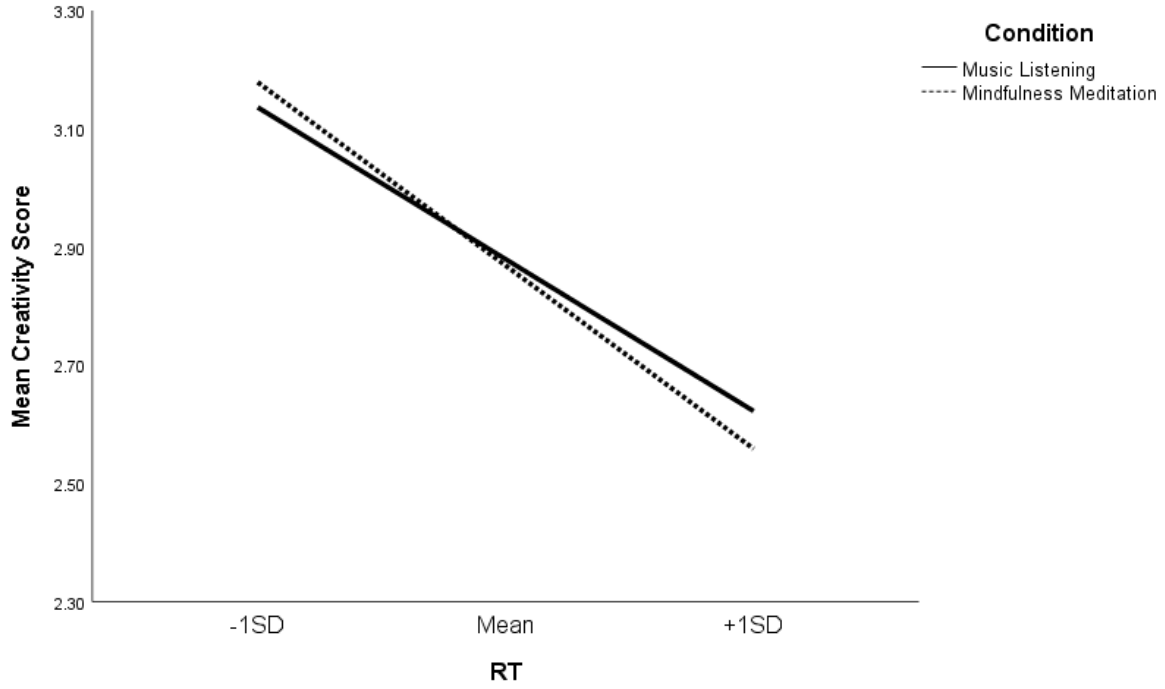

Figure 2. Simple slopes (i.e., unstandardized coefficients) of RT on correct responses for the CIT predicting creativity scores for music listening versus mindfulness meditation condition, with significant main effect but non-significant interaction effect.

Supplementary analyses. To ascertain if the negative relationship between RT on correct responses and creativity (novelty ratings) also held prior to the intervention, participants' RT on correct responses assessed at baseline was regressed on their baseline creativity scores. Results revealed a negative association between RT on correct responses and creativity scores at marginal significance, B = -0.0002, SE = 0.0001, 95% CI [-0.0004, 0.00001], t = -1.86, p = .067, but only when participants who dropped out were excluded from the analysis. Including these participants rendered the association non-significant, B = 0.000004, SE = 0.0001, 95% CI [-0.0002, 0.0002], t = 0.05, p = .958, which remained non-significant after controlling for number

of incorrect responses (i.e., accuracy), B = -0.000002, SE = 0.0001, 95% CI [-0.0002, 0.0002], t = -0.02, p = .984.

Post-hoc analyses were then conducted on participants' convergent thinking ability as measured by the RAT (post-intervention). An independent samples t-test revealed that there was no significant difference in number of correct responses in the RAT between participants assigned to the mindfulness meditation condition (M = 1.03, SD = 1.02) versus music listening condition (M = 0.93, SD = 1.02), t(65.00) = -0.43, p = .669, Cohen's d = 0.10, even when time spent on the RAT was controlled for, F(1, 70) = 0.12, p = .735, η_p^2 = .002. Similarly, conducting a simple linear regression analysis revealed that RT on correct responses in the CIT (post-intervention) was also not associated with the number of correct responses in the RAT, B = -0.0001, SE = 0.0002, 95% CI [-0.001, 0.0004], t = -0.41, p = .682, even when time spent on the RAT was controlled for, B = -0.0001, SE = 0.0002, 95% CI [-0.001, 0.0003], t = -0.61, p = .547. There was no significant difference in time spent on the RAT between participants of the two conditions, t(70.74) = -0.80, p = .429, Cohen's d = 0.18. Repeating these analyses on baseline RAT data yielded null results as well. A follow-up mixed-design ANOVA revealed that there was a significant increase in RAT scores between baseline and post-intervention, F(1, 71) = 7.20, p = .009, η_p^2 = .092. However, this increase was not dependent on condition, F(1, 71) = 0.02, p = .886, η_p^2 = .0003.

In light of the null result of the main analyses, post-hoc Analysis of Covariance (ANCOVA) was conducted to examine if accounting for baseline assessments of the key variables would affect the results pertaining to these variables. First, an ANCOVA was conducted on participants' post-intervention mindfulness scores, with their baseline mindfulness scores controlled. Results revealed that, with baseline mindfulness levels controlled, those assigned to

the mindfulness meditation condition (M = 3.15, SD = 0.41) had marginally significantly higher post-intervention mindfulness levels than those assigned to the music listening condition (M = 3.06, SD = 0.44), $F(1, 70) = 3.72$, $p = .058$, $\eta_p^2 = .050$. Separate ANCOVAs were then conducted for each mindfulness facet, which yielded null results with one exception – the "act with awareness" facet. Results revealed that, with baseline "act with awareness" levels controlled, those assigned to the mindfulness meditation condition (M = 3.22, SD = 0.57) had marginally significantly higher post-intervention "act with awareness" levels than those assigned to the music listening condition (M = 3.03, SD = 0.82), $F(1, 70) = 4.55$, $p = .036$, $\eta_p^2 = .061$.

Next, an ANCOVA was conducted on participants' post-intervention creativity scores, with their baseline creativity score controlled. However, results revealed that even when baseline creativity was controlled, there was no significant difference in post-intervention creativity scores, with $F(1, 70) = 3.58$, $p = .158$, $\eta_p^2 = .028$ for scores derived through criteria counting and $F(1, 70) = 0.001$, $p = .980$, $\eta_p^2 < .001$ for scores derived through novelty rating. Finally, an ANCOVA was conducted on participants' post-intervention inhibitory control levels, with their baseline inhibitory control levels controlled. Results revealed that even when baseline inhibitory control level was controlled, there was no significant difference in post-intervention inhibitory control levels, $F(1, 67) = 0.27$, $p = .607$, $\eta_p^2 = .004$.

Further post-hoc within-subject analyses were then conducted to re-examine all relationships tested in the main analyses section. Firstly, a mixed-design ANOVA compared participants' baseline mindfulness levels with their post-intervention mindfulness levels between the two conditions. Results revealed that there was a significant increase in mindfulness levels from baseline to post-intervention, $F(1, 71) = 13.12$, $p = .001$, $\eta_p^2 = .156$. Critically, this increase was found to be moderated by condition, $F(1, 71) = 4.18$, $p = .045$, $\eta_p^2 = .056$. Decomposing this

interaction effect, results showed that there was a significant increase in mindfulness levels for participants assigned to the mindfulness meditation condition, Mean Difference = .20, 95% CI [0.08, 0.33], *SE* = 0.06, $p = .003$, but there was no significant increase in mindfulness levels for those assigned to the music listening condition, Mean Difference = .06, 95% CI [-0.03, 0.14], *SE* = 0.04, $p = .172$. This is illustrated in Figure 3.

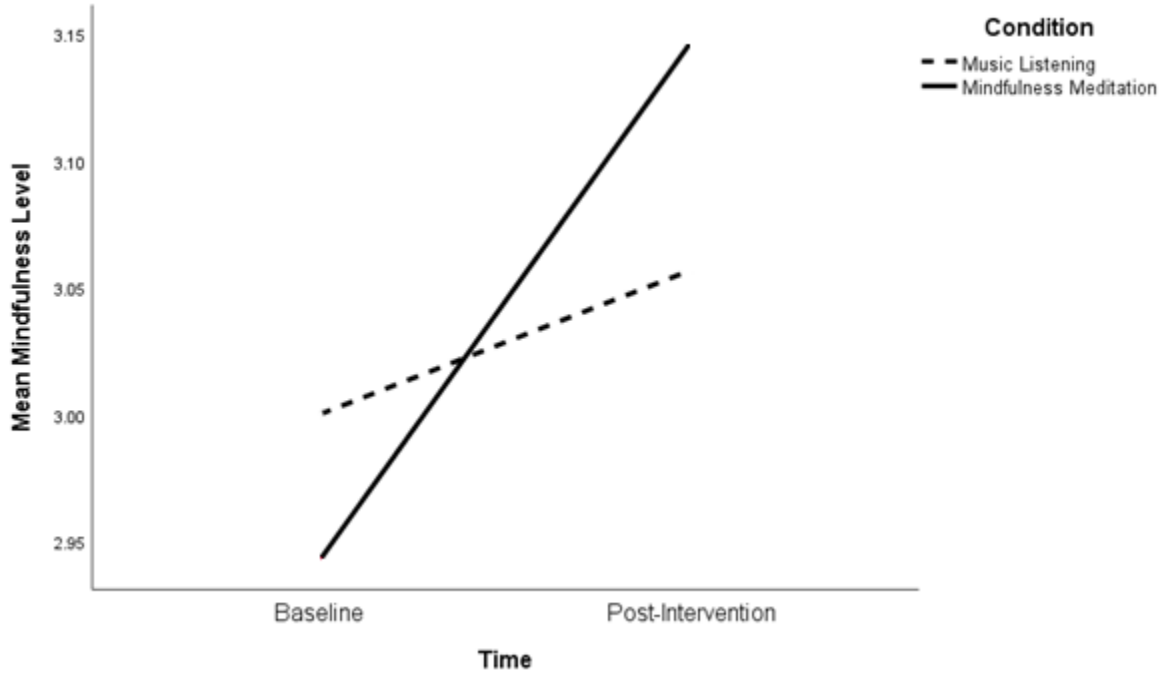

Figure 3. Simple slopes of change in mean mindfulness level from baseline to post-intervention comparing music listening versus mindfulness meditation condition

Repeating the analyses above for each mindfulness facet, results revealed that there was a significant increase between baseline and post-intervention for only two facets: “act with awareness”, $F(1, 71) = 27.53$, $p < .001$, $\eta_p^2 = .279$, and “accept without judgement”, $F(1, 71) = 13.69$, $p < .001$, $\eta_p^2 = .162$. However, only the increase in the “act with awareness” facet was found to be significantly moderated by condition, $F(1, 71) = 4.98$, $p = .029$, $\eta_p^2 = .066$; the

increase in the "accept without judgement" facet was not dependent on condition, $F(1, 71) = 1.45$, $p = .232$, $\eta_p^2 = .020$. Decomposing the interaction effect, there was a greater increase in "act with awareness" for participants assigned to the mindfulness meditation condition, Mean Difference = .48, 95% CI [0.27, 0.69], $SE = 0.10$, $p < .001$, as compared to those assigned to the music listening condition, Mean Difference = .19, 95% CI [0.03, 0.36], $SE = 0.08$, $p = .021$, although both increases remained statistically significant for both conditions. This is illustrated in Figure 4.

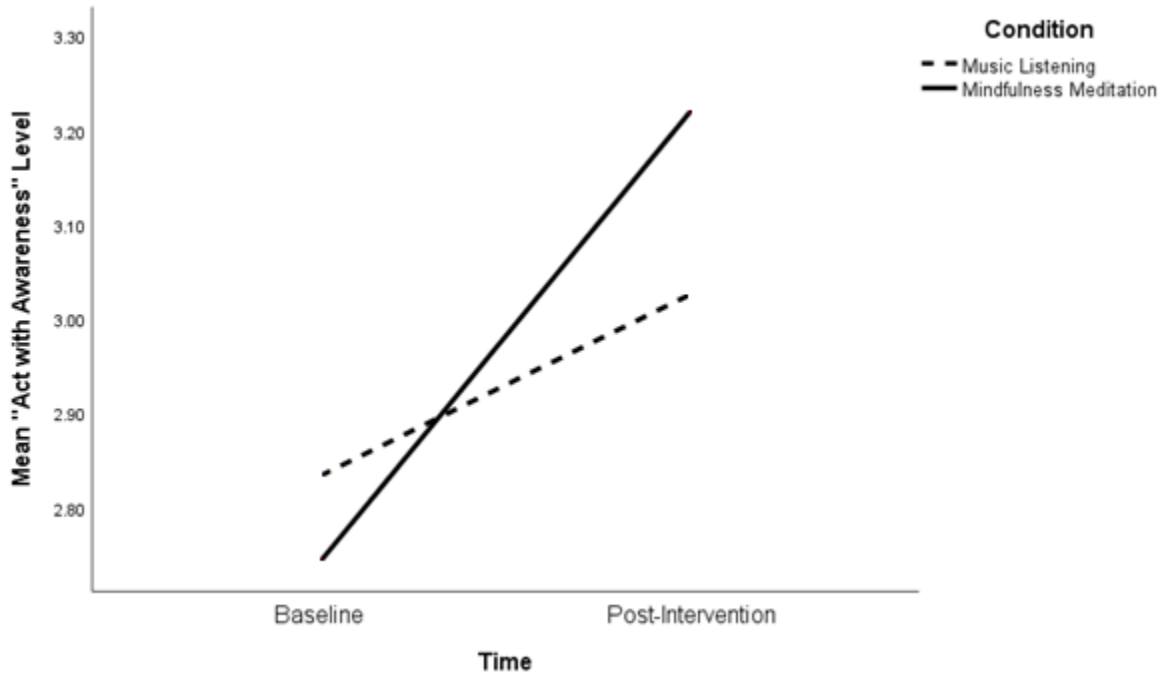

Figure 4. Simple slopes of change in mean "act with awareness" level from baseline to post-intervention comparing music listening versus mindfulness meditation condition

Next, a mixed-design ANOVA compared participants' creativity scores (novelty ratings) at the baseline with their creativity scores (novelty ratings) after intervention between the two conditions. Results revealed that there was a significant increase in creativity scores from

baseline to post-intervention, $F(1, 71) = 40.45$, $p < .001$, $\eta_p^2 = .363$. However, this increase was not dependent on condition, $F(1, 71) = 0.02$, $p = .902$, $\eta_p^2 = .0002$. Furthermore, this effect was rendered non-significant when PA, action orientation and trait self-control were controlled for. Conducting independent samples *t*-tests on these covariates revealed that there was no significant difference between the two conditions on these variables.

Moderation analyses were then conducted to examine if a measured variable may have masked an interaction effect between condition and time (baseline versus post-intervention) on creativity scores. To examine this, interaction terms were created by multiplying the dummy variable which coded "1" for mindfulness meditation condition and "0" for music listening condition with each potential moderating variable. The dummy variable, the potential moderator being tested, as well as the interaction term between the two were then specified as predictors using a mixed-design ANOVA. None of the measured variables was found to exert a significant moderating effect.

A mixed-design ANOVA was then carried out on participants' RT on correct responses in the CIT, comparing baseline with post-intervention levels between the two conditions. Results revealed that there was a significant decrease in average RT from baseline to post-intervention, $F(1, 71) = 6.95$, $p = .010$, $\eta_p^2 = .093$. However, this decreases was not dependent on condition, $F(1, 71) = 0.38$, $p = .538$, $\eta_p^2 = .006$. Furthermore, this effect was rendered non-significant when PA, NA, action orientation and trait self-control were controlled for. Conducting independent samples *t*-tests on these covariates revealed that there was no significant difference between the two conditions on these variables.

Moderation analyses were then conducted to examine if a measured variable may have masked an interaction effect between condition and time (baseline versus post-intervention) on

RT values. To examine this, interaction terms were created by multiplying the same dummy variable described above with each potential moderating variable. The dummy variable, the potential moderator being tested, as well as the interaction term between the two were then specified as predictors using a mixed-design ANOVA. Similarly, none of the measured variables was found to exert a significant moderating effect.

Finally, to examine if the increase in creativity scores could be attributed to the decrease in average RT from baseline to post-intervention, baseline creativity scores and RT values were first subtracted from post-intervention creativity scores and RT values, respectively. Difference in RT values was then regressed on difference in creativity scores. However, the analysis showed that the increase in creativity scores was not associated with the decrease in RT values, B = -0.0005, SE = 0.0004, 95% CI [-0.01, 0.0004], t = -1.04, p = .304. Expectedly, a mediation analysis conducted using the SPSS PROCESS macro (Model 4; Hayes, 2017) by specifying the dummy variable which coded "1" for mindfulness meditation condition and "0" for music listening condition as the predictor, difference in RT values as the mediator, and difference in creativity scores as the outcome variable yielded null results for all paths. A bootstrap estimation approach conducted with 5,000 samples (Shrout & Bolger, 2002) confirmed that the indirect path was non-significant, B = -0.02, SE = 0.05, 95% C.I. = [-0.14, 0.07]. Repeating this analysis with difference in "act with awareness" levels specified as the mediator demonstrated a non-significant indirect effect as well, B = 0.18, SE = 0.14, 95% C.I. = [-0.001, 0.53].

Discussion

Findings from Study 3 suggest that improving one's self-regulatory capacity does not result in inhibitory control or creativity gains. While the manipulation check yielded null results, which suggest that the subsequent a priori between-group analyses may not be substantiated,

post-hoc within-subject analyses revealed that there was a significant increase in mindfulness levels only for participants who underwent the 10-day mindfulness meditation sessions (versus music listening sessions). Furthermore, these analyses revealed that the specific facet boosted by these mindfulness meditation sessions (versus music listening sessions) was the "act with awareness" facet – the same and only facet that was reported by the two past studies conducted in this area to be positively correlated with creativity (Agnoli et al., 2018; Baas et al., 2014). Yet, such increases did not seem to drive an increase in inhibitory control over salient concepts or creativity, even though significant increases in inhibitory control and creativity were found between the baseline and post-intervention measures.

It is possible that increases in inhibitory control and creativity could be attributable to changes in PA, NA, action orientation and/or trait self-control levels simply due to having experienced a 10-day routine of online sessions. However, as these variables were measured only at a single time point (i.e., post-intervention), this proposition cannot be tested within this study. PA and NA was only measured post-intervention as they were intended to be used as covariates to ensure that any between-group effects found could not be attributable to systematic differences in PA or NA levels elicited by the two different types of interventions. Action orientation and trait self-control, on the other hand, were only measured once as these variables have been established by past studies as being personality-like, enduring characteristics (Jostmann & Koole, 2007; Tangney et al., 2004). It should be noted that no between-group differences for any of these variables were observed, suggesting that all participants regardless of their intervention condition exhibited similar levels of PA, NA, action orientation, and trait self-control. It is also possible that mindfulness meditation did confer improvements in inhibitory control and creativity and it is just that listening to music for 10 days also conferred similar

improvements, although no study till date has examined music listening in relation to these outcome variables.

Another possible explanation is that the observed decreases in average RT on correct responses in the CIT and increases in novelty ratings were not indicative of true improvements in inhibitory control and creativity. Decreases in average RT could potentially be attributable to practice effect, as the same CIT was administered at baseline and post-intervention, albeit with trials randomized. Increases in novelty ratings observed, on the other hand, may possibly be attributable to difference in task characteristics. Specifically, the UUT administered during baseline involved the production of numerous verbalized ideas, whereas the chocolate design task administered post-intervention involved the production of a single visual idea. It is thus possible that the latter could be more conducive in drawing out higher quality creative output from participants, resulting in heightened creativity scores. This potential explanation is especially likely, given that decreases in average RT was not found to be associated with increases in novelty ratings, even though average RT was significantly associated with novelty ratings during baseline (marginal) and post-intervention assessments. Further studies are required to ascertain and validate these postulations. Therefore, it is acknowledged that any observed increase in inhibitory control and/or creativity may not be attributable specifically to the intervention of improving self-regulation through mindfulness meditation.

It is worth highlighting that inhibitory control over salient concepts (indicated by average RT on correct responses in the CIT) was only marginally significantly associated with creativity assessed at baseline when data from participants who dropped out midway were excluded; including data from these participants rendered the association non-significant and controlling

for their differences accuracy did not change this result. This suggests that some other unmeasured characteristics may instead contribute towards the null association.

Recall that Study 1 found that the association between inhibitory control and creativity is moderated by ego-depletion status, such that the positive association only holds for those who are non-depleted. In Study 3, the association between inhibitory control and creativity became non-significant when the data from participants who later dropped out were included in the analysis. One possible explanation is that participants who dropped out may have been chronically more ego-depleted as compared to those who stayed on. Studies have shown that individuals who are chronically ego-depleted tend to exhibit lower levels of goal adherence (Wang et al., 2015) As such, these participants were unable to tap upon their inhibitory control ability to generate creative ideas at Day 1 and could not adhere to the goal of completing the 12-day study. This theorization, however, requires further validation.

The postulated relationship between inhibitory control and creativity based on Study 1's finding, such that inhibitory control positively predicts creativity for non-depleted individuals but not for ego-depleted individuals, was generally supported by findings of Study 2 (primarily ego-depleted participants) and Study 3 (non-depleted participants) when considered collectively; however, this is true only when subjective rather than objective creativity ratings were considered for Study 3 at post-intervention. Post-intervention, inhibitory control measured was positively associated with novelty ratings for the chocolate design task. However, inhibitory control was found not to be associated with creativity ratings derived through criteria counting, even though both sets of creativity ratings are positively correlated with each other ($r = .610$, $p < .001$). There are two potential explanations for this null relationship. First, it is possible that the list of criteria was not sufficiently comprehensive in capturing the full range of creative

indicators applicable to the chocolate design task. This is unlike the objective scoring criteria used in Study 1, where all possibilities and permutations were accounted for. Second, it is also possible that getting the same judges to provide the two types of ratings side-by-side may have falsely induced a frame of mind that both ratings must be distinct from one another. Nonetheless, follow-up studies are required to test and validate these postulations.

Chapter 7: General Discussion

Across three proposed studies, I set out to provide substantive empirical evidence for the pivotal role of self-regulation in creative idea generation. Specifically, that self-regulatory resources are needed to exert inhibitory control over the automatic tendency to fixate on salient and highly accessible semantic concepts. However, across three experimental studies, I consistently found that self-regulatory resource status was not associated with individuals' inhibitory control over salient concepts and their creativity. Specifically, Studies 1 and 2 found that declines in self-regulatory resources effected by ego-depletion manipulations did not result in substantive declines in inhibitory control or creativity levels. Examining the flip side, Study 3 found that practicing mindfulness meditation, which has been shown to improve one's self-regulatory capacity, did not translate into inhibitory control and creativity gains. These studies suggest that self-regulation may not be involved in the process of exerting inhibitory control over the pull of salient semantic concepts and generating creative ideas.

Through post-hoc analyses, however, I found evidence suggesting that people's self-regulatory resource may, instead, modulate the relationship between inhibitory control and creativity levels. Specifically, Study 1 revealed that a positive association between inhibitory control over salient concepts and creativity held only for non-depleted participants. The association was otherwise non-significant for ego-depleted participants. Similarly, Study 2, which consisted predominantly of ego-depleted participants, demonstrated a null association between inhibitory control and creativity despite inhibitory control being positively associated with categorical flexibility, whereas Study 3, which consisted of non-depleted participants, demonstrated a significant positive association between inhibitory control and creativity.

One might reason that perhaps self-regulatory resources may be needed in the process of transition between inhibiting salient concepts and generating creative ideas. Specifically, while inhibitory control over salient concepts may facilitate the exploration of more semantically remote concepts, it requires one to possess a certain amount of self-regulatory resources in order to synthesize and coalesce the activated remote concepts to produce highly creative ideas. However, given that there was no observable effect of any self-regulation manipulation on participants' convergent thinking ability, as assessed via the RAT across the three studies, it suggests that convergence and integration of remote semantic concepts might not be the key factor that is tapping upon self-regulatory resources instead.

Furthermore, given that no significant difference in creativity levels was observed between participants who were ego-depleted versus non-depleted (Studies 1 and 2), it indicates that those with lower levels of self-regulatory resources were still able to generate ideas of comparable creativity to those who had higher levels of self-regulatory resources. This suggests that those with compromised self-regulatory resources may have employed other means of creative idea generation that do not require inhibiting salient concepts – hence their inhibitory control levels were inconsequential towards their creative performance.

While the consensus is that creative ideas are generated through exploration and incorporation of elements from remote semantic concepts (Mednick, 1962; Moran, 2009), some researchers have propounded that there is a second means to generating creative ideas. Proposing that a dual pathway exists in creative ideation, Nijstad et al. (2010) propounded that individuals may also generate highly creative ideas when they considered a small number of concepts but to a great depth. Terming this as the persistence pathway and the typical means of exploration and incorporation of elements from remote semantic concepts as the flexibility pathway, Nijstad et al.

(2010) explained that even when an individual has low levels of cognitive flexibility to explore remote semantic concepts, he/she could still produce creative ideas by engaging in a systematic search process focusing the few salient semantic concepts that are automatically activated. The researchers propounded that, over time, individuals engaging in the persistence path would still be able to generate highly creative ideas as they sieve through non-novel elements within these salient concepts to uncover novel ones. It is worth noting that whereas the researchers termed this as the persistence pathway, the term "persistence" is used to denote the pattern of cognitive search (deep search within few salient semantic concepts) and is distinct from the concept of task persistence, which relates more to behavioral perseverance in a motivational sense (Battle, 1965; Deater-Deckard et al., 2006).

In the context of the current study, it is possible that self-regulation was tapped upon in switching from the persistence pathway to the flexibility pathway, rather than in inhibiting salient concepts directly. As noted by Nijstad et al. (2010), the persistence pathway does not require effortful activation and consideration of numerous remote semantic concepts, and is considerably less distractible because salient concepts are activated effortlessly. Hence, it is reasonable to argue that, compared to the flexibility pathway, this might be the default pathway that people would engage in when faced with a creative idea generation task. As such, ego-depleted participants, who are lacking in self-regulatory resources, were unable to muster enough strength to overcome this natural tendency and ended up acquiescing to the persistence pathway of generating ideas. Because the persistence pathway does not involve the inhibitory control over salient concepts to explore remote concepts, their inhibitory control ability and subsequent quantity of semantic concepts considered became inconsequential towards their creative

performance, as it is the depth rather than the breadth of exploring the concepts that matters in this path.

On the other hand, non-depleted participants, who possess healthy levels of self-regulatory resources, were able to exert inhibitory control over this natural tendency and switches to the flexibility pathway. As such, the extent to which they were able to exert inhibitory control over salient concepts was facilitative towards the flexibility path that entails exploring and incorporating remote semantic elements to benefit creative ideation. In this pathway, breadth rather than depth of exploring concepts matters.

One might then question why individuals would exert inhibitory control on one pathway over the other when both paths could lead to the generation of equally creative ideas. The answer might lie in the different levels of cognitive effort involved. At the get-go, the persistence pathway might seem to be less cognitively taxing as it does not require cognitive exploration of remote semantic concepts; however, over time, the persistence pathway can actually become more cognitive taxing as it requires brute cognitive effort to systematically explore each concept deeply for creative ideation (Nijstad et al., 2010). On the flip side, the flexibility pathway may require more cognitive effort in exploring numerous remote semantic concepts, but it requires substantively less effort to produce creative ideas by heuristically integrating these concepts as compared to systematically exploring each concept in great depths and detail (Nijstad et al., 2010). Based on the cognitive miser theory, which details the existence of a natural tendency for people to minimize cognitive effort on a given task whenever possible (Böckenholt, 2012; Orbell & Dawes, 1991), it is much more efficacious to expand some self-regulatory resources in switching to the flexibility pathway and to save cognitive effort for the long haul – a luxury that those with depleted self-regulatory resources cannot afford. If this proposition is indeed

supported, then we should expect steep creative performance declines over time for ego-depleted individuals as they engage in the more cognitively taxing route of creative idea generation with their cognitive resources being already strained. Future studies are needed to validate this.

Findings from Study 2, however, suggest that replenishing one's self-regulatory resources may not facilitate such creativity-related inhibitory control. Specifically, Study 2 found that ego-depleted participants who were given glucose-containing candies did not experience an increase in inhibitory control over salient concepts or creative performance, and the association between inhibitory control and creativity remained non-significant for these participants. It is possible that this null finding, along with the predominantly null findings of other main analyses presented in Studies 1 to 3, may be indicative of the non-applicability of the notion of limited self-regulatory resources among the participants of these studies. Studies have shown that when one holds a lay belief that self-regulatory resources are non-exhaustible, they do not experience noticeable declines in self-regulatory task performance after engaging in a supposedly ego-depleting task (Job et al., 2010). While I had attempted to control for such an individual difference by a) adopting random assignment of participants and b) controlling for such lay beliefs about self-regulatory resources as a covariate, participants of all three studies were predominantly Asians – whom researchers have shown evidence that they predominantly hold a belief about non-exhaustible self-regulatory resources (Savani & Job, 2017). Nonetheless, further studies are needed to replicate Study 2 with other forms of ego-replenishment intervention to ascertain if the null effect is limited to the specific ego-replenishment intervention of glucose consumption. Follow-up cross-cultural studies could then be conducted to test these postulations.

Admittedly, it is also possible that the predominantly null results observed for the main analyses involving ego-depletion reflect a true null effect of ego-depletion, with post-hoc

findings observed reflecting spurious statistical artefacts. This would then effectively add to the growing literature questioning the conceptual validity of self-regulation as a limited resource (e.g., Carter et al., 2015; Friese et al., 2019). While the most recent multi-lab replication study observed a small but statistically significant effect of ego-depletion (Dang et al., 2019), consensus has not yet been achieved with regards to the conceptual validity of limited self-regulatory resources. As such, readers should exercise due caution when interpreting these findings.

Interestingly, Study 3 did not find a positive association between increased mindfulness and creativity. In particular, this was despite significant increments in the "act with awareness facet" of mindfulness – the facet which two prior studies have demonstrated to be positively associated with creativity (Agnoli et al., 2018; Baas et al., 2014). Improvements in inhibitory control and creativity was observed for all participants, regardless of whether they practiced mindfulness meditation or listened to music for 10 days. Several potential explanations were discussed in Study 3's discussion section. Overall, these findings further underscore the elusiveness of the association between mindfulness and creativity as noted by researchers in this emerging field (Baas et al., 2014; Lebuda et al., 2016). Based on the findings of Study 3, the adoption of mindfulness meditation as a creativity-boosting intervention did not receive support.

Implications and Contributions

Despite the presence of several unexpected findings, the findings of the three studies collectively provide several important theoretical and practical contributions. Firstly, this series of experiments provides the first empirical examination of a possible relationship between self-regulation and creative idea generation. Despite calls from some researchers to bridge the fields of self-regulation and cognitive psychology (e.g., Hofmann, Schmeichel, & Baddeley, 2012;

Robinson, Schmeichel, & Inzlicht, 2010), this area has remained understudied till date. Through a series of rigorous experimentation that examined both the depleting and boosting of self-regulatory resources, results obtained suggest that self-regulatory resources may not play a direct role in affecting people's ability to exert inhibitory control over salient concepts or to generate creative ideas.

Instead, post-hoc findings suggest that self-regulatory resources may be needed to allow one to disengage from the persistency pathway of creative idea generation and to engage in the flexibility pathway. Switching to the flexibility pathway, in turn, may confer advantages in terms of reducing cognitive effort and time needed to generate creative ideas, though it may not necessarily result in the generation of ideas that are more creative than those generated via the persistence pathway (Nijstad et al., 2010). However, restoring one's self-regulatory resources via glucose consumption did not seem to aid ego-depleted individuals in making such as a switch. If empirically validated and supported, this bears potential implications for work task management. Specifically, if sustained and/or quick generation of highly creative ideas is critical, employees and managers alike should endeavor to arrange the preceding task to be one that does not require (or requires minimal) self-regulatory resources.

Study 3 also bears direct implications for the mindfulness-creativity field, which is an emerging field with only few empirical studies. Among the limited number of empirical studies, most rely on correlational data and those that adopted an experimental method used mainly short-term mindfulness meditation interventions (e.g., a single 10-minute session; Baas et al., 2014; Lebuda et al., 2016; Walsh, 2013). Using a full experimental approach and a 10-day long mindfulness meditation, Study 3 found that increased mindfulness (in particular, the facet of "act with awareness") did not lead to increased creativity as compared to the control comparison

condition of music listening. These findings further underscore the need for more rigorous studies to be conducted in this area before mindfulness meditation can be recommended as a creativity-boosting intervention.

Last but not least, the series of three studies provided substantive evidence for the predictive validity of the concept inhibition task (CIT). The CIT ushers two unique contributions to the field of creativity. Firstly, the CIT is the first measure of inhibitory control specific to the context of creativity. Prior to which, only general inhibitory control measures, such as the Stroop task, were available. The CIT allows for a direct assessment of one's inhibitory control over the tendency to fixate on salient concepts – a key creativity-related cognitive skill (Mednick, 1962; Moran, 2009). Secondly, as demonstrated in Study 2, it holds potential as a predictor of cognitive flexibility in the context of creativity. Prior to the CIT, there had been no published cognitive task or self-report scale available to predict one's cognitive flexibility in the context of creativity. Cognitive flexibility has hitherto been assessed after-the-fact, by categorizing ideas generated and counting the number of unique categories to which the generated ideas fit. The CIT then, could potentially be used as a selection tool for jobs requiring sustained and/or quick generation of highly creative ideas. Future studies are encouraged to conduct more rigorous testing of the CIT, such as by examining its incremental predictive validity and discriminant validity in comparison to other predictors of creativity.

Limitations and Conclusion

Even though a full experimental approach with random assignment was adopted for all three studies, several limitations exist. First, there was a preponderance of female, Chinese, social sciences major participants across all three studies. Although controlling for these factors did not result in substantive changes to the reported findings, future studies can seek to replicate

the findings with a more heterogeneous sample to test its generalizability. It would be especially beneficial if those with greater means could replicate these studies on the general working population, beyond college student samples.

Second, the manipulation check for Study 1 yielded equivocal results. Given the inclusion of both ego-depleted and non-depleted conditions in Study 2, it could serve as a conceptual replication for Study 1. However, there was a considerable imbalance in participants assigned to the ego-depleted versus non-depleted because Study 2's major goal was to examine the effects of glucose consumption, which required more participants undergo ego-depletion (depleted-sugar, depleted-non-sugar, depleted-no candy) than being non-depleted. Hence, it would be beneficial for a future direct replication study to validate Study 1's results. Similarly, the manipulation check for Study 3's mindfulness intervention yielded null results comparing between the mindfulness and music listening conditions and was only deemed successful when comparing between pre- and post-intervention. Thus, this renders between-groups analyses problematic and many findings in Study 3 focused on post-hoc within-subject analyses. As such, a conceptual replication of Study 3, perhaps using a longer intervention duration, would be useful in further validating its findings as well.

Finally, for Study 3, because within-subject analyses were not planned a priori for creativity, the creativity tasks administered during baseline and post-intervention were different. This was in part due to resource constraints (i.e., limited subject pool credits). Hence, within-subject analyses conducted between baseline and post-intervention creativity scores may have been confounded by task specific characteristics. This further underscores the importance of conducting a direct replication of Study 3 in order to validate its findings.

Withstanding these limitations, the present research takes an important first step to shed light on the interplay between self-regulatory resources, inhibitory control over salient concepts, and creativity. These findings point towards new research avenues for intervention development that bear potential implications for creative work arrangements in the industry; specifically, the potential utility of self-regulatory resources in switching from a persistence to flexibility path of creative idea generation. These studies also provide empirical support for the predictive validity of the CIT, which holds tremendous potential as both a research and personnel selection tool in the field of creativity.

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Appendix A1

Action Orientation

The following questions have two different answers. Please choose the alternative (A or B) that applies best to you. There are no right or wrong answers.

1 When I know I must finish something soon	A. I have to push myself to get started. (SO) B. I find it easy to get it done and over with. (AO)
2 When I don't have anything in particular to do and I am getting bored	A. I have trouble getting up enough energy to do anything at all. (SO) B. I quickly find something to do. (AO)
3 When I am getting ready to tackle a difficult problem	A. It feels like I am facing a big mountain that I don't think I can climb. (SO) B. I look for a way that the problem can be approached in a suitable manner. (AO)
4 When I have to solve a difficult problem	A. I usually don't have a problem getting started on it. (AO) B. I have trouble sorting out things in my head so that I can get down to working on the problem. (SO)
5 When I have to make up my mind about what I am going to do when I get some unexpected free time	A. It takes me a long time to decide what I should do during this free time. (SO) B. I can usually decide on something to do without having to think it over very much. (AO)
6 When I have work to do at home	A. It is often hard for me to get the work done. (SO) B. I usually get it done right away. (AO)
7 When I have a lot of important things to do and they must all be done soon	A. I often don't know where to begin. (SO) B. I find it easy to make a plan and stick with it (AO)
8 When there are two things that I really want to do, but I can't do both of them	A. I quickly begin one thing and forget about the other thing I couldn't do. (AO) B. It's not easy for me to put the thing that I couldn't do out of my mind. (SO)
9 When I have to take care of something important but which is also unpleasant	A. I do it and get it over with. (AO) B. It can take a while before I can bring myself to do it. (SO)
10 When I am facing a big project that has to be done	A. I often spend too long thinking about where I should begin. (SO) B. I don't have any problems getting started. (AO)
11 When I have a boring assignment	A. I usually don't have any problem getting through it. (AO) B. I sometimes just can't get moving on it. (SO)
12 When I have an obligation to do something that is boring and uninteresting	A. I do it and get it over with. (AO) B. It usually takes a while before I get around to doing it. (SO)

Scoring: Action-oriented (AO) responses are coded as 1 whereas state-oriented (SO) responses as 0. Scores summed for the entire scale could range from 0-12

Appendix A2

Lay Theory of Willpower

Please indicate how much you agree or disagree with each of the following statements by ticking the number that corresponds to your opinion in the space next to each statement, "1" indicates "Strongly disagree", "6" indicates "Strongly agree". There are no right or wrong answers.

	Strongly disagree					Strongly agree
1 Strenuous mental activity exhausts my resources, which I need to refuel afterwards (e.g. through taking breaks, doing nothing, watching television, eating snacks).	1	2	3	4	5	6
2 After a strenuous mental activity, my energy is depleted and I must rest to get it refueled again.	1	2	3	4	5	6
3 When I have been working on a strenuous mental task, I feel energized and I am able to immediately start with another demanding activity.	1	2	3	4	5	6
4 My mental stamina fuels itself. Even after strenuous mental exertion, I can continue doing more of it.	1	2	3	4	5	6
5 When I have completed a strenuous mental activity, I cannot start another activity immediately with the same concentration because I have to recover my mental energy again.	1	2	3	4	5	6
6 After a strenuous mental activity, I feel energized for further challenging activities.	1	2	3	4	5	6

Scoring: Averaging of scores, with items 1, 2, 5 reversed scored, to indicate the extent to which an individual subscribes to an unlimited resource lay theory

Appendix A3

Trait Self-Control

Please indicate how much each of the following statements reflects how you typically are, "1" indicates "Not at all", "5" indicates "Very much". There are no right or wrong answers.

	Not at all Very much
1 I am good at resisting temptation	1 2 3 4 5
2 I have a hard time breaking bad habits.	1 2 3 4 5
3 I am lazy.	1 2 3 4 5
4 I say inappropriate things.	1 2 3 4 5
5 I do certain things that are bad for me, if they are fun.	1 2 3 4 5
6 I refuse things that are bad for me.	1 2 3 4 5
7 I wish I had more self-discipline.	1 2 3 4 5
8 People would say that I have iron self- discipline.	1 2 3 4 5
9 Pleasure and fun sometimes keep me from getting work done.	1 2 3 4 5
10 I have trouble concentrating.	1 2 3 4 5
11 I am able to work effectively toward long-term goals.	1 2 3 4 5
12 Sometimes I can't stop myself from doing something, even if I know it is wrong.	1 2 3 4 5
13 I often act without thinking through all the alternatives.	1 2 3 4 5

Scoring: Averaging of scores, with items 2, 3, 4, 5, 7, 9, 10, 12, 13 reversed scored, to indicate the extent to which an individual has high levels of trait self-control

Fatigue

From a scale of 1 being *not at all* to 7 being *very much*, indicate the extent to which you are feeling

1. Tired
2. Sluggish
3. Drowsy

Scoring: Averaging of scores

Appendix A4

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you “feel this way right now” (Study 3: “have felt this way during the past 10 days”). Use the following scale to record your answers.

1: very slightly or not at all 2: a little 3: moderately 4: quite a bit 5: extremely

Items Assessing PA	Items Assessing NA
Interested	Distressed
Excited	Upset
Strong	Guilty
Enthusiastic	Scared
Proud	Hostile
Alert	Irritable
Inspired	Ashamed
Determined	Nervous
Attentive	Jittery
Active	Afraid

Appendix B

1	University environment, such as (architecture of) lecture halls, seminar rooms, and opening hours
2	Student facilities, such as extracurricular activities, library access, and classroom interiors
3	Student quality, including selecting better students and increasing cooperation and contact among students
4	Teaching materials, such as readers, textbooks, handouts of PowerPoint presentations, examination issues, and grading systems
5	Teachers, such as teacher training and selection, use of teaching evaluations, and use of mentors and coaches
6	Policy, such as scholarships and other financial issues, information distribution, and reduced bureaucracy
7	Other issues

Appendix C1

Kentucky Inventory of Mindfulness Skills (KIMS)

The KIMS is used to assess 4 mindfulness skills:

Observe:
Items: 1, 5, 9, 13, 17, 21, 25, 29, 30, 33, 37, 39.
Describe:
Items: 2, 6, 10, 14, 18, 22, 26, 34.
Act with awareness:
Items: 3, 7, 11, 15, 19, 23, 27, 31, 35, 38.
Accept (or allow) without judgment:
Items: 4, 8, 12, 16, 20, 24, 28, 32, 36.

Scoring:
Items reflect either direct descriptions of the mindfulness skills, or they describe the absence of that skill and are reverse scored. High scores reflect more mindfulness.

Please rate each of the following statements using the scale provided. Indicate the extent to which each statement is generally true for you.

(1)never or very rarely (2)rarely true (3)sometimes true (4)often true (5)very often or always true

_____1. I notice changes in my body, such as whether my breathing slows down or speeds up.
_____2. I'm good at finding the words to describe my feelings.
_____3. When I do things, my mind wanders off and I'm easily distracted.
_____4. I criticize myself for having irrational or inappropriate emotions.
_____5. I pay attention to whether my muscles are tense or relaxed.
_____6. I can easily put my beliefs, opinions, and expectations into words.
_____7. When I'm doing something, I'm only focused on what I'm doing, nothing else.
_____8. I tend to evaluate whether my perceptions are right or wrong.
_____9. When I'm walking, I deliberately notice the sensations of my body moving.
_____10. I'm good at thinking of words to express my perceptions, such as how things taste, smell, or sound.
_____11. I drive on "automatic pilot" without paying attention to what I'm doing.
_____12. I tell myself that I shouldn't be feeling the way I'm feeling.
_____13. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____14. It's hard for me to find the words to describe what I'm thinking.
_____15. When I'm reading, I focus all my attention on what I'm reading.
_____16. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
_____17. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____18. I have trouble thinking of the right words to express how I feel about things.

_____19. When I do things, I get totally wrapped up in them and don't think about anything else.
_____20. I make judgments about whether my thoughts are good or bad.
_____21. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
_____23. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____24. I tend to make judgments about how worthwhile or worthless my experiences are.
_____25. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____26. Even when I'm feeling terribly upset, I can find a way to put it into words.
_____27. When I'm doing chores, such as cleaning or laundry, I tend to daydream or think of other things.
_____28. I tell myself that I shouldn't be thinking the way I'm thinking.
_____29. I notice the smells and aromas of things.
_____30. I intentionally stay aware of my feelings.
_____31. I tend to do several things at once rather than focusing on one thing at a time.
_____32. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
_____33. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
_____34. My natural tendency is to put my experiences into words.
_____35. When I'm working on something, part of my mind is occupied with other topics, such as what I'll be doing later, or things I'd rather be doing.
_____36. I disapprove of myself when I have irrational ideas.
_____37. I pay attention to how my emotions affect my thoughts and behavior.
_____38. I get completely absorbed in what I'm doing, so that all my attention is focused on it.
_____39. I notice when my moods begin to change.

Appendix C2

Five Facet Mindfulness Questionnaire

Description:
This instrument is based on a factor analytic study of five independently developed mindfulness questionnaires. The analysis yielded five factors that appear to represent elements of mindfulness as it is currently conceptualized. The five facets are observe, describe, act with awareness, non-judging of inner experience, and non-reactivity to inner experience.
Please rate each of the following statements using the scale provided. Indicate the extent to which each statement is generally true for you during the past 10 days.

(1)never or very rarely (2)rarely true (3)sometimes true (4)often true (5)very often or always true

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.
_____ 2. I'm good at finding words to describe my feelings.
_____ 3. I criticize myself for having irrational or inappropriate emotions.
_____ 4. I perceive my feelings and emotions without having to react to them.
_____ 5. When I do things, my mind wanders off and I'm easily distracted.
_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____ 7. I can easily put my beliefs, opinions, and expectations into words.
_____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____ 9. I watch my feelings without getting lost in them.
_____ 10. I tell myself I shouldn't be feeling the way I'm feeling.
_____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____ 12. It's hard for me to find the words to describe what I'm thinking.
_____ 13. I am easily distracted.
_____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.

_____ 15. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____ 16. I have trouble thinking of the right words to express how I feel about things
_____ 17. I make judgments about whether my thoughts are good or bad.
_____ 18. I find it difficult to stay focused on what's happening in the present.
_____ 19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.
_____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____ 21. In difficult situations, I can pause without immediately reacting.
_____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.
_____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.
_____24. When I have distressing thoughts or images, I feel calm soon after.
_____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.
_____ 26. I notice the smells and aromas of things.
_____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.
_____ 28. I rush through activities without being really attentive to them.
_____ 29. When I have distressing thoughts or images I am able just to notice them without reacting.
_____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
_____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
_____ 32. My natural tendency is to put my experiences into words.
_____ 33. When I have distressing thoughts or images, I just notice them and let them go.
_____ 34. I do jobs or tasks automatically without being aware of what I'm doing.
_____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.
_____ 36. I pay attention to how my emotions affect my thoughts and behavior.
_____ 37. I can usually describe how I feel at the moment in considerable detail.
_____ 38. I find myself doing things without paying attention.
_____ 39. I disapprove of myself when I have irrational ideas.

Scoring Information:
Observe items:
1, 6, 11, 15, 20, 26, 31, 36
Describe items:
2, 7, 12R, 16R, 22R, 27, 32, 37
Act with Awareness items:
5R, 8R, 13R, 18R, 23R, 28R, 34R, 38R
Non-judge items:
3R, 10R, 14R, 17R, 25R, 30R, 35R, 39R
Non-react items:
4, 9, 19, 21, 24, 29, 33

Appendix D

Chocolate Design Task Instructions

In light of revolution, chocolate confectioners are starting to move their designs away from traditional chocolate. ‘‘Chocolate in Belgium is an icon, like pasta in Italy. But why do we feel obliged by tradition? We must disturb the traditional shapes. We must create new combinations, new ingredients,’’ says Giovanna Massini, a researcher who is leading this chocolate design initiative in Brussels, Belgium. Suppose you are a member of Giovanna’s research lab; your task is to revolutionize the design of chocolate.

Chocolate Design Task Scoring Criteria

(a) The chocolate is of unconventional overall shape (e.g., a microphone shaped chocolate)

(b) The presence of unconventional shape within the chocolate itself (e.g., shapes of eyes and nose on the chocolate)

(c) The presence of nonchocolate edible ingredients (e.g., chili)

(d) The presence of inedible ingredients (e.g., photograph)

(e) Whether the design implicates unconventional matter states of chocolate (e.g., chewable chocolate)

(f) The presence of an additional function the chocolate serves (e.g., a greeting card made out of chocolate)

(g) The presence of a filled center (e.g., filled with syrup)

(h) Whether there is an elaboration about the filling (e.g., the filling contains milk, caramel, or liquor)