Mind Wandering and Creativity

Effects of mind wandering valence on divergent and convergent creative thinking

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1. Introduction

Creative thinking is critical to one's overall effective functioning. Namely, people need to solve problems, generate new insights, and create new products and services in order to truly prosper (Amabile, 1983; Eysenck, 1993; Runco, 2004; Simonton, 2003 as cited in Baas, De Dreu & Nijstad, 2008). This critical importance of creativity is the reason why this concept is widely studied throughout and in combination with various sub-areas, such as social, organizational and cognitive Psychology. Within the various sub-areas, concepts are studied in relation to creativity to determine a possible causal relationship.

Creativity is not a unitary concept and different factors influence the performance on each aspect of the concept. Creative thinking is generally conceived of as the generation of ideas, insights, or problem solutions that are both unique and potentially useful (Baas, De Dreu & Nijstad, 2008). When looking at the creative process, a distinction is made between: divergent and convergent creative thinking (Baas et al., 2008). Divergent creative thinking is the ability to generate multiple alternative solutions to a question while convergent creative thinking restructures the problem information to come up with a single solution to a question (Baas et al., 2008). Performance on creative tasks can be decomposed into various distinct but interrelated components, such as: fluency, cognitive flexibility, originality, focus and persistence (Guilford, 1967; Torrance, 1966 as cited in Baas et al., 2008). It is believed that fluency, cognitive flexibility, and originality improve performance on divergent creative thinking tasks while focus and persistence, also known as cognitive stability, improve performance on convergent creative thinking tasks (Baas et al., 2008).

Although one would like to hope that people keep their full focus on the task at hand, irrespective of its kind, this is not always the case. Mind wandering is a mental state of distraction which in turn can affect performance on the two forms of creative thinking. Some studies suggest that during mind wandering a person's imagination is largely undisturbed by stimulation from the environment (Zedelius & Schooler, 2016). This could be interpreted as mind

wandering being positively related to creativity. On the other hand, some studies suggest that mind wandering could be negatively related to creativity because the control processes involved in creative problem solving are impaired by the lack of focus during mind wandering (Hao, Wu, Runco & Pina, 2015). The contradicting ideas regarding mind wandering make it an interesting subject to study further. Previous studies say little about the actual valence of this mind wandering and its possible effect on divergent and convergent creative thinking. Because of this, to fill this gap, we look further into the valence of mind wandering (Zedelius & Schooler, 2016).

Based on previous research, we can assume a correlating relationship between valence and mind wandering, meaning that negative valence would lead to negative mind wandering while positive valence would lead to positive mind wandering (Zedelius & Schooler, 2016). Research shows that positive valence can be beneficial during divergent creative thinking tasks while negative valence can be beneficial during convergent creative thinking tasks (Baas et al., 2008). We suspect that this experienced valence state can in turn lead to its correlating mind wandering style.

Based on Hao et al (2015), it is believed that mind wandering possibly affects overall creativity negatively. However, we suspect that positively valenced mind wandering can compensate for a negative effect of mind wandering during divergent thinking, and negatively valenced mind wandering can compensate for a negative effect of mind wandering during convergent thinking. This could be because positive mind wandering enhances cognitive flexibility while negative mind wandering enhances cognitive stability. So far, studies only look at mind wandering in general. Hence, this study looks at the valence of the mind wandering.

This thesis is structured as follows. In section 2.1 we review the creative process distinguishing further between divergent and convergent thinking. In section 2.2 we review the concept of mind wandering in relation the creative process and in section 2.3 we review valence and the effect it can have on overall creativity. The latter will be explained with use of examples

of priming and induction studies. In section 2.4 all the main elements will be combined to form a connected whole while discussing the research question and possible hypotheses. In the method section, the process of the conducted research study will be explained in a comprehensive manner. Thereafter, in the results section, the results and analysis of the conducted research will be given in the form of tables and figures. Finally, a thorough conclusion and discussion is presented discussing the overall findings of the study as well as focusing on possible limitations as well as future prospects in the research field.

The scientific contribution of this study is that it attempts to incorporate the valence of mind wandering in order to further study the relation between mind wandering and creative thinking. Although plenty of research has been done on the topic of mind wandering, present-day research fall short on taking this valence of mind wandering into account (Zedelius & Schooler, 2016). Studying the valence of mind wandering fills this academic gap.

Seeing as creativity is of critical importance to the effective functioning of individuals, it is of great societal relevance to research this further in various relationships. The focus lies on mind wandering valence and how this can possibly compensate for the negative effect mind wandering has on creative thinking. With the focus lying on divergent and convergent creative thinking. Studying this relationship and its possible effects could reshape how creative tasks are set up in the professional world in order to get the desired answers.

2. Theoretical Framework

2.1 The creative process

The concept of creativity is worth researching because in a world of rapid social and technological change, high premium is placed on creative talent (Deva, 1984 as cited in Mumford & Gustafson, 1988). It is no secret that the quality of human life is greatly influenced by the creative contributions of certain individuals (Albert, 1983 as cited in Mumford & Gustafson, 1988). Because of this, since the time of Galton (1883; as cited in Mumford & Gustafson, 1988), Psychology has shown a great deal of interest in the creative act. Much of this research has been carried out in the hope that a thorough understanding of the phenomenon would lead to more effective use of this valuable social resource (Taylor, 1964 as cited in Mumford & Gustafson, 1988). In other words, creativity is indispensable to human existence (Baas et al., 2008). Namely, the creation of something new and unique is meant to improve one's effective functioning (Amabile, 1983; Eysenck, 1993; Runco, 2004; Simonton, 2003 as cited in Baas et al., 2008). Creativity is a multifaceted concept and because of this it is essential to distinguish between different creative processes.

According to Brophy (2001), looking at creative problem solving (CPS) is a great way to get insight into overall creative thinking. His study states that a complete CPS process uses divergent ideation and convergent judgment. Divergent and convergent creative thinking are both crucial cognitive abilities which represent a key cognitive component underlying creative production (Mumford & Gustafson, 1988). Divergent creative thinking is linked to the concept of creativity in the sense that divergent thinking refers to the production of unique material that can later be shaped into something useful (Baas et al., 2008). Divergent creative thinking refers to the ability to generate multiple alternative solutions to a problem or question (Mumford, 2001 as cited in Baas et al., 2008). An individual's ability to generate multiple, high-quality solutions to a problem enhances the likelihood of major contributions towards a project (Mumford & Gustafson, 1988). Because of this, great importance is put on this skill. Meanwhile, convergent

creative thinking is linked to the concept of creativity in the sense that convergent thinking refers to the mental restructuring of problem information or information origination from the divergent process, in hopes to come up with a single solution to a problem (Bowden, Jung- Beeman, Fleck, & Kounios, 2005; Gilhooly & Murphy, 2005; Schooler & Melcher, 1995 as cited in Baas et al., 2008). This reflects an individual's ability to use multiple understandings or concepts in addressing problems, representing a process equally fundamental to project contribution (Mumford & Gustafson, 1988).

Divergent creative thinking is typically measured by fluency, cognitive flexibility, and originality (Guilford, 1967; Torrance, 1966 as cited in Baas et al., 2008). Fluency refers to the number of generated ideas while cognitive flexibility refers to the breadth and number of distinct semantic categories that a person accesses. Originality refers to the uncommonness of a generated idea (Baas et al., 2008). Fluency, cognitive flexibility, and originality are indicators of performance on divergent creative thinking tasks (Baas et al., 2008). These three components are linked together in the following manner: cognitive flexibility enables an individual to access various semantic categories thus possibly increasing the number of generated ideas, or fluency. This then increases the chances of generating original ideas as categories are accessed which otherwise may have been ignored. Important to note is that this is not always the case, low cognitive flexibility could also make it easier to generate a lot of ideas, but this would just not be very diverse. Divergent creative thinking refers to coming up with multiple solutions and alternatives, thus, cognitively accessing a wide variety of categories is of utmost importance.

Moreover, *convergent creative thinking* requires undivided focus and persistence, or cognitive stability, to be able to combine information from various sources into a single contributing solution. Cognitive stability refers to the state of having and producing clear definition without distraction or losing motivation on the task at hand (Baas et al., 2008). Additionally, detail orientation and logical problem solving are also linked to performance during convergent thinking. Detail orientation and logical problem solving refer to the selection of, or

the switching among, alternative cognitive sets, which are accessed in the divergent creative thinking process (Isen, 2000b; Isen & Daubman, 1984; Isen, Daubman, & Nowicki, 1987 as cited in Baas et al., 2008).

Fluency, cognitive flexibility, originality and cognitive stability each serve their own respective purpose when measuring creative performance (Lissitz & Willhoft, 1985 as cited in Mumford & Gustafson, 1988). When measuring performance on creative tasks, it is desirable for individuals to put their entire mental focus on the task at hand. But when dealing with mental states of people, this is not always the case as people often deal with external distraction as well as internal distraction, such as mind wandering.

2.2 Mind wandering and creativity

Mind wandering has been defined as engaging in spontaneous thoughts related or unrelated to one's (stimulus-independent) current context (Singer and Schonbar, 1961; Smallwood and Schooler, 2006 as cited in Zedelius & Schooler, 2016). It occurs frequently while performing a task. There are two views on the mind wandering - creativity relationship; firstly, mind wandering is associated with creative exploration and expression because it facilitates the formation of novel associations and the recombination of mental images, which can be a source of creative ideas (Shepard, 1978; Flowers & Garbin, 1989 as cited in Zedelius & Schooler, 2016). The latter is attributed to the fact that during mind wandering a person's imagination is relatively undisturbed by stimulation from the environment. Secondly, the other view regarding the mind wandering - creativity relationship, suggest that mind wandering could be negatively related to creativity because the performance on divergent and convergent creative tasks are impaired by the lack of focus during mind wandering (Hao et al., 2015).

As with creativity, mind wandering too is not a unitary concept. Mind wandering can be distinguished between positive and negative styles (Zedelius & Schooler, 2016). An example of positive mind wandering could be dreaming about your next holiday during a lecture while an

example of negative mind wandering could be thinking about how many chores you have to do when you get home. It has been suggested that positive mind wandering facilitates creativity by increasing insight while negative mind wandering can enhance creativity through analytical thought and persistence. The former could be beneficial for divergent creative thinking while the latter could benefit convergent creative thinking. However, previous studies say little about the actual content of mind wandering which is why we look further into the valence of mind wandering (Zedelius & Schooler, 2016).

It is believed that incubation could compensate for the negative effect of mind wandering on creativity. Incubation is a phenomenon defined by taking a break from consciously working on a creative problem and engaging in an another task, such as mind wandering (Sio & Ormerod, 2009 as cited in Zedelius & Schooler, 2016). Previous research supports the theories benefit of stimulus-independent thought for creativity (Hao et al., 2015). Moreover, the incubation phenomenon can be enhanced by engaging in undemanding tasks that leave room for automatic, and somewhat unavoidable, mind wandering (Baird et al., 2012 as cited in Zedelius & Schooler, 2016). Studies often use priming and induction methods to get participants into an intended valence state which carries over the effect it can have on creativity (Baas et al., 2008). An example of an induction studies is the Velten technique (Velten, 1968 as cited in Baas et al., 2008). Participants are presented with emotional stimuli without the explicit instruction to the participants to experience the suggested valence state. Examples are unexpected gifts, evocative film clips, music excerpts, and emotional stories (Baas et al., 2008). It would be interesting to see whether this effect can be achieved without explicitly making use of incubation.

2.3 Valence and creativity

Previous research assumes a causal relationship between valence and mind wandering (Zedelius & Schooler, 2016). This relationship refers to the fact that when an individual experiences a positive valence state, they are likely to have more positive mind wandering and if they experience a negative valence state, they are likely to have more negative mind wandering.

The correct valence state can positively affect divergent and convergent creative thinking, respectively. The valence hypothesis suggests that positive valence states trigger more overall creativity than negative valence states (Lyubomirsky et al., 2005; Murray et al., 1990 as cited in Baas et al., 2008). Additional research shows that positive valence could be beneficial during divergent creative thinking tasks while negative valence could do just so during convergent creative thinking tasks (Forgas, 2002, 2007; Schwarz, 1990; Soldat & Sinclair, 2001 as cited in Baas et al., 2008). This could be explained by the fact that it has been argued that valence has a signaling function (Forgas, 1995; Schwarz & Bless, 1991). An important note is that not all negative emotions aid performance on convergent creative thinking tasks, hence we can assume some uncertainty in this respect (Baas et al., 2008).

Positive valence signals a satisfactory and safe context, suggesting that processing requirements are relaxed, which in turn enables individuals to explore unique procedures and creative alternatives (Fiedler, 1988; Russ, 1993 as cited in Baas et al., 2008). This fits in with the idea of divergent creative thinking which refers to accessing multiple semantic categories. Cheerfulness-related positive valence states (i.e. happy, upbeat, satisfied) are more effective than quiescence-related positive mood states (i.e. relaxed, calm, serene) (Carver, 2006; Higgins, 1997, 2001, 2006 as cited in Baas et al., 2008). This could be attributed to the fact that while performance on a creative task, regardless of its kind, requires an active mental state. A more laid back approach will generate less ideas.

In contrast, negative valence signals a problematic context, which requires a clear and careful assessment of the environment (Ambady & Gray, 2002; Fiedler, 1988; Schwarz & Bless, 1991 as cited in Baas et al., 2008). This fits in with the idea of convergent creative thinking which refers to assessing the various semantic categories and processing these in order to create a single solution. An important note here is that not all negative valence states aid performance on convergent thinking tasks. Dejection-related negative valence states (i.e. sadness, disappointment, discouragement, anger, frustration) are unsuccessful while agitation-related negative valence states (i.e. fearful, tense, worried) are successful (Carver, 2006; Higgins, 1997, 2001, 2006 as cited in Baas et al., 2008). This difference in effect causes some uncertainty as it is not always clear in which exact state an individual finds him or herself, which makes it an interesting topic for us to study further.

2.4 Synthesis

Although Hao et al. (2015) assumes that mind wandering affects creativity negatively overall, it's clear from other previous research that an individual's valence state can benefit their performance on divergent or convergent creative thinking tasks. Moreover, seeing how an individual's experienced valence state correlates with their mind wandering style, there is room for further research and assumptions. Namely, perhaps positive valence can compensate for a negative effect of mind wandering during divergent thinking, and negative valence can compensate for a negative effect of mind wandering during convergent thinking. Thus, valence can be seen as a moderator of the relationship between mind wandering and the two forms of creative thinking. The idea of mind wandering being a solely negative predictor of creativity can possibly be demolished and reframed. Because of this, the research question, hypotheses, and conceptual model of this paper are as follows:

RQ: What are the effects of mind wandering valence on divergent and convergent creative thinking?

H1A: Mind wandering has a negative effect on divergent thinking.

H1B: Mind wandering has a negative effect on convergent thinking.

H2A: More positive mind wandering can compensate for a negative effect of mind wandering during performance on divergent creative thinking tasks.

H2B: More negative mind wandering can compensate for a negative effect of mind wandering during performance on convergent creative thinking tasks.

3. Method

3.1 Design

The design of the conducted study was a correlation study as there were no conditions. The study was conducted in an online survey format. The survey was conducted in English as well as Dutch in order to reach a wide variety of participants in their respective mother language. The duration of the entire survey was approximately 40 minutes. Firstly, participants were presented with a consent form as well as an introduction to the study. The participants were asked to complete a divergent thinking task as well as a convergent thinking task, in a within-group format. Before each task, participants were presented with instructions as well as an example. They were allotted 15 minutes for each of the creative tasks. The remainder 10 minutes was to make room for reading instructions as well as answering the given probe questions. Throughout the 15 minutes of each task, participants were presented with a thought probe every 100 seconds. Thus, 8 thought probes within each task. Thought sampling questions were asked after each inserted thought probe. This was done in order to identify mind wandering and mind wandering valence. The ultimate goal with this is to measure the effect of mind wandering valence on divergent and convergent creative thinking.

3.2 Participants

The sample used to test the hypothesis consisted of 66 participants of which 1 outlier was excluded from the dataset because of extreme negative values. Of the remainder 65 participants (N = 65), 24 (36.9%) were male and 41 (63.1%) were female. The age range of the participants was between 14 and 57 years (M = 29, SD = 9.05). 41 (63.1%) people participated in the English language survey while 24 (36.9%) participated in the Dutch language survey. This was a convenience sample as the use of an online survey as well as two language options made the reach bigger.

3.3 Material and Measurements

3.3.1 Alternative Uses Task (AUT)

The Alternative Uses Task (AUT; Guilford, 1967) was used to test creativity during divergent thinking. The AUT requires respondents to generate as many unusual or original uses as possible for common objects (e.g. paper clip, chopstick and matchstick). Guilford (1976) believed that the AUT was a well-established test of creative potential but not all previous studies shared this opinion. Zeng, Proctor and Salvendy (2011) found that the AUT had its limitations for measuring creativity during divergent thinking, mainly due to the lack of its external validity and practical value. They believed that an individual's creative potential would be more validly and reliably measured based on the final productions resulting from the integrated creative thinking process, instead of measuring on the basis of separate cognitive phases, such as divergent thinking (Zeng et al., 2011). On the other hand, Runco and Acar (2012) view the measurement of divergent thinking with the use of the AUT as a valid indicator of creative performance. Although they do not believe that it guarantees actual creative achievement, they do emphasize its reliability and validity. We still made use of the AUT in our study because the studies we have built our theoretical framework on also use psychometric tasks such as this one. By also choosing psychometrics, we can yield results that can be compared to previous work. Also, it is important to note that the use of divergent and convergent thinking tasks in this study are meant as a proxy to measure actual creative ability.

Participants' performance on the AUT problem was measured on the scores of fluency, flexibility and originality (see Guilford, 1967; Runco, 1991, 1999). Fluency scores were based on the total number of ideas given the AUT problem. Flexibility scores were based on the total amounts of semantic categories that a participant accessed. Originality scores were based on statistically infrequent responses. The ideas of all participants generated for the AUT problem were collected into a comprehensive lexicon. Synonyms were identified and ideas assigned to

semantic categories accordingly. If a response was statistically infrequent, then it was given a score of “1”. All other responses received scores of “0”.

3.3.2 Remote Associates Task (RAT)

The Remote Associates Test (RAT; Mednick, 1968) was used to test creativity during convergent thinking. The RAT requires respondents to analyze the problem information in order to come up with a single, correct answer. In this test participants are presented with three words and are asked to come up with the fourth associative word based on the three cue words. Chermahini, Hickendorff and Hommel (2012) encourage the use of the RAT as its high construct validity makes it a good measure of creative convergent thinking. It is wrong to assume that the RAT provides a comprehensive assessment of overall creativity. Rather, it does allow assessing individual differences in one separate cognitive phase, namely convergent thinking (Chermahini et al., 2012). Thus, the results following from a RAT are assumed to be a reliable measurement of convergent thinking and good indicator of creative performance.

Participants’ performance on the RAT problem was measured by looking at the amount of correctly answered items. This was indicator of convergent thinking performance. During a task of 15 minutes, participants were asked to provide one correct answer for each of the 30 RAT problems. Bowden and Jung-Beeman’s (2003) study provided normative data of a large RAT, so we decided to make a selection of 30 items of moderate difficulty for the English language survey. The 30 Dutch language RAT problems were taken from the study of Chermahini et al. (2012). All the problem items were provided on the screen at once in order to give participants the option to move on to the next problem if they were stuck at a previous one. The complete RAT can be found in the appendix.

3.3.3 Probes

Probes were inserted throughout the two 15-minute tasks in order to measure mind wandering and its valence. Participants were presented with 8 thought probes per task. These probes were based on a 'self-report' measure. Each of these probes consisted of three questions, of which the last two were only presented if the first question was answered with a yes answer. The first presented thought question was: Did your thoughts wander from the task at hand? With the possibility to answer with a yes or no answer. If yes, participants were presented with two 7-point Likert scale statements. The first statement varied from 'My thoughts were not positive' to 'My thoughts were very positive'. The second statement varied from 'My thoughts were not negative' to 'My thoughts were very negative'. The thought probes and corresponding thought sampling questions made it possible to identify the participants' mind wandering and mind wandering valence throughout each of the creative tasks.

3.4 Procedure

The procedure of the study was identical for those completing the survey in English as well as Dutch. Participants were able to complete the online survey from various platforms: desktop computers, laptops, tablets and smartphones. This was done using the online survey programme Qualtrics. As mentioned, the entire survey duration time was approximately 40 minutes. Firstly, participants were presented with a consent form and a detailed instruction to the overall study. They were asked to carefully read and agree with the terms before they started the actual tests. Then participants were presented with some general questions such as gender, age and preferred language.

Shortly thereafter, participants were provided a short informational text explaining the AUT as well as an example. The participants were then presented with three AUT problems (i.e. coming up with as many uses as possible for a 'chopstick') and given 15 minutes to complete the task. Participants were encouraged to try their best to produce ideas that would be thought

of by no one else (Harrington (1975); Runco (1999), and Torrance (1995) as cited in Hao et al., 2015). Throughout the 15-minute task, participants were presented with a thought probe after every passing 100 seconds. After completing the AUT, participants were provided a short informational text explaining the RAT as well as an example. Following this, participants were presented with all 30 RAT problems and given 15 minutes to solve as many as possible. Identical to the AUT, participants were presented with a thought probe every 100 seconds. Thus, eight thought probes during each task. Finally, after completing the RAT, participants were thanked for their time and participation.

4. Results

4.1 AUT

Because the conducted study consisted of two creative tasks, it would be sensible to view the results with this in mind. First, the results from the AUT are discussed below in relation to mind wandering valence. The mean and standard deviation of the various variables and the relevant correlations are presented below with the use of tables. Additionally, the hypotheses relevant to the AUT and divergent creative thinking are discussed.

Table 1. AUT mean, standard deviation and correlation.

Variable	Mean	SD	1.Fluency	2.Flexibility	3.Originality	4. Mind wanders	5.Derived positive mw	6.Derived negative mw
1.Fluency	23.48	8.70	-	.821**	.646**	.092	.289*	-.224
2.Flexibility	16.12	6.64	.821**	-	.671**	.110	.151	-.182
3.Originality	2.82	2.23	.646**	.671**	-	-.048	.235	-.250
4.Mind wanders	4.45	2.29	.092	.110	-.048	-	-.108	.122
5.Derived positive mind wanders	4.58	1.34	.289*	.151	.235	-.108	-	-.710**
6.Derived negative mind wanders	3.10	1.30	-.224	-.182	-.250	.122	-.710**	-

A Pearson correlation coefficient was computed to assess the relationship between the fluency, flexibility and originality of the answers given during the AUT. There was a positive correlation between the three variables, namely: correlation between fluency and flexibility was $r(65) = .821$, $p < .001$, correlation between fluency and originality was $r(65) = .646$, $p < .001$ and correlation between flexibility and originality was $r(65) = .671$, $p < .001$. A scatter plot summarizes the results (Figure 2). Overall there was a strong, positive correlation between the fluency, flexibility and originality of the answers given during the AUT. Increases in fluency were

positively correlated with increases in flexibility and increases in originality. Similarly, increases in flexibility were positively correlated with increases in originality.

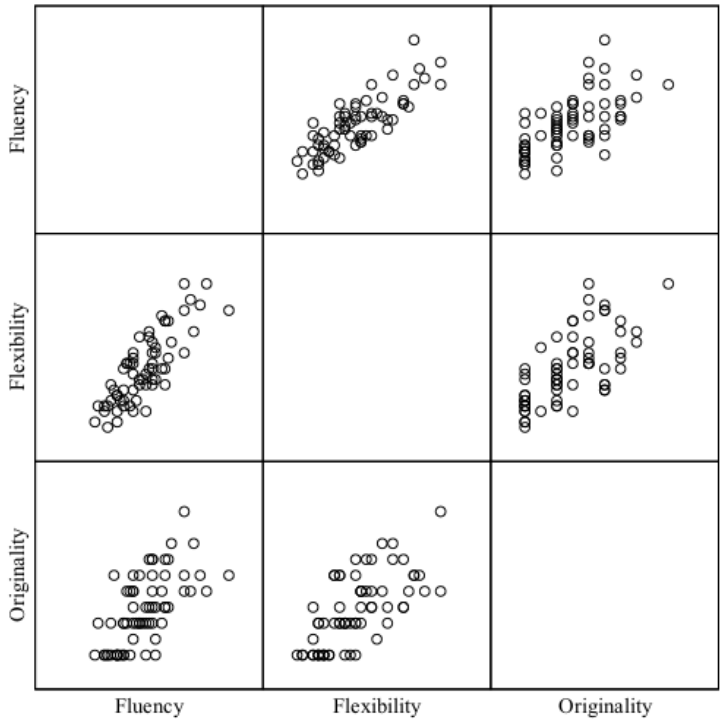

Figure 2. Scatter plot correlation between AUT fluency, AUT flexibility and AUT originality.

Looking at the mind wandering probes, various Pearson correlation coefficients were computed to assess the relationships between the different probe variables. The relationship between AUT mind wandering and positive mind wandering displayed a positive significant correlation, namely $r(65) = .828$, $p < .001$. Similarly, the relationship between AUT mind wandering and negative mind wandering displayed a positive significant correlation, namely $r(65) = .756$, $p < .001$. Thus, increases in mind wandering during the AUT was positively correlated with increases in positive mind wandering and increases in negative mind wandering.

H1A: Mind wandering has a negative effect on divergent thinking. In order to test hypothesis H1A, a Pearson correlation coefficient was computed to assess the relationship

between the amount of mind wanders during the AUT and fluency, flexibility and originality. The correlation between amount of wanders and each of the three variables was insignificant, namely: $r(65) = .092$, $p = .466$, $r(65) = .110$, $p = .385$ and $r(65) = -.048$, $p = .704$. Since the results show that the correlation between these variables was insignificant, we have enough reason to invalidate H1A.

H2A: More positive mind wandering can compensate for a negative effect of mind wandering during performance on divergent creative thinking tasks. In order to test hypothesis H2A, a Pearson correlation coefficient was computed to assess the relationship between the derived positive mind wanders during the AUT and fluency, flexibility and originality. The correlation between amount of wanders and each of the three variables was as follows: $r(62) = .289$, $p = .023$, $r(62) = .151$, $p = .242$ and $r(62) = .235$, $p = .066$. These results show that positive mind wanders only correlated significantly with fluency while the other two correlations were not significant. Thus, there is a polarity with negativity when looking at fluency. Meaning that negative mind wandering subtracts while positive mind wandering adds to fluency performance on divergent creative thinking tasks. Looking at these results, H2A can therefore be partially validated in terms of fluency.

4.2 RAT

The results from the RAT are discussed below in relation to mind wandering valence. The mean and standard deviation of the various variables and the relevant correlations are presented below with the use of tables. Additionally, the hypotheses relevant to the RAT and convergent creative thinking are discussed.

Table 2. RAT mean, standard deviation and correlation.

Variable	Mean	SD	1.Total answers	2.Total correct	3.Derived % correct	4.Mind wanders	5.Derived positive mw	6.Derived negative mw
1.Total answers	19.12	7.21	-	.071	-.438**	-.107	.007	-.001
2.Total correct	10.12	6.68	.071	-	.813	.031	-.116	-.066
3.Derived % correct	58.14	33.15	-.438**	.813**	-	.071	-.036	-.076
4.Mind wanders	3.66	2.60	-.107	.031	.071	-	.103	-.018
5.Derived positive mind wanders	4.38	1.36	.007	-.116	-.036	.103	-	-.763**
6.Derived negative mind wanders	3.36	1.36	-.001	-.066	-.076	-.018	-.763**	-

A Pearson correlation coefficient was computed to assess the relationship between the total amount of answers given during the RAT and the amount of correct answers given during the RAT. There was an not significant correlation between the two variables, namely $r(65) = .071$, $p = .576$. A scatter plot summarizes the results (Figure 3). Overall there was a weak, positive correlation between the total RAT answers and the correct RAT answers. Interestingly, there was a negatively correlated relationship between the total amount of items answered during the RAT and the derived percentage of correct answers $r(65) = -.438$, $p < .001$.

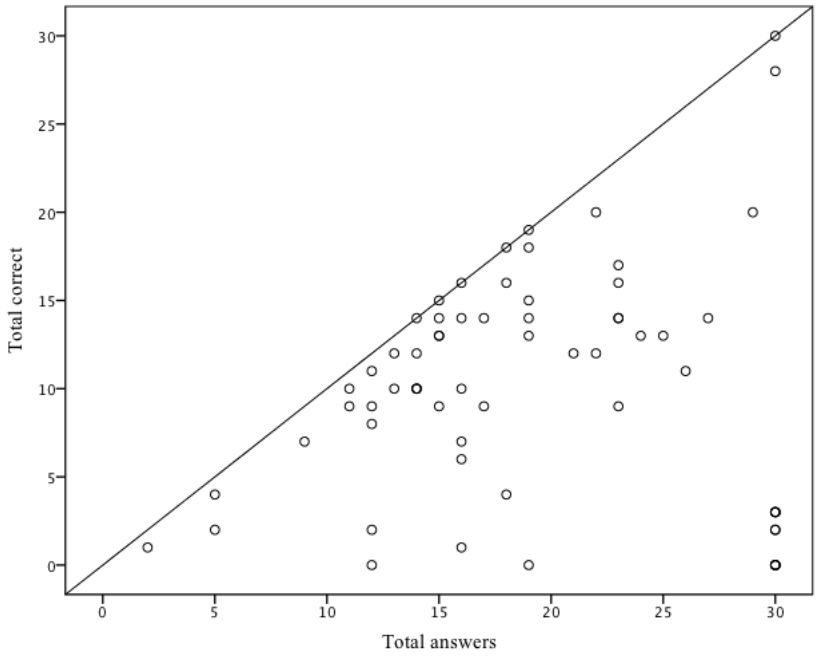

Figure 3. Scatter plot correlation between total RAT answers and correct RAT answers.

Likewise to the AUT, looking at the probes, the relationship between RAT mind wandering and positive mind wandering displayed a positive significant correlation, namely $r(65) = .896$, $p < .001$. Similarly, the relationship between RAT mind wandering and negative mind wandering displayed a positive significant correlation, namely $r(66) = .843$, $p < .001$. Thus, increases in mind wandering during the RAT was positively correlated with increases in positive mind wandering and increases in negative mind wandering.

H1B: Mind wandering has a negative effect on convergent thinking. In order to test hypothesis H1B, a Pearson correlation coefficient was computed to assess the relationship between the amount of mind wanders during the RAT and total answers, total correct and derived percentage of correct answers. The correlation between amount of wanders and each of the three variables was as follows: $r(65) = -.107$, $p = .396$, $r(65) = .031$, $p = .805$ and $r(65) = .071$, $p = .572$. Since the results show that the correlation between these variables was not significant, we have enough reason to invalidate H1B

H2B: More negative mind wandering can compensate for a negative effect of mind wandering during performance on convergent creative thinking tasks. In order to test hypothesis H2B, a Pearson correlation coefficient was computed to assess the relationship between the derived negative mind wanders during the RAT and total answers, total correct and derived percentage of correct answers. The correlation between amount of wanders and each of the three variables was as follows: $r(56) = -.001$, $p = .996$, $r(56) = -.066$, $p = .628$ and $r(56) = -.076$, $p = .580$. Since the results show that the correlation between these variables was not significant, we have enough reason to invalidate H2B.

5. Discussion and conclusion

5.1 Summary of the results and link to previous work

Creativity in some form is indispensable to problem solving. Depending on the task at hand, divergent or convergent creative thinking could be more effective. Regardless of its importance to problem solving, it is evident that we as human beings, are unable to keep our full mental attention on a task without at least having our thoughts wander to some degree at one point. Countless studies in the past (Baas et al., 2008) and the present (Zedelius & Schooler, 2016) underline the importance creativity as well as mind wandering plays in our day-to-day endeavors. The idea of filling in the academic gap by incorporating valence in the mix is meant to give more insight into this fundamental relationship. This idea is formulated in the research question: What are the effects of mind wandering valence on divergent and convergent creative thinking?

Previous research has looked into the relationship between mind wandering and creativity, but what sets this study apart from the rest is that valence has been taken into account. For example, Hao et al. (2015) talks about overall creativity, although the findings are based on a divergent creative thinking task, namely the AUT. This addition was based off the research done by Chermahini et al. (2012), who emphasized the difference between the creative processes. Brophy (2001) gave further insight into the importance of divergent ideation and convergent judgment for efficient creative problem solving. Additionally, according to Mumford and Gustafson (1988), both are crucial cognitive abilities necessary for cognitive abilities.

Our study differentiated mind wandering in terms of valence, this differs from Hao et al. (2015), who differentiated mind wandering in terms of quantity. Hao et al. (2015) categorized participants in high mind wandering and low mind wandering groups. The idea to differentiate mind wandering on the basis of valence comes from Zedelius and Schooler (2016), who assumed a causal relationship between valence and mind wandering. In other words, this

relationship implies that when an individual experiences a positive valence state, they are more likely to have positive mind wandering and if they experience a negative valence state, they are more likely to have negative mind wandering. Additionally, research from Baas et al. (2008) claim that positive valence could be beneficial for divergent creative thinking, while negative valence could be beneficial for convergent creative thinking. Keeping all this in mind, the current study incorporated the valence of mind wandering into the research question and hypotheses with the hopes of finding some type effect, and where appropriate, compensation for an undesired effect.

Our results didn't show a negative effect of mind wandering on divergent thinking or convergent thinking. These results go against the findings of Hao et al. (2015), which suggest a negative effect of mind wandering on creativity. Because of this, hypothesis *H1A: Mind wandering has a negative effect on divergent thinking* and hypothesis *H1B: Mind wandering has a negative effect on convergent thinking* were invalidated. But we took this study a step further by incorporating the valence of mind wandering to test whether this could affect the previously assumed effect or at the least give some further insight.

The study of Baas et al. (2008) claim that positive valence could be beneficial during divergent creative thinking tasks while negative valence could be beneficial during convergent creative thinking tasks. The remainder two hypotheses were based off this belief. Additional results from the presently conducted research invalidated this claim to a great extent, with some interesting exception. Hypothesis *H2A: More positive mind wandering can compensate for a negative effect of mind wandering during performance on divergent creative thinking tasks* was partially validated. Positive valence had no effect on flexibility and originality during divergent creative thinking but it did improve participants' fluency. This means that a positive mind wandering state could benefit the generation of ideas during divergent creative thinking tasks. On the other hand, hypothesis *H2B: More negative mind wandering can compensate for a negative effect of mind wandering during performance on convergent creative thinking tasks*

was invalidated as the results didn't show effect of valence on convergent creative thinking during mind wandering.

5.2 Limitations and alternative explanations of the results

The results of the conducted study invalidated hypotheses H1A and H1B because no significant effect of mind wandering on divergent or convergent creative thinking could be measured. This does not imply that findings of previous research, that mind wandering has a negative effect on creativity, should be dismissed. An alternate explanation for the results could be that self-report mind wandering measurement is less effective. It is difficult to pinpoint whether participants were truly being truthful and active. The insignificant effect of the current study could also possibly be due to the construct validity of the test. Both creativity and mind wandering are intangible, internal concepts, which makes its measurement that much more complicated. The method of the conducted study is based off previous successful research, namely: the AUT (Hao et al., 2015) and the RAT (Chermahini et al., 2012). This emphasizes that although the intention of the study was in the right place, due to the nature of the key concepts of the study, construct validity can explain many inconsistencies. Construct validity refers to how well a test measures up to its claims and actually measures what it is meant to measure. In this context for example, even though the tasks are set up in such a way to measure mind wandering and creative performance, it is tough to pinpoint whether this is really the case.

The idea of construct validity flows over into the testing of hypotheses H2A and H2B. And although these two hypotheses could have been completely invalidated on the basis of the invalidation of hypotheses H1A and H1B, this was not the case. Hypothesis H2B was invalidated, which isn't too surprising as no significant effect of mind wandering on convergent thinking was found to begin with. Thus, a compensation for a negative effect was unlikely to be found within the same dataset. On the other hand, hypothesis H2A was partially validated for

fluency. Meaning that, people who experienced more positive mind wandering also generated more ideas. This could be explained by the claim that positive mind wandering facilitates creativity by increasing insight (Zedelius & Schooler. 2016).

5.3 Future work

The field of mind wandering and creativity is a broad, rather dubious field. With the nature of the concepts in mind, it comes to no surprise that results from testing tend do be hazy. This study has attempted look further into creative thinking by differentiating between divergent and convergent thinking, but it could be of great interest for further research to take this even a step further by testing other elements of the creative process in relation to mind wandering. Various research combined could give better insight into the concepts and relationships between.

Seeing as the results did not find a significant effect between mind wandering and either form of creative thinking, it could be of interest for further research to conduct the AUT and RAT with another form of thought probe testing to see whether this delivers a significant effect. It is possible that self-report may deliver something different than another form of mind wandering measurement.

5.4 Conclusion

In conclusion, looking at the overarching research question of this paper *'What are the effects of mind wandering valence on divergent and convergent creative thinking?'* the answer is as follows: the results from the conducted study didn't show a significant effect of mind wandering on creative thinking, whether that be divergent or convergent creative thinking. When incorporating valence, an effect can be found during divergent creative thinking but not during convergent creative thinking. Namely, positive valenced mind wandering can assist the generation of ideas, in other words fluency. This latter finding is consistent with that of Baas et al. (2008). It is clear from the results of the conducted study that the answer isn't exactly what

we had expected to find. Regardless, coming full circle, if all you hope to do is come up with more ideas, regardless of its correctness; don't write mind wandering off as a form of negative procrastination.

7. References

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8. Appendix

RAT (English):

Triad	Solution
1. Fox/Man/Peep	Hole
2. Sleeping/Bean/Trash	Bag
3. Dust/Cereal/Fish	Bowl
4. Light/Birthday/Stick	Candle
5. Food/Forward/Break	Fast
6. Peach/Arm/Tar	Pit
7. Water/Mine/Shaker	Salt
8. Palm/Shoe/House	Tree
9. Basket/Eight/Snow	Ball
10. Wheel/Hand/Shopping	Cart
11. Right/Cat/Carbon	Copy
12. Sandwich/House/Golf	Club
13. Sage/Paint/Hair	Brush
14. French/Car/Shoe	Horn
15. Boot/Summer/Ground	Camp
16. Chamber/Mask/Natural	Gas
17. Mill/Tooth/Dust	Saw
18. Main/Sweeper/Light	Street
19. Pike/Coat/Signal	Turn
20. Fly/Clip/Wall	Paper
21. Wagon/Break/Radio	Station
22. Lift/Card/Mask	Face
23. Dress/Dial/Flower	Sun
24. Force/Line/Mail	Air
25. Eight/Skate/Stick	Figure
26. Down/Question/Check	Mark
27. Animal/Back/Rat	Pack
28. Pine/Crab/Sauce	Apple
29. House/Thumb/Pepper	Green
30. Carpet/Alert/Ink	Red

RAT (Dutch):

	Triad	Solution	Solution (English)
1.	man / lijm / ster	Super	Super
2.	hond / druk / band	Bloed	Blood
3.	palm / familie / huis	Boom	Tree
4.	kamer / masker / explosie	Gas	Gas
5.	strijkijzer / schip / trein	Stoom	Steam
6.	kop / boon / pauze	Koffie	Coffee
7.	controle / plaats / gewicht	Geboorte	Birth
8.	bar / jurk / glas	Cocktail	Cocktail
9.	kolen / land / Schacht	Mijn	Mine
10.	kaas / land / huis	Boeren	Farmers
11.	achter / kruk / mat	Deur	Door
12.	schommel / klap / rol	Stoel	Chair
13.	vlokken / ketting / pet	Sneeuw	Snow
14.	riet / klontje / hart	Suiker	Sugar
15.	licht / dromen / maan	Dag	Day
16.	vis / mijn / geel	Goud	Gold
17.	worm / kast / legger	Boeken	Book
18.	bed / zee / school	Ziek	Sick
19.	grond / vis / geld	Pot	Pot
20.	olie / pak / meester	Bad	Bath
21.	room / vloot / koek	Boter	Butter
22.	trommel / beleg /mes	Brood	Bread
23.	ga / daar / dag	Zon	Sun
24.	water / schoorsteen / lucht	Pijp	Pipe
25.	goot / kool / bak	Steen	Stone
26.	deur / werk / kamer	Huis	Home
27.	nacht / vet / licht	Kaars	Candle
28.	arm /veld / stil	Muis	Mouse
29.	val / meloen / lelie	Water	Water
30.	school / ontbijt / spel	Bord	Board