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IS CREATIVITY HIGHER IN A MESSY ENVIRONMENT? AN EXPERIMENTAL STUDY TO INVESTIGATE THE MEDIATING ROLE OF MIND-WANDERING

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ABSTRACT

Recently, it has been shown that a messy environment may have benefits for creative performance, because a messiness may trigger unconventional thinking (Vohs, Redden & Rahinel, 2013). However, the mechanism that causes this effect is still unknown and the experimental findings need to be replicated. I hypothesized that a messy environment leads to mind-wandering and that mind-wandering subsequently increases creativity. Furthermore, Working Memory Capacity (WMC) could act as a moderator between messiness and mind-wandering, so that people with a higher WMC are less affected by messiness than people lower in WMC. To test my hypotheses, I manipulated the structure of the environment and created two conditions, a messy and a tidy room, in which 74 subjects were asked to complete a version of the Alternative Uses Task. The correlations and the multiple regressions showed that messiness of the environment increased distraction and mind-wandering, but this had a negative rather than a positive effect on creativity. WMC did not moderate these effects. My study, therefore, suggests that messiness may also affect creativity negatively, and future research is needed to find out when positive and negative effects of messiness on creativity are to be expected.

Keywords: *creativity, environment structure, messiness, mind-wandering, Working Memory Capacity.*

INTRODUCTION

Order and disorder have always been physically present in nature and humans have not tried to eliminate either one of those. On the one hand, people experience substantial benefits from being tidy and environmental orderliness increases revenue in the industry (Vohs, Redden & Rahinel, 2013). On the other hand, famous scientists, writers, artists and Nobel-awarded individuals cultivate messy environments as help to their work (Abrahamson & Freedman, 2007). Vohs et al. (2013) argued that the reason why such differences exist is that each environment suits different outcomes. For instance, order might give an advantage to people who value tradition, convention and conservatism and it is linked to morality and correctness; instead, messiness is connected to deviations and taboo, besides allowing more freedom and ambiguity. Depending on the importance assigned to those outcomes and the mind-set activated, one will have better behavioural or situational consequences in either a tidy or a messy environment (Vohs et al., 2013).

The focus of this empirical research is on the role of a messy work environment, compared with a tidy one, in stimulating creativity. Creativity can be defined as "the production of ideas, problem solutions, and products that are both novel (original) and appropriate (feasible, potentially useful)" (Nijstad, De Dreu, Rietzschel & Baas, 2010, p. 35). Contrary to what people generally think, creativity is not just an attribute of some brilliant minds: in fact, it is connected to human cognitive functioning, such as the use of languages, our flexible use of mental categories and schemes to organize experiences and the ability to manipulate objects (Nijstad et al., 2010; Ward, Smith & Finke, 1999). The importance of being creative is widespread in culture, business and arts: it has long been studied because it is also relevant for the physical survival and life improvement of our species (Simonton, 2003). Through creativity we have always solved our problems, the old ones and the newest, both in work and everyday life.

The purpose of my investigation is to link those two main variables, environment and creativity. One study by Vohs et al. (2013) has shown a positive relationship between messiness and creativity, and these authors speculate that a messy environment triggers unconventional thinking. However, Vohs et al. (2013) did not study the underlying mechanism, and given that this is the only study linking messiness to creativity so far, their results are in need of empirical replication. I propose the inclusion of mind-wandering as a mediator, which refers to a state of decoupled attention in which a person "stray[s] from the here and now in favor of thoughts unrelated to current external events" (Killingsworth & Gilbert, 2010, p. 932). Based on latent inhibition theory (Lubow, 1989), the recent evidence from Vohs et al. (2013) and the Dual Pathway to Creativity Model (DPCM; De Dreu, Baas & Nijstad, 2008; Nijstad et al., 2010; Baas, De Dreu & Nijstad, 2008), I propose that the unconventionality and the unexpected number of noticeable objects in a messy room leads to mind-wandering. This, in turn, enhances creativity because a state of defocused attention increases the number of relevant and irrelevant ideas and associations that come to mind (for evidence: Baird, Smallwood, Mrazek, Kam, Franklin, & Schooler, 2012).

Furthermore, the question arises whether the relationship between messiness and creativity holds for everyone. If mind-wandering plays a role, it is plausible that people who are more easily distracted are more affected by environmental messiness than those that are less easily distracted. Therefore, I also examine the role of Working Memory Capacity (WMC), a variable that could influence the extent to which one is able to focus. WMC, defined as "the system responsible for holding information available for complex cognitive activities" (De Dreu, Nijstad, Baas, Wolsink & Roskes, 2012, p. 657), can be measured by the number of items that we are able to recall during a complex task, maintaining, at the same time, a certain amount of information active and ready for computations (De Dreu et al., 2012). The executive attention theory of WMC (Engle & Kane, 2004) suggests that for subjects relatively low in WMC the selection of stimuli entering their mind will be less strict than for people higher in WMC. Because of this, low WMC individuals will engage in

mind-wandering more frequently in an environment that provides them with more stimuli (e.g., a messy room). As a consequence, messiness may be more strongly associated with creativity for individuals who are low as opposed to high in WMC. In sum, the question that I address is: *Why and for whom does a messy environment increase creativity?*

Disorder, defocused attention and a low Working Memory Capacity have long been seen from a psychological point of view as having only disruptive effects for humans: my experimental investigation aims at demonstrating that those can have a practical, hidden and adaptive value. To address the issue, I will manipulate the structure of the environment and measure WMC in a sample of 74 university students. Within two different conditions, a messy and a tidy room, subjects will be asked to complete a creative task and, afterwards, to fill in some questionnaires about their experience. My hope is that this research will lead to a practical utility, for instance in an organizational environment, especially to help those people who have always suffered from an incapacity to keep their attention focused, but they can now see this trait as useful to society and themselves.

THEORETICAL SECTION

2.1 How mind-wandering mediates between environmental messiness and creativity

The criteria taken into account by Nijstad et al. (2010) to define creativity are originality and appropriateness (theoretical or practical relevance): if an idea possesses these two qualities, it can be considered a creative one. Operationally, creativity can be measured as a personality trait (Gough, 1979), a preference for complexity in abstract designs (Eisenman, Borod, & Grossman, 1972) or as divergent thinking (Rubinstein, 2003). According to Guilford (1967), creativity is influenced by contextual factors, such as family and working environment. In my research I concentrate on the specific physical environment structure in which the person is when he is asked to carry out a task requiring creativity. My aim is to study how a factor, messiness versus tidiness of the environment, will influence the creative performance. With "work environment structure" I mean whether a work environment, such as an office or a studying room, is tidy or messy. For the purpose of my research, the work environment structure is defined as high when the environment is tidy; low when the environment is messy.

Recently, researchers have investigated the relationship between the environment structure and creativity: findings by Vohs et al. (2013) showed that in a messy room more creative ideas, more "fresh insights", were generated than in an orderly one. Furthermore, they showed that “environment can be an effective way to shape behaviour” (Vohs et al., 2013, p. 1861). Those authors based their reasoning on the idea that orderliness inspires valuing convention and following traditional habits, which is exactly what a person does not need when facing a creativity task. Conversely, being in a messy room should encourage breaking with convention, breaking rules and conservatism, which, instead, is needed to be creative (Simonton, 1999; Dollinger, 2007). In particular, Simonton (1999) argued that breaking with convention is necessary for creativity, since the most obvious ways of thinking (the conventional ones) are not going to succeed to solve a

creative problem. When you are facing an issue requiring creativity, you typically need a reformulation of the problem, to see it from a different point of view, and, in order to do this, it is very useful to be influenced by as many inputs and stimuli as possible. It is logical to assume that those fruitful stimuli coming from the external environment could help you to be more creative. Those inputs produce a series of new insights, alternative formulations, random associations that eventually lead the individual to a creative solution (Simonton, 1999; Seifert, Davidson, Patalano, & Yaniv, 1995).

Based on the theory explained and the evidence suggested, I predict that a messy environment (a low-structured one) will trigger, in general, more original ideas, those that do not follow the most common path of reasoning, but are less habitual. Therefore, the first hypothesis is:

Hypothesis 1 (H1). The level of structure of the work environment is negatively related to creativity (i.e. messiness is positively related to creativity).

Vohs et al. (2013) suggested that unconventionality is the explanation for creativity in a messy environment. However, my alternative hypothesis is that mind-wandering mediates between the two variables. Mind-wandering is "the tendency for the mind to stray from the here and now in favor of thoughts unrelated to current external events" (Killingsworth & Gilbert, 2010, p. 932). The tendency to mind-wander is associated with costs and deficits in performance on a great range of activities and states, such as cognitive performance, reading, comprehension, happiness and mood (Mooneyham & Schooler, 2013). Indeed, mind-wandering is characterized by a decoupling of attention from an immediate task context toward unrelated concerns (Smallwood & Schooler, 2006; Schooler, Smallwood, Christoff, Handy, Reichle, & Sayette, 2011), and it can be described as a voluntary failure of cognitive control (McVay & Kane, 2010). Although this can be true, since mind-wandering is so prevalent in our daily life, "it may not be solely erroneous" (Mooneyham & Schooler, 2013, p. 11), but, in fact, adaptive: mind-wandering exists because it helps us, for instance, coping with boredom or disinterest (Baird, Smallwood & Schooler, 2010), thinking about

the future (autobiographical planning) and solving creativity problems (Mooneyham & Schooler, 2013). This shows that it can generally have hidden benefits. That is why I would like to focus my research only on the benefits and functionalities of mind-wandering and, specifically, those that are related to more creativity.

In a messy environment there are more stimuli than in a tidy one. More specifically, even though the number of objects present is the same, an individual in a messy environment notices more objects than in a tidy one, because of the unconventional disposition of elements in the room, and the cognitive system receives more inputs. Due to the unconventional and unexpected environment and due to the greater number of salient stimuli present in the environment, the individual is firstly attracted by it and then pushed to be distracted and, so, to mind-wander more than in a tidy environment. In other words: messiness is distracting.

According to Dreisbach and Goschke (2004), an increased sensitivity for irrelevant inputs or alternative options may be costly and increases distractibility and impulsivity, but this sensitivity can also promote cognitive and behavioural flexibility. Moreover, different authors have argued that creativity may occur during daydreaming (e.g. Dietrich, 2004; Martindale, 1999) or during distraction (Dijksterhuis & Meurs, 2006). Friedman and Forster (2005) proposed that creativity is originated by defocused attention and unsystematic random processes: these processes "would result in the generation of associations that are more remotely related to existing ideas (and thus more original)" (Nijstad et al., 2010, p. 40). The underlying mechanism may be a reduction in latent inhibition. Latent inhibition refers to the capability of the brain to select and filter out from current attentional focus some stimuli previously experienced as irrelevant (Lubow, 1989). For more creative individuals, these irrelevant stimuli are not inhibited, because of their low level of latent inhibition: when irrelevant stimuli enter the attentional focus, there are more elements to consider in a creative tasks, generating, proportionally, more original answers (Nijstad et al., 2010). One factor

to explain the positive relationship between mind-wandering and creativity could be the level of latent inhibition. This leads to the following hypotheses:

Hypothesis 2a (H2a). The level of structure of the work environment is negatively related to mind-wandering (i.e. messiness is positively related to mind-wandering).

Hypothesis 2b (H2b). Mind-wandering is positively related to creativity.

Hypothesis 2c (H2c). The relationship between the structure of the work environment and creativity is mediated by mind-wandering.

2.2 The moderation of WMC

Working Memory Capacity has been theoretically defined as "the system responsible for holding information available for complex cognitive activities" and it is, therefore, associated with language production and comprehension, deliberate and conscious processing information, reasoning and future hypothetical planning (De Dreu et al., 2012, p. 657). Operationally, WMC has been measured by the number of items that we are able to recall during a complex task, maintaining, at the same time, a certain amount of information active and ready for computations (De Dreu et al., 2012). Individual differences in WMC, together with its current load, correlate with different individual cognitive capacities, such as general intelligence (Kane, Hambrick, Tuholski, Wilhelm, Payne & Engle, 2004), learning and comprehension (Kane, Brown, McVay, Silvia, Myin-Germeys & Kwapil, 2007).

Besides keeping novel information in an active state, WMC helps to distinguish between relevant and irrelevant information (Unsworth & Engle, 2007). The difference between people who have a relatively low level of WMC[1] and people who have a relatively high level of it is that the former take into consideration more stimuli than the latter do, simply because they are less able to

[1] Please notice that WMC is a continuous variable. Therefore, when defining people as “low” or “high” in WMC, I refer to people who are, respectively, closer to the lowest extreme of the continuum or to the highest extreme.

distinguish relevant from irrelevant contextual elements (Unsworth & Engle, 2007). "People with lower WMC are less able than people with higher WMC to sustain goal-directed thought and behaviour in the face of competition from environmental and mental events" (Kane et al., 2007, p. 620). That means that a relatively low WMC leads to more distraction, depending on the environmental situation occurring while the task is performed. Kane et al. (2007) showed that WMC is an individual predictor for task-unrelated thought, also defined as mind-wandering, in daily life. WMC is the ability through which we can control every kind of stimulus and thought. Therefore, if we have a relatively high WMC, we will put effort on controlling each stimulus, trying to select the relevant ones for current problem solving. Conversely, if our WMC is low, attention will be defocused and control will be not so strict: in this case, many more unconscious and unrelated thoughts are allowed to enter our mind, making us distracted. Engle and Kane (2004) interpret individual differences in WMC as reflecting variation in executive attention. In a very unstructured environment, a messy one, people higher in WMC would tend to be more focused on the task and less distracted by the context and the stimuli from the environment, while lower WMC individuals will mind-wander more. This reasoning is supported by the executive attention theory of WMC, by Engle and Kane (2004), according to which WMC works as a predictor of the attention paid by the individual during the execution of a cognitive task.

Therefore, I hypothesize that low WMC people are more prone to mind-wander in a messy work environment than high WMC people. The unconventionality and the amount of stimuli coming from the environment keeps low WMC individuals distracted and defocused, because they do not only isolate the important information. Then, in turn, their defocused attention or mind-wandering will lead to the generation of more original ideas and, therefore, to creativity. In contrast, high WMC subjects will be less distracted by the external environment and will keep their attention focused on the task: they only pay attention to relevant information concerning their current task and show an analytical problem solving approach (Wiley & Jarosz, 2012). My prediction, at this

point, is that they will be less subjected to mind-wandering. The reasoning just followed leads to my last hypothesis:

Hypothesis 3 (H3). WMC acts as a moderator between work environment structure and mind-wandering, such that a messy (low-structured) environment originates more mind-wandering for low WMC subjects than it does for high WMC subjects.

My hypotheses are graphically displayed in Figure 1.

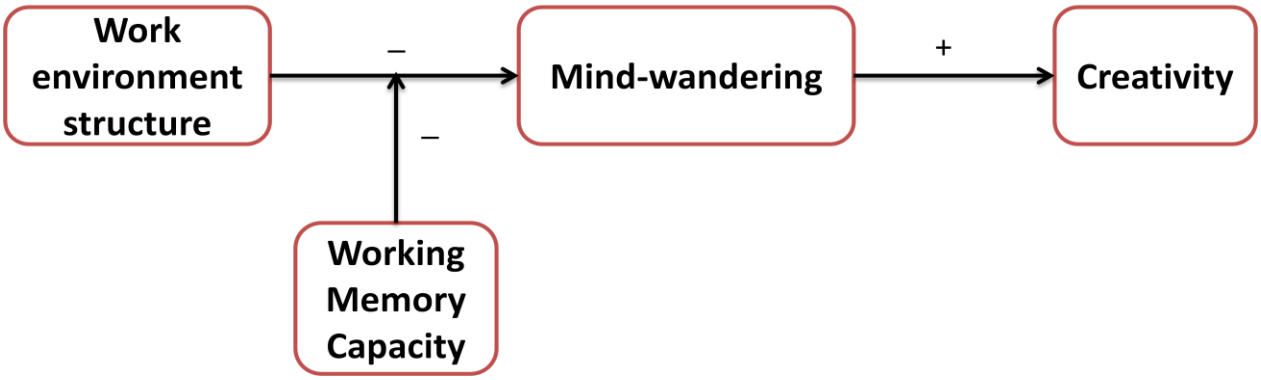

Figure 1: The conceptual model.

In the previous I argued that high WMC subjects are not helped by a messy environment regarding creativity, because they do not lose their executive attention and do not get distracted by the context: their level of latent inhibition is high and irrelevant inputs do not become conscious. Although they do not frequently engage in mind-wandering, this does not imply that they are less creative: conversely, they can also be very creative, but for different reasons. One of these has been provided by the Dual Pathway to Creativity Model (De Dreu et al., 2008; Nijstad et al., 2010; Baas et al., 2008), according to which there are two ways to creative performance: flexibility and persistence. Flexibility is "the ease with which people can switch to a different approach or consider a different perspective"; persistence is defined as the "degree of sustained and focused task-directed cognitive effort" (Nijstad et al., 2010, p. 42). Those two pathways are influenced by dispositional and situational factors, and WMC has been found to positively affect creativity through the

persistence pathway (De Dreu et al., 2012). Therefore, through hard work, systematic and effortful in-depth exploration of only few perspectives, high WMC people can also reach creative results (Nijstad et al., 2010). Thus, people scoring high on WMC are not uncreative, rather they are less affected by the stimuli from the environment.

METHODOLOGY

3.1 Data collection: Participants, experimental design and manipulation

Participants were 74 undergraduate students from the Rijksuniversiteit Groningen, mostly studying at the Faculty of Economics and Business. The average age among the sample was 22.03 (*SD* = 2.18), with a minimum of 18 and a maximum of 29. Gender was equally distributed: in the sample there were 33 males and 41 females. Participants had a great variance in nationality, but the majority came from the Netherlands (48.6%) and from Germany (8.1%). The rest had a different nationality (43.2%). As a compensation for their participation, they received "partial course credits" or a small amount of money (€8,00).

To test my hypotheses and collect the necessary data, I used a between-participants experimental design in which I manipulated my independent variable, the structure of the environment. Structure was high when the room in which the participants were tested was very tidy, with no clutter (highly structured); low when it was messy, with many books, sheets, pens and other office items scattered throughout the space (see Figure 2 and 3). All participants were tested in the same room (about 3 x 5 m). There were one big table, one small table, four chairs and two waste bins in the room. The light was artificial because there was no window. The number and kind of objects present in the two conditions was exactly the same for both, but what changed was the set-up and position of everything. Since I used only one room, I had to change the setting according to the condition which I wanted the participant to be involved in. For the nine days during which I conducted my experiment, on Tuesday and Thursday in the first week and on Monday, Wednesday and half of Friday in the second week the room setting was the messy one. The remaining days, the room was tidy.

Figure 2: The tidy room.

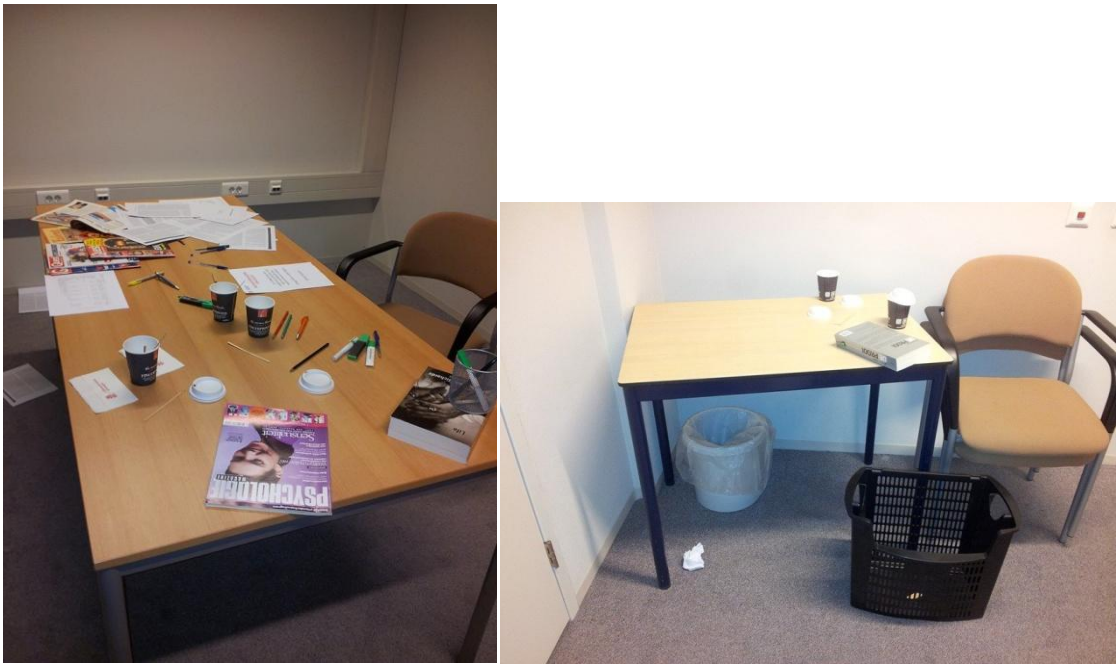

Figure 3: The messy room.

3.2 Data collection: Procedure

Participants came to the FEB Lab at a given time and, after being informally introduced to me and my research, they were explained what they will be asked to do and how much time will be necessary to complete their tasks. Before starting the experiment, subjects were told that they had the possibility to interrupt the study at any time and cancel their voluntary participation. Moreover,

an informed consent for the data treatment was signed by everyone. Anonymity was completely guaranteed by the use of a different numerical code to indicate each participant.

Before using the room in which the manipulation occurred, I measured the individual level of WMC, as the second independent variable. The test I used to measure WMC was the *Operation Span*, validated by Turner and Engle (1989). Ospan requires participants to solve a series of math calculations while, at the same time, trying to remember strings of unrelated alphabet letters (Unsworth & Engle, 2005). Upon solving the math operation and after the letter has been memorized, the next operation-letter string is presented. The task consists of recalling in the exact order all the letters previously read, following each string. The level of WMC stems from the sum of perfectly recalled letter strings, plus an 85% accuracy criterion regarding the math operations. This was tested on a laptop, in a cubicle, a neutral room different from the rooms where the first independent variable was manipulated, and it took about twenty minutes to complete.

Immediately after that, I measured the participants mood[2] through a 13-items questionnaire (from 1 "Definitely do not feel" to 5 "Definitely feel") based on the Brief Mood Introspection Scale (Mayer & Gaschke, 1988). Next, an explanation of the creative task and instructions on how to complete it were provided. Afterwards, depending on the day of the experiment, the participant went either to a tidy or to a messy room. I tested 37 subjects for each experimental condition. In the experimental room the participants were asked to complete a creative task in ten minutes, while they were unknowingly video-taped[3]. To measure creativity, a very common task was employed: the Alternative Uses Task. It requires to find as many unusual uses as possible for a common object in a

[2] In the questionnaire, I asked to indicate how well each adjective described the subject's mood. Through a factor analysis, four factors have been identified: the first concerned a negative irritable mood ($\alpha = .77$, e.g. "How well does the adjective irritable describe you now?"), the second was about tiredness ($\alpha = .73$, e.g. "How well does the adjective sleepy describe you now?"), the third was a passive negative component ($\alpha = .64$, e.g. "How well does the adjective sad describe you now?") and the last one an active and positive component ($\alpha = .66$, e.g. "How well does the adjective happy describe you now?"). Only the third component (sadness) was negatively related to the number of good ideas (-0.22, $p<.10$) .

[3] I used a room of the FEB Research Lab in which it was possible to use video cameras. I could create a more realistic idea of messiness in this big room and I wanted to video-tape the subjects while doing the task in order to measure mind-wandering more exactly.

certain amount of time that has been previously set. This classic instrument, introduced by Guilford in 1967, has been validated as a measure of divergent thinking and originality. In particular, using the same task already tested by Vohs et al. (2013), participants imagined that a company wanted to create new uses for the ping-pong balls that it manufactured. They were required to list up to 10 new uses for ping-pong balls, generating as many as possible original and useful ideas within the given time.

Then, a series of questionnaires was provided. First of all, to check whether the manipulation worked, I asked every participants to evaluate the messiness of the room through two items: "The room was tidy" and "The room was quite messy", from 1 ("Completely disagree") to 5 ("Completely agree"). Secondly, participants answered 14 items concerning mind-wandering. Their mood was checked again with the same questionnaire that they completed before the creative task, in order to see whether it changed after the creativity task.

For exploratory reasons, I administered two personality questionnaires: openness to experience and need for structure. Those two variables are known to be related to creativity: openness usually correlates positively with creativity and need for structure shows the opposite trend. A 10-items scale was used to measure openness to experience, a personality trait belonging to the Five Factors Model (Tupes & Christal, 1961). People who score high in openness have in general an active imagination and creativity, they appreciate variety, they are intellectually curious, introspective, unconventional and original (McCrae & John, 1992). The scale has been adapted based on the Ten-Item Personality Inventory (Muck, Hell & Gosling, 2007) and on the Big-Five Factor Markers (Goldberg, 1992). Examples of the items were "I do not have a good imagination" or "I am full of ideas" (from 1 "Strongly disagree" to 7 "Strongly agree"). This scale's reliability was $\alpha = .79$.

As regards personality, it is also important to know whether the subjects have a low or high need for structure. Therefore, I used a 11-items scale to measure this tendency, defined as a need for orderliness, a discomfort for unpredictability and a disdain for ambiguity. People who score high in

need for structure generally need to make sense of the world around them more quickly and completely than other people do (Thompson, Naccarato, Parker & Moskowitz, 2001). High need for structure has also been shown, sometimes, to negatively correlate with creativity (Rietzschel, De Dreu & Nijstad, 2007). Two of the items I have used were "I enjoy having a clear and structured mode of life" and "I am not bothered by things that interrupt my daily routine" (with the same answer range as the openness scale, from 1 to 7). Those items have been taken from the work by Thompson, Naccarato and Parker (1989). The scale measuring the need for structure had a reliability of $\alpha = .82$.

Furthermore, I asked if they knew the task before and to express their opinion about what the experiment was about. At the end of the questionnaire participants were required to provide some demographic information. To ensure anonymity, a specific consent form was signed at this point, in order to guarantee that the tape-recordings will only be used for this research purpose and to promise that all the material will be destroyed afterwards. Together with the compensation for participating, a printout of the debriefing was provided. The total time needed for each subject was about fifty minutes.

3.3 Data analysis: Measurement

Mind-wandering. The instrument[4] to assess mind-wandering was a 14-items scale, in which some items have been taken from the Mind Wandering Questionnaire by Mrazek, Smallwood and Schooler (2012) and the rest from the Dundee Stress State Questionnaire (Matthews, Szalma, Panganiban, Neubauer & Warm, 2013), in its short version validated by Helton (2004). Examples of the items I have used to assess the construct were "I did the creative task without paying much attention", "During the task, I had thoughts of personal worries" and "During the task, I was

[4] Apart from this self-reported measurement, to increase the possibility to know whether an individual mind-wandered, I also video-taped each participant in order to count the times in which the person seemed to think about something unrelated (e.g. looking around, standing up, closing the eyes, touching objects in the room). In the end, these data were not analysed for the present report.

daydreaming about myself" (from 1 "Never" to 5 "Very often"). An exploratory factor analysis (Principal components with Varimax Rotation) extracted two factors: one represented the extent to which the subjects were distracted ("MW - Distraction", $\alpha = .89$) and the other represented the extent to which the subjects thought about something different from the creative task during the experiment ("MW - Other thoughts", $\alpha = .80$). The initial eigenvalue for the first component (MW - Distraction) was 5.84, with 48.69% explained variance and for the second component (MW - Other thoughts) these values were 1.41 and 11.73%, respectively. Two items did not seem to belong to any component and they were, therefore, deleted ("While reading the task instructions, I found I haven't been thinking about the text and must therefore read it again" and "During the creative task, I had thoughts of how much time I have left"). The Rotated Component Matrix, generated by the SPSS software, can be found in Appendix 1.

Creativity. The creativity measurement was based on the originality and usefulness of the ideas generated in the Alternative Uses Task. To measure creativity, two coders rated each idea on a 3-points scale: 1 corresponded to an unoriginal idea, something already existing or that give no benefits, not well elaborated or very common among the sample (e.g. "Use balls to play a different sport from ping-pong"); 2 was assigned to ideas that were quite original, not very common in my sample and somewhat feasible (e.g. "Fill a pool of ping-pong balls for kids to play in"); 3 was given to all those ideas which were judged as very original and creative, unique, not existing in reality and well-elaborated (e.g. "Make the balls fluorescent and use them as a danger signal" or "Use the balls to create a model to explain atoms and molecules to science students"). The level of agreement between the two coders was acceptable and significant ($\kappa = .54$, $p<.001$). Afterwards, for each subject, I measured the average creativity score across all creative ideas, the fluency (number of relevant answers generated), and the number of good ideas (ideas which were given 3 as a score).

RESULTS

4.1 Manipulation check

First I checked if the manipulation of the independent variable worked. I asked people whether they found the room messy or tidy using the following items: "The room was tidy" and "The room was quite messy" (from 1 "Completely disagree" to 5 "Completely agree"). To check the manipulation efficacy, I conducted two *t* tests, with condition as independent variable (whether the subject was in a tidy or a messy environment).

The *t* tests showed that for the first item there was a significant difference: $t(71) = -10.62$, $p<.001$. In the messy room, people agreed less with the item that the room was tidy ($M = 1.72$) than people in the tidy room did ($M= 3.97$). For the second item there was a significant difference as well: $t(72) = 17.52$, $p<.001$. In the messy room, people agreed more with the item that the room was quite messy ($M = 4.41$) than people in the tidy room did ($M = 1.62$). Therefore, I conclude that the manipulation was successful.

4.2 Descriptive statistics

The descriptive statistics are displayed in Table 1. Condition was dummy-coded, using code 0 for the messy room and code 1 for the tidy room.

Table 1: Descriptive statistics and correlations between dependent and independent variables

	M	SD	Correlations								
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Condition (dummy)[a]	0.50	0.50	1.00	0.04	-0.25*	-0.27*	0.08	0.08	0.18	0.21+	-0.01
2. Ospan score	45.95	12.89		1.00	-0.10	-0.10	-0.15	0.05	-0.09	0.16	-0.08
3. MW - Distraction	17.32	6.50			1.00	0.60***	-0.23*	-0.32**	-0.20+	-0.11	0.06
4. MW - Other thoughts	6.77	3.29				1.00	-0.16	-0.17	-0.15	-0.15	0.15
5. Average creativity	1.95	0.34					1.00	0.24*	0.83***	0.19	0.00
6. Fluency	7.88	2.14						1.00	0.42***	0.19+	0.00
7. Number good ideas	1.92	1.66							1.00	0.23+	-0.05
8. Openness	45.78	8.96								1.00	-0.05
9. Need for structure	44.20	10.27									1.00

*+ p<.10; * p<.05; ** p<.01; *** p<.001.*

[a] *0 = messy condition; 1 = tidy condition.*

First of all, as can be expected, the two different kinds of mind-wandering correlate with each other. Moreover, there is a significant negative correlation between distraction and all the three creativity variables (average, fluency and number of good ideas). This implies that my reasoning was incorrect, because I expected a positive relation between mind-wandering and creativity. As can be seen in Table 1, the three creativity variables were also positively related to each other. Furthermore, also the condition in which the subject is correlates with mind-wandering, indicating that mind-wandering occurred more frequently in the messy room. Finally, the number of good ideas correlates positively and significantly with openness.

3. Hypothesis testing

To test my hypotheses, five multiple regression analyses have been conducted.

My first hypothesis (H1) stated that the structure of the environment negatively influenced creativity: in the tidy room creativity should be lower than in the messy room. The second hypothesis (H2) investigated the role of mind-wandering as a mediator between the environment structure and creativity. According to H3, WMC would be a moderator in the relationship between the environment structure and creativity, through mind-wandering.

To test these hypotheses, I used the three creativity variables and the two mind-wandering variables as dependent variables (DV) in multiple regressions: the average evaluation of creativity (the mean creativity across all ideas generated by a person), the fluency (number of ideas generated), the number of good ideas generated (ideas which were evaluated with the maximum score), the mind-wandering distraction component and the component regarding the other thoughts. As independent variables (IV), I had condition, dummy-coded with 0 for the messy room and 1 for the tidy room; the Ospan score, Z-transformed, and the interaction between those two (condition and Ospan).

The results of those regressions are shown in Table 2. The table shows unstandardized B with t-values in parenthesis.

Table 2: Regression WMC - Creativity/Mind-wandering

IV	DV				
	Average creativity	**Fluency**	**Number good ideas**	**MW - Distraction**	**MW - Other thoughts**
Condition	0.06(0.72)	0.34(0.68)	0.61(1.58)	-3.15(-2.15)*	-1.74(-2.35)*
Ospan	-0.11(-1.98)+	0.22(0.61)	-0.4(1.43)	0.60(0.56)	0.28(0.53)
Interaction	0.12(1.46)	-0.22(-0.43)	0.46(1.20)	-2.23(-1.51)	-1.14(-1.53)
R^2	0.06	0.1	0.06	0.10+	0.11*

*+ p<.10; * p<.05; ** p<.01; *** p<.001.*

As can be seen in Table 2, condition had no effect on any of the creativity measures. H1 was, therefore, rejected: the structure of the environment did not influence creativity. H2a, predicting a positive relationship between messiness and mind-wandering was confirmed: a messy room led to greater distraction and more thoughts about other things during the task. However, according to the previously reported correlations, a negative relationship was found between mind-wandering and creativity; since H2b predicted a positive relationship, this hypothesis was disconfirmed. Based on these results, the mediation hypothesis, H2, was, as a whole, rejected. Finally, H3 was rejected: there is no moderation effect of WMC on creativity. A messy environment did thus generate more distraction, but this relation is not moderated by WMC, as you can see from the Ospan regression results. Finally, and unexpectedly, the regressions revealed that WMC was negatively related to average creativity.

The conclusion is that all the hypotheses have been rejected. I can only confirm that working in a messy room increased mind-wandering, but the messiness of the room did not have any effects on creativity, nor did these effects depend on WMC.

4. Exploratory analysis

Given that WMC did not moderate the effects of environmental structure, I further explored whether creativity was related to openness and to need for structure and how these two variables interacted with the environment structure. Openness has been shown (McCrae & John, 1992) to be

a creativity-related personality trait and need for structure in contrast may have a negative influence on creativity (Rietzschel et al., 2007). Furthermore, people high in openness may respond more positively to messiness and benefit more from it than people low in openness. This would be due to their higher or lower, respectively, appreciation of variety, originality and unconventionality. Conversely, high need for structure might have a negative influence on people in a messy condition: they may have more problems in dealing with messiness than people low in need for structure. Messiness, for people who need structure and order, gives too many stimuli and no benefits. Because of these reasons, I analysed the effects of those traits on my dependent variables.

First, I conducted a regression analysis using creativity (average, fluency and number of good ideas) and mind-wandering as dependent variables (DV) and the dummy-coded condition, openness (Z-transformed) and their interactions as independent variables (IV). Secondly, I replaced openness with need for structure (Z-transformed) leaving all the other variables unchanged.

The results are shown in Table 3 and in Table 4.

Table 3: Regression Openness - Creativity/Mind-wandering

IV	**DV**				
	Average creativity	**Fluency**	**Number good ideas**	**MW - Distraction**	**MW - Other thoughts**
Condition	0.02(0.20)	0.13(0.25)	0.42(1.07)	-2.86(-1.87)+	-1.60(-2.08)*
Openness	0.04(0.80)	0.25(0.85)	0.23(0.99)	0.05(0.05)	-0.24(-0.54)
Interaction	0.10(1.03)	0.55(0.94)	0.40(0.89)	-1.63(-0.93)	-0.24(-0.28)
R^2	0.05	0.05	0.08	0.08	0.08

*+ p<.10; * p<.05; ** p<.01; *** p<.001.*

Table 4: Regression Need for structure - Creativity/Mind-wandering

IV	DV				
	Average creativity	**Fluency**	**Number good ideas**	**MW - Distraction**	**MW - Other thoughts**
Condition	0.05(0.66)	0.35(0.70)	0.59(1.57)	-3.18(-2.13)*	-1.74(-2.35)*
Need for structure	0.05(0.97)	0.14(0.42)	0.24(0.95)	0.47(0.48)	0.31(0.63)
Interaction	-0.12(-1.47)	-0.34(-0.65)	-0.76(-1.96)+	-0.18(-0.12)	0.43(0.57)
R^2	0.04	0.01	0.09+	0.07	0.10+

*+ p<.10; * p<.05; ** p<.01; *** p<.001.*

The results showed no effects of openness on creativity or mind-wandering, and no interactions between openness and condition. Need for structure had no significant relation with creativity. Only the interaction between need for structure and condition on the number of good ideas was (marginally) significant. This interaction is shown in Figure 4. As can be seen in the Figure, need for structure had a negative relation with the number of good ideas in the tidy room, but no effect in the messy room. Phrased differently, the number of good ideas was low in a messy room regardless of need for structure, and higher in the tidy room but only for those participants who were low in need for structure.

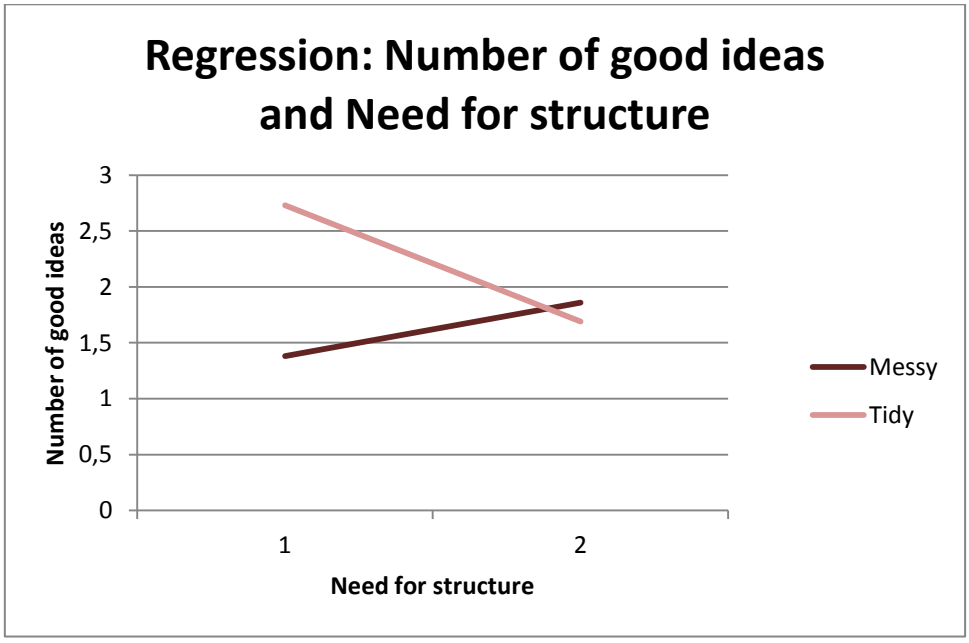

Figure 4: Number good ideas/Need for structure regression graph

DISCUSSION

The aim of this thesis was to find out whether messiness of the environment leads people to be more creative and why and for whom this is the case. Vohs et al. (2013) have obtained evidence that messiness can increase creativity, and they attributed that finding to the unconventionality of a messy environment. I hypothesized that mind-wandering would be a mediator between environmental structure and creativity. Distraction could increase in a messy room because of the larger amount of relevant stimuli and this, in turn, could lead to the generation of more and more creative ideas. This reasoning was based on the assumption that defocused attention and random cognitive processes occurring during distraction could lead to greater creativity because of the generation of more associations which are more original and less closely related to existing ideas (e.g. Dietrich, 2004; Martindale, 1999; Dijksterhuis & Meurs, 2006; Friedman and Forster, 2005; also see Nijstad et al., 2010). Finally, with the purpose of finding out what kind of people could be more influenced by the messiness in generating creativity, I analysed Working Memory Capacity as a potential moderator of these effects. I based my reasoning on the executive attention theory of WMC (Engle & Kane, 2004) that argues that individuals relatively low in WMC are less strict in the selection of stimuli entering their mind. Because of this, they will engage in mind-wandering more frequently when in a messy environment. Therefore, my third hypothesis was that the effects of messiness on creativity would be more pronounced for low WMC individuals.

5.1 Summary of results and interpretation

Concerning the first hypothesis, I expected to replicate results by Vohs et al. (2013), that messiness of the environment (a low structure of the room) leads to more creativity. This idea was, instead, disconfirmed: there was generally no relation between messiness and creativity, and this relation was not moderated by WMC. This failure to replicate potentially implies that the results found by Vohs et al. (2013) are not very robust. Alternatively, the diverging results may be due to differences

between the experiment reported by Vohs et al. and the present study. For example, participants of the present experiment belonged to a different population, and cultural differences may have played a role.[5] Another reason could have been that the participants were required to complete a very demanding test, the Ospan, before the creative task: this could have undermined their performance. However, speaking against this possibility is that the level of tiredness was assessed after completing the Ospan task and before the creativity task, and tiredness was not associated with measures of creativity (see Footnote 2). Finally, participants in the present experiment often reported that they felt time-pressured, and indicated that ten minutes were not enough to concentrate on their task. Potentially, this may have undermined the beneficial effects of messiness for creativity.

As regards the second hypothesis, messiness of the room led to more distraction, as expected in H2a, but mind-wandering was negatively related to creativity. This negative relationship between mind-wandering and creativity was unexpected and inconsistent with H2b. Subjects in the messy room reported more mind-wandering, but, because messiness had no influence on creativity, mind-wandering did not mediate the effects of messiness on creativity and H2 must, as a whole, be rejected: mind-wandering is not the factor that can explain the positive relationship between messiness and creativity. Rather, it was found that messiness increased mind-wandering, and mind-wandering undermined creativity. It seems possible that messiness has two contradictory effects on creativity: it may, on the one hand, stimulate unconventionality (as argued by Vohs et al., 2013), but on the other hand it may also increase distraction which undermines creative performance.

Regression analysis further showed that WMC did not have any effects on mind-wandering and creativity, and that WMC did not moderate the effects of environmental messiness. It is surprising

[5] I analyzed the correlations between gender and creativity and between nationality and creativity. Gender did not show any significant results. Concerning nationality, I coded Dutch subjects with 0 and all the others with 1. Nationality correlates positively with creativity, meaning that people with a non-Dutch nationality had more creative ideas than Dutch people had ($r = 0.25$, $p<.05$).

that WMC was unrelated to creativity, given that previous work has established a positive relation (De Dreu et al., 2012). An hypothetical reason for this absence of effects is that the Ospan test was too tiring for the participants: they completed it before the creative task and, afterwards, this tiredness could have led them to generate few creative ideas. In particular, it might be that tiredness impeded the use of the persistence pathway of the Dual Pathway to Creativity Model (De Dreu et al., 2008). Previous work has shown that WMC is related to creativity through increased persistence (De Dreu et al., 2012), and given that persistence requires executive control, it may be the case that tiredness after completing the Ospan task negatively affected especially high WMC participants. Alternatively, the variation in WMC in the current sample may have been limited (given that participants were university students, who can generally be expected to have relatively high WMC), or the sample size may have been too small to establish an effect (e.g., the interaction between WMC and messiness).

Finally, for exploratory reasons, I analysed the results of openness to experience and need for structure, two personality traits that have been shown to be related to creativity. Openness was expected to correlate positively with creativity (McCrae & John, 1992), but, instead, did not show any significant results in the regression analysis. Furthermore, need for structure, that has been previously proved to be sometimes negatively related to creativity (Rietzschel et al., 2007), did not show correlations with creativity either. Only one interaction between need for structure and condition was (marginally) significant: people who had a low need for structure and were in a tidy room generated more creative ideas, whereas in the messy room creativity was low regardless of need for structure. My results could have been undermined by the fact that the messy room was too confusing and distracting, even for those people who usually do not require high structure.

5.2 Implications

The importance of creativity for human beings is beyond doubt: creativity is connected to human cognition, language abilities, mental schemes, organisation of our cognitive experiences, thinking,

decision making and problem solving (Nijstad et al., 2010; Ward, Smith & Finke, 1999). It has long been studied in various fields (business, art, culture) because of its relevance for our physical and mental survival and improvement (Simonton, 2003). As a consequence, many studies have been conducted to determine what could predict creative performance. My thesis had the objective to help the literature forward, by examining environmental structure and mind-wandering in relation to creative performance.

Although not relation was found between environmental messiness and creativity, this research has several implications. First of all, I would like to stress that it is not only important to confirm hypotheses, but also the empirical rejection of an idea increases the scientific knowledge about a topic. In particular, the disconfirmation of my first hypothesis (a positive association between messiness and creativity) is worthwhile, because it suggests that this effect may not always occur, and more research is needed to delineate when a positive effect can be expected and when not (or even negative effects).

Theoretically, it is interesting that messiness increased mind-wandering, and that mind-wandering was negatively associated with creativity. There are theories which affirm that creativity may occur during daydreaming (e.g. Dietrich, 2004; Martindale, 1999) or during distraction (Dijksterhuis & Meurs, 2006). Friedman and Forster (2005) proposed that creativity is originated by defocused attention and unsystematic random processes. Moreover, the latent inhibition theory (Lubow, 1989) also states that people who do not filter out some irrelevant stimuli generate more creative ideas. Apparently, this is not always the case. Distraction can undermine creativity. Instead, some other theories, the Dual Pathway to Creativity Model (De Dreu et al., 2008; Nijstad et al., 2010; Baas et al., 2008) in particular, argue that creativity actually requires concentrated effort (e.g., the persistence pathway). My results are more aligned with this latter idea.

From a practical point of view, my thesis indicates that cultivating a messy environment may not always stimulate creativity. People in a messy environment were more prone to be distracted and

distraction was not always a benefit to increase creativity. Therefore, people managing organisations, designing internal work environments, or deciding upon the environment structure in general should be aware of this negative effect. Organisations aiming at reaching creativity and innovation increments should be careful with keeping the work environment messy. There is no clear and demonstrated effect of messiness on creativity yet: researchers cannot be sure about the benefits of messiness. This thesis suggests that sometimes messiness can lead, as a side effect, to distraction, and this may undermine rather than stimulate creativity.

5.3 Limitations and future research

Given that my initial hypotheses were almost all disconfirmed, I focus here on some limitations that could be the reasons for such a conclusion. One limitation concerns the influence of the lab setting on performance. In my case, participants could have considered it strange to be in the experimental room, especially in the messy condition, and this may have affected my results. Further, the messiness in my setting had no specific logic. It was different from the messiness to which we are used to because we created it ourselves. Indeed, it may be the case that our own “personal mess” has different consequences for creativity than an artificially created one. To address this limitation, future research could let the participants create their own "personal mess", for example by giving people the possibility to arrange personal items in the room where they are required to express creative ideas. The problem with this "personal mess" manipulation is that the setting would differ for each subject, introducing many other factors that could potentially influence creativity.

Moreover, it is potentially problematic that the manipulation schedule was previously arranged: I decided at the beginning in which days the setting was going to be messy and which days tidy. For this reason, the subjects were not really randomly assigned to conditions, but they were assigned to conditions depending on the day they signed up to do the experiment. This could have influenced

randomization and outcomes. This problem would have been avoided if it had been possible to use two rooms instead of just one. Another limitation is that the sample included only students. The doubt is, then, whether it is possible to generalize results to the other populations. One specific problem is that university students may have relatively high WMC, and this could potentially have affected results. Of course, to solve this issue would require selecting external subjects who represent the whole population, but this would be, unfortunately, very costly and time consuming for the researcher.

Regarding specific issues of my experiment, as I stated before, the Ospan test, used to measure WMC, was described by many participants as a very tiring instrument. It requires to do mathematical calculations while keeping in mind a string of letters that randomly appear on the computer screen. A possible explanation for the lack of relevant results could be, then, that subjects were so tired that they could not concentrate well on the task or let new creative ideas or associations come to their mind. It is worth to notice, however, that subjects were required to self-report their level of tiredness both before and after the creative task, but tiredness seemed not to be correlated to creative performance. I would advise researchers using the Ospan test to conduct it in a separate session, in order not to have any possible factor influencing the main dependent variables.

Finally, a possible limitation could be the short time allocated: participants had only ten minutes to complete it. I noticed that, for many of them, this time was not enough to write down all the ideas they had in mind. Some others self-reported that they felt a lot of time pressure during the task, or they explicitly said that the time was not enough to have a good creative performance or that they did not see the point of thinking about the possible new uses for ping-pong balls, so the task did not involve them well. Future researchers should try to address all these issues by giving more time to generate ideas or by providing people with more interesting creative tasks, in order to involve subjects more deeply into the test.

To conclude, the absence of a link between the structure of the environment and creativity leaves room for further research and for a possible replication of this study. Also, the mediation of mind-wandering and the moderation of WMC seem interesting and need to be replicated. Another factor that could be addressed in future work is need for structure and personality in general. As an additional future research suggestion, I would study the same topic from another point of view and with completely different methods. More specifically, I would select people who are objectively judged as creative because of their daily life job (e.g. designers, architects, chef cookers, artists, writers, etc.) and I would ask them to work either in a messy or in a tidy setting, for a longer period of time. The objects in the setting should be freely chosen by the subjects themselves. Furthermore, I would ask them to report their level of distraction, subsequently, in an unstructured interview, using qualitative methods. Finally, in order to know whether they worked better in the messiness or in the tidiness, I would ask other people to separately judge the level of creativity of the participants. I believe that this further study would address all the limitations I faced and lead to more interesting findings on the topic.

5.4 Conclusions

In conclusion, I can conclude from this thesis that messiness of the environment leads to distraction. However, there was no evidence for the expected positive effect of messiness on creativity. Therefore, people should be careful when opting for a messy work environment, if their aim is generating creative or highly innovative outcomes. Organisational managers should also be aware of this effect of messiness on mind-wandering, and the potential negative implications for employee creativity.

Despite the results obtained, I am still not fully convinced by the fact that messiness has only the negative power to distract people. I tend to think that there are people who are more able than others

to exploit messiness to help their creativity. Otherwise it would be difficult to explain why some of the most important artists and creators work in a complete chaos. I hope some future research will be done in order to give a possible answer to this famous Albert Einstein's question: "If a cluttered desk is a sign of a cluttered mind, of what, then, is an empty desk a sign?".

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Appendix 1: Mind-wandering Rotated Component Matrix

Rotated Component Matrix

	Items	Component 1	Component 2
MW1	During the creative task, I had difficulty in maintaining focus on the task.	,692	,090
MW3	I did the creative task without paying full attention.	,819	,091
MW4	I found myself thinking about the creative task and about something else at the same time.	,802	,287
MW5	I mind-wandered during the creative task	,742	,240
MW6	During the creative task, my mind was wandering a great deal.	,619	,205
MW7	My attention was directed towards the task.	-,686	-,309
MW12	During the creative task, I was daydreaming about myself.	,615	,473
MW14	It was hard for me to keep my mind from wandering during the creative task.	,688	,394
MW8	During the creative task, I thought about something that happened earlier today.	,097	,757
MW10	During the creative task, I had thoughts of personal worries.	,187	,823
MW11	During the creative task, I was reflecting about myself.	,337	,630
MW13	During the creative task, I thought about personal concerns and interests.	,289	,801