Daydreaming and Creativity

Effects of task related and task unrelated mind wandering on the production of original and useful ideas

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Abstract

This research argues that creativity is influenced by the dynamic interplay of task unrelated mind wandering, task related mind wandering, originality and usefulness. It was expected that task related thoughts would positively relate to both the originality and usefulness of ideas, while a positive relation between task unrelated thought and originality was also taken into consideration. A sample of 116 students from Tilburg University participated in a creative design experiment that included a divergent and a convergent phase, where in total 783 ideas were generated and evaluated. Even though both hypotheses were rejected, the study provided new gains and insights in creativity research. Moreover, the distinction between originality, usefulness and different types of mind wandering prove to be fundamental for a better understanding of the relation between daydreaming and creativity. Implications for future research are also discussed.

1. Introduction

Different definitions and interpretations of daydreaming and mind wandering have emerged from past research. In this paper both terms will be treated similarly as being equal to one another as current study considers daydreams to be wandering minds and wandering minds to be daydreams. The term daydreaming is associated with multiple disadvantages, according to most studies (McMillan, Kaufman, Singer, 2013). However, since mind wandering occupies nearly half of our waking time (Killingsworth & Gilbert, 2010), it seems plausible that the outcomes of this kind of mental imagery are not solely negative for a person's condition. As a matter of fact, the most investigated association with daydreaming is the impact of a wandering mind on human creativity (add a few references here to support your claim regarding high frequency of research).

The process of creative thinking refers to the sequence of cognitive activities that can result in novel, yet useful products in a given problem context (Lubart, 2000–2001). Several studies found that daydreams or wandering minds, preceding tasks or cognitive problem solutions, can enhance creativity (references). When someone is daydreaming, the person engages in sudden thoughts that are not related to the current context (Zedelius & Schooler, 2016), while mind wandering has been described as daydreaming that takes place during the performance of another task. It is essential to distinguish between alternative styles of mind wandering and different stages in the creative process to fully understand the relationship between the phenomena of daydreaming and creativity (Zedelius & Schooler, 2016).

Present-day research falls short on taking into consideration that daydreams vary in style and content (Zedelius & Schooler, 2016). A novel perspective on the creative process emphasizes the importance of the mechanisms trough which different types of daydreams can facilitate several distinct creative processes. The cognitive process underlying mind wandering can be divided into task related thought and task unrelated thought. Task unrelated thinking entails thought directed away from the current situation (Smallwood, Obonsawin & Heim, 2003); for example, a daydream about a memory of a certain holiday in the past. Task related thinking also consist of self-generated thought, but involves a certain degree of relevance with regard to the task. This task related train of thought can involve cognitive processes, such as brainstorming for a certain solution or strategy in order to achieve the task (Smallwood, Obonsawin & Heim, 2003). In general, task related thought refers to both the focus on the task and task related mind wandering. However, current research uses the terms task related thoughts (TRT) and task unrelated thoughts (TUT) for different

types of mind wandering. The other form of task related thought, will be stated as task focus related thought in this paper. Thus, task related thought refers to task related mind wandering, indicating task related and self-generated thought with regard to the task. More specifically, when you catch yourself daydreaming or mind wandering about the task and not when you are deliberately focusing on the task solution/idea. An example of task related mind wandering is '*GRR!?! What is the point of this task?*' (Smallwood & Schooler, 2015). The goal of this study is to investigate whether there is a difference in output in creative ideas, when people are mind wandering task related or task unrelated. Thus, this research focuses on the possible difference in creative solutions, depending on the type of mind wandering.

Despite the existence of multiple definitions of creativity, according to a wide range of research on the creative process, it entails people who use their knowledge and expertise to rely on their cognitive capabilities to create outcomes (ideas, insights, products) that are both original and useful (Baas & Maas, 2015). This broad process definition of creativity distinguishes between creative outcomes, the role of expertise, knowledge and cognitive skills. A comprehensive review of past literature reveals that the key cognitive processes held to contribute to creative thinking can be summarized in four phases: problem analysis, idea generation, evaluation, and implementation (Zeng, Proctor & Salvendy, 2011). Although creativity seems an abstract phenomenon, there are two key elements considered essential for a creative prediction; originality and usefulness (Sternberg, 1999; Diedrich, Benedek, Jauk & Neubauer, 2015). For a creative product to be useful within a business context it must also adequately tackle real-world issues that occur in several industries.

However, there are practically no creativity tests that measure both originality and usefulness within the frame of creativity (Baas & Maas, 2015). Studies that found a positive relationship between daydreaming and creativity mostly experimented with psychometric tasks, but creative problem solving requires a lot of processes that are not covered by these psychometric tasks. A study by Zeng, Proctor and Salvendy (2011) even concluded that the traditional divergent thinking tests are a weak indicator of real-world creativity. The problem that arises from this is the low external validity of the previously used tests in past and contemporary research. A skeptical view on past research might question what we really know about the relation between mind wandering and creativity. Previous studies have shown a relation between mind wandering and creativity, but the applied tasks of measurements have their shortcomings.

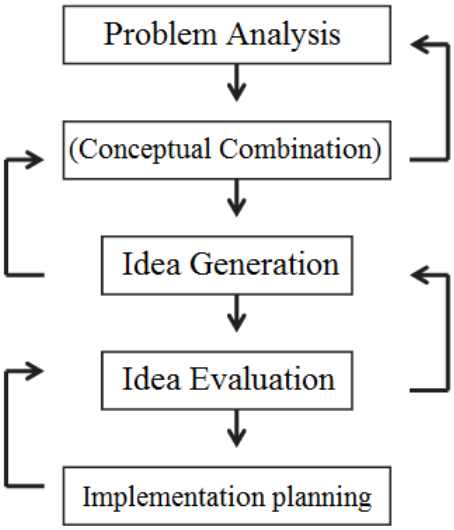
This study aims to investigate the creative output in terms of both originality and usefulness after a period of task related and task unrelated thoughts. The problems to be solved will demonstrate a creative design task and the evaluation of the output will be done through Maximum Difference Scaling (MaxDiff) by domain experts. This form of analysis by experts in the field will assess the creative output of the results in terms of originality and usefulness. The current study strives towards a scientific contribution that helps individuals to get the most out of their own creative capabilities. A high level of external validity is necessary for the reflection of the creative output on real-world problem solving. Creativity is characterized by originality and usefulness, but it is the latter aspect that determines whether the idea can actually be applied on a societal level. The current study aims to address the following research question:

Is there a relation between task related and task unrelated daydreams and the originality and usefulness of creative design ideas?

2. Theoretical Background

The production of creative ideas involves multiple cognitive processes. Despite the existence of cross-domain differences in the influence of particular process operations, creative thinking involves four key processes: problem analysis, idea generation, evaluation, and implementation (Zeng, Proctor & Salvendy, 2011). The process of conceptual combination might also play an important role, since knowledge emerges from conceptual combination that allows for idea generation and evaluation (Mumford, Medeiros & Partlow, 2012). This study emphasizes the processes of idea generation and idea evaluation and is congruent with the notion that it is not sufficient just to generate ideas. Ideas must also be evaluated and solutions in a problem context should be based on these ideas (Basadur, Runco & Vega, 2000; Osburn & Mumford, 2006). While in theory it is argued that generation and evaluation are executed sequentially, it seems more likely that the creative process has a more reciprocal nature. This means that individuals go back and forth between the processes for the production of creative problem solutions and ideas. When the current process is intermitted or interrupted, it can have consequences for the execution of the other cognitive process. When a wandering mind hinders, interrupts or distorts the cognitive step(s) during creative thought, this might result in consequences for the creative process and idea production as a whole.

The distinction of multiple cognitive processes during creative thought gave rise to current model based on earlier work (Mumford, Mobley, Reiter-Palmon, Uhlman & Doares, 1991; Mumford et al., 2012). This model assumes that creative thought begins with a problem analysis where the problem is defined, information is gathered and concepts are selected to understand the information. These concepts enable a fundament for conceptual combination, which elicits new knowledge that allows for idea generation and evaluation. When viable ideas have emerged, implementation planning takes place with individuals conveying their ideas in a real-world problem context. Ideally, the final output entails original and useful problem solutions of applicable nature.



Idea generation and idea evaluation

A core aspect of the creative process is the ability to generate ideas (Aurum & Gardiner, 2003). The process of generating ideas addresses partly to divergent thought. Divergent thinking refers to the thought process when exploring many possible solutions to come up with original ideas. Divergent thinking should not be viewed the same as creative thinking, because divergent thinking results in originality and originality is a main characteristic of creativity (Runco & Acar, 2012). Therefore, divergent thought serves as an indicator or predictor of creative potential. Several studies (Moore, 1985; Runco & Okuda, 1988) have investigated the relation between problem solving and divergent thinking. Razoumnikova (2000) suggested that during divergent thought people use lots of unique ways to generate creative products. Due to the broad and widespread nature of divergent thinking it occurs in the early stages of creative thought processes, the phase of idea generation. An individual is considering as many (unconventional) options possible during divergent thought before choosing a definite solution. Many scientists (from Aristotle to present day) have claimed that the development of thinking includes moving from one idea to another via a chain of thoughts and associations (Aurum & Gardinder, 2003). An individual's capacity for solving a problem can therefore be explained by their capacity for generating associations. Brainstorming is an example of a process that involves divergent thinking by generating and combining concepts through possible associations.

The process of evaluating ideas involves more than deciding whether an idea is good or bad. There is a relation between evaluating ideas and producing ideas and it has been found that idea evaluation is linked to the production of creative problem solutions (Dailey & Mumford, 2006). In contrast to idea generation, idea evaluation requires a convergent train of thought. Convergent thinking refers to "the process of generating one possible solution to a particular problem" (Colzato, Ozturk & Hommel, 2012: page); i.e., the moment when possible ideas and problem solutions are evaluated. The main characteristics of convergent thought are speed, high accuracy and logic (Colzato et al., 2012). In contrast to the divergent process, convergent thinking relies on stereotyped mental operations that converge on only one task solution (Razoumnikova, 2000). In other words, the difference between the cognitive processes is that one concerns the "production of variability", while the other involves the "production of singularity" (Cropley, 1999). During the convergent phase, an individual is oriented towards deducing the single best option to a raised problem from the available or stored information. For example, when choosing the final solution after generating multiple ideas in the preceding divergent phase.

Daydreaming and mind wandering

Since daydreams or wandering minds can occur at any moment, they might influence the process of creative thinking and its consequences regarding creative problem solutions. Similarly to creativity, mind wandering is not a unitary concept. Mind wandering is multidimensional and can vary in thought content, affective tone and style of thinking (Zedelius & Schooler, 2016). Studies have defined mind wandering as a mental break or "a situation in which executive control shifts away from a primary task to the processing of personal goals and often occurs without intention or even awareness that one's mind has drifted" (Smallwood & Schooler, 2006). Empirical research has indicated that almost half of our everyday thoughts can be categorized as mind wandering and the drifting of the mind appears to occur repeatedly in all sorts of daily life activities (Killingsworth & Gilbert, 2010), such as driving, working, showering and even during conversations. The tendency to mind wander is customary to many different cultures or individuals and the frequent extent of these 'zone-outs' rather implies it to be normal instead of an abnormal or deviant part of the human cognition (Smallwood, 2015). The question remains whether mind wandering serves functional or dysfunctional purposes with regard to creative production. The first step in this investigation is distinguishing between different creative processes and varying styles

of mind wandering (Zedelius & Schooler, 2016). This study entails the central belief that the processing that occurs during a mind wandering episode can be adaptive in a given context. In other words, certain types and characteristics of mind wandering can fit or match with a process that enhances a creative activity.

Researchers consistently make a prominent distinction between task-related and task-unrelated thoughts to define the nature of mind wandering (McVay & Kane, 2012). Task unrelated mind wandering is generally understood in terms of a shift of executive control away from a primary task to the processing of self-generated thoughts related to personal goals (Baird, Smallwoord & Schooler, 2011) or memories. This drifting process is broadly conceptualized as containing two phases: (1) an onset phase, which consists out of the initial shift from focus on task to focus off task, and (2) a maintenance phase, characterizing the cognitive experience and length of action of the off-task period (Smallwood, Tipper, Brown, Baird, Engen, Michaels & Schooler, 2013). In other words, when engaged in a task, someone's personal attention is directed to information that is not promptly observable in one's current environment. This makes the thoughts unrelated to the demands of the current task or moment, enabling an unlimited amount of freedom for a person to go beyond information in the immediate perceptual context (Baird, Smallwood & Schooler, 2011). Furthermore, the spontaneous nature of task unrelated thinking seems to make it unpredictable in occurrence, while the content of thought typically revolves around current goals (Baird et al., 2011). The shift in attention may reflect a situation in which conscious awareness becomes somewhat detached from the processing of external information (Kanwisher, 2001; Merikle, Smilek, & Eastwood, 2001).

By contrast, task related thinking is characterized as thought maintained on the primary task at hand, which means that the cognitive process contains attention towards and for the sake of the task (Randall, Oswald & Beier, 2014). Task related mind wandering is also considered task related thought, as it refers to a self-generated thought concerning the primary task. For example, when someone starts thinking about how boring or annoying a task is, it is considered a task related mind wander (Smallwood & Schooler, 2015). In this case, the person is not thinking about the task with the intention to solve the problem. There is no task focus, while the self-generated thought is task related. Therefore, note that current research distinguishes between task unrelated thought (TUT), task related thought (TRT) and task focus related thought, where TUT and TRT refer to mind wandering.

Synthesizing cognition with creativity

The mismatch between adaptive characteristics associating the two types of mind wandering and underlying idea generation and evaluation might lead to the emergence of ideas that are both useful and/or original. Both the costs and advantages of mind wandering have been thoroughly researched in the past and the same goes for the many studies concerning the creative process. Mumford, Medeiros and Partlow (2012) have investigated the creative processes trough tasks regarding the invention and development of marketing strategies/campaigns for a certain service or product. Mind wandering studies resulted in contradicting conclusions regarding the relationship between task unrelated mind wandering and creativity. Hao et al. (2015) predicted that task unrelated mind wandering during the course of creative idea generation may have negative effects on creativity, unlike the positive effects of task unrelated mind wandering in the incubation period on creativity (Baird et al., 2012). Task unrelated mind wandering has been implicated in the creative process and is linked to larger working memory capacity (Levinson, Smallwood & Davidson, 2012). Also, task unrelated thoughts have been associated with poor performance on the primary task of the moment, including errors while reading and other cognitive flaws under laboratory conditions (Smallwood, Ruby & Singer, 2013). However, the majority of mind wandering studies used psychometric tasks (e.g. Alternative Uses Task) and mainly focused on originality, while Mumford (and colleagues) did not take task unrelated thoughts or task related thoughts into consideration during the performance of the experimental tasks. Current research is the first study to examine the effects of task unrelated thoughts and task related thoughts on the originality and usefulness of a creative problem solution with the use of Maximum Difference Scaling by a panel of expert judges. Given the varying views and emphasizes on characteristics of the mind wandering state, it seems acceptable to derive contradicting predictions about the effects of mind wandering.

Considering the nature of task focus one might think that this cognitive process is more effective for both idea generation and evaluation during a problem-solving task. With regard to task performance, more than a decade of studies have reported the negative effect of task unrelated mind wandering in a wide range of varying task related situations. This corresponds to findings of past research (McVay & Kane, 2009; Smallwood, Baracaia, Lowe, & Obonsawin, 2003) where task focus related thought contributed to performance, while task unrelated thoughts drew away

from it. Whether individuals engage in task related, task unrelated or task focus related thoughts depends on the complexity and length of the task and subjects' working memory capacity. People with fewer cognitive resources tend to engage in more mind wandering, while those with more cognitive resources are more likely to engage in task related thought (Randall, Oswald and Beier, 2014). These findings support the study by Levinson, Smallwood and Davidson (2012), who established that task unrelated thought increases with increasing working memory capacity when the task is low-demanding on working memory resources. Conversely, a task related cognitive process might prevent task unrelated thought, at an early stage, by making it unavailable for mental illustration through working memory. The goal-oriented focus of generating and evaluating solutions/ideas for a specific problem implies that a task unrelated shift of attention will only hinder the process. On the other hand, task unrelated thought is not restricted by the boundaries of the task and might allow greater variation in idea generation. You need a bridge to the next section here.

Creativity divided into originality and usefulness

This study investigates the effects of mind wandering on the creative process by focusing on the two key elements of creativity; originality and usefulness. Creative output should be a product that is both novel and of useful value (Horn & Salvendy, 2006; Paulus, 2000; Runco & Charles, 1993; Zeng, Salvendy, & Zhang, 2009a). Apart from looking at the influence of mind wandering on creativity as a whole, it is important to explore whether task unrelated and task related wandering minds during specific parts of creative thinking have an impact on originality and usefulness. More accurate and valid findings are likely to arise from the dichotomy between generation and evaluation, since novel ideas are produced during generative phases and their actual utility assessed during subsequent evaluative phases (Ellamil, Dobson, Beeman & Christoff, 2012). The characteristics of idea generation and idea evaluation share a resemblance with the two key elements of creativity: originality and usefulness. The generation of many unique possible ideas/solutions to a creative problem indicates the nature of originality, while the critical evaluation of the ideas produced that requires speed, accuracy and logic (Colzato et al., 2012) addresses to usefulness. In theory, the two cognitive operations are usually executed as a fixed sequence, where divergent thinking (generation) takes place before convergent thinking (evaluation) (Hommel, 2012). However, in reality alternation occurs as well

in the form of instantly evaluating generated ideas while new ideas can emerge in the phase of evaluating other ideas. The awareness of the predominance of originality and usefulness is congruent with the reasoning of creative realism with regard the framework of business and industry (Finke, 1995). In addition, when creative output is novel, but odd, bizarre and serves no practical purpose in actuality, it shouldn't even be considered really creative at all (Zeng et al., 2011).

Measuring creativity

Various attempts to test and measure one's creative potential, i.e., the ability to turn expertise and knowledge into creative performances by the use of cognitive skills (Baas & Maas, 2015), have been made in the past. The vast majority of past and present-day research in testing and measuring creativity has been derived from psychometric tasks in the form of divergent thinking tests. However, these psychometric methods of measuring creativity have their weaknesses with regard to external validity and practical value (Zeng et al., 2011). A prominent limitation of the psychometric approach is that it does not cover all processes of creativity. Creativity should be understood in terms of several distinct processes (Zedelius & Schooler, 2016). In creative cognition there may be a diverse set of mental processes that can influence creativity under varying circumstances (Zeng et al., 2011). This study's perspective on the general creative process consists of four dominant phases: problem analysis, idea generation, evaluation and implementation (Howard, Culley & Dekoninck, 2008: Zeng, Proctor & Salvendy, 2011). The processes of analysis and evaluation have received little attention or no attention at all in psychometric studies concerning creativity. One's creative abilities would be more validly and reliably tested when the final solutions would be based on all noteworthy creative processes, instead of a restricted amount of mental phases (Zeng et al., 2011). Another weakness of the broadly used and traditional psychometric tests within the frame of divergent thinking is the unreliable predictive validity for real-world problem solving. The main reason for this is the fact that the requirement for originality is present in available creative thinking tasks, while the aspect of usefulness is widely ignored in divergent thinking studies (Zeng et al., 2011). The way psychometric tasks are executed may exaggerate particular effects that are misinterpreted as an effect on creativity. For example with the alternative use task, where subjects have to think of possible uses for an object, task unrelated thought can be detrimental to divergent thinking or simply cause for less time to generate uses of

a brick under strict time limitations. This experimental setting may not address to real-world creativity at all. In other words, the appropriateness and practical value of a proposed solution to a problem are not considered. Although previous research has focused on the validity and reliability of instruments which establish creativity, there has been little attention to the predictive value of these tools for creative work performance and the creative potential in practice (Baas & Maas, 2015). Therefore the vulnerability of the current psychometric approach lies in the fact that any novel/original idea counts as proof of creativity, regardless how inappropriate it practically is (Zeng et al., 2011).

In contrast to previous divergent thinking studies, measuring creativity that serves the purpose and potential of real-world problem solving requires a different approach. According to Zeng et al. (2011) the problem regarding usefulness as a criterion is that "*tasks in conventional divergent thinking tests do not have innate goals, which is possibly caused by employing abstract and unrealistic tasks*". When basic goals of problem solving cannot be clearly recognized it is not functional to evaluate an idea's appropriateness. To identify fundamental goals, it is necessary to have a clear problem context to measure the actual creativity of interest. The lack of problem context is a prominent issue and makes the external validity questionable in common psychometric tests (Zeng et al., 2011). For example, during a divergent thinking test such as "list as many uses of a pencil as possible," a crazy idea such as "use the pencil to stab a bird" would probably score on fluency, flexibility and originality, since few participants came up with this use. However, this idea would be considered as malevolent, inappropriate and not truly creative in most real-world situations. Yet, it might be appropriate and novel under some extraordinary conditions. To sum up, the majority of psychometric tasks lack a clear problem context with innate goals. Another possible factor is the degree to which the measured divergent skills are relevant to a specific domain in which people generate creative productions (Baer, 1998). It does not seem far-fetched to state that people with domain specific knowledge and expertise will provide more useful creative solutions to a specific problem within that domain. Additionally, Hong (2014) argues that more domain-specific divergent thinking tasks may have more predictive value for creative work performance in real-world settings.

The current constraints in psychometric tasks emphasize the essence for a task that focuses on the external validity of real-world problem solving. The aim of this study is to determine the originality and usefulness of solutions/ideas through a creative design task and evaluate it through

Maximum Difference Scaling. Mumford et al. (2012) point out the importance of understanding the factors influencing creative thinking is useful as it determines guidelines for attempting to enhance creativity in real-world settings. Participants' motivation and beliefs concerning the usefulness are important for dealing with creative problem solutions (Mumford, Decker, Connelly, Osburn, & Scott, 2002). The raised problem should be somewhat challenging and motivating to the individuals confronted with the issue. This perspective is congruent with the work of Dailey and Mumford (2006) who have demonstrated that positive beliefs about operational intentions contribute to creative problem solving. Hong (2014) also emphasizes the importance of creativity-fostering environments to prevent the individuals' interest in creativity from being suppressed. Otherwise it might instigate a situation where the creative spark gets lost. Furthermore, the current research supports the notion that a creativity test regarding problems in a certain domain of interest will strengthen external validity and may be more predictive of someone's creative potential. A typical example is a study regarding creative design by Dorst and Cross (2001), where five design teachers were employed to assess the creative extent of students' ideas and designs for a 'litter disposal system' for a new Dutch train. Therefore, to measure creativity this study will take into account the type of creative task, the cognitive processes of creative production, the domain-expertise, a real-world creative problem context and the distinction between originality and usefulness.

The effect of mind wandering on originality and usefulness

Despite the distinction between task related and task unrelated thought and between idea generation and idea evaluation, both types of mind wandering can occur in each phase. In fact, to test the effects of task related and task unrelated mind wandering on the production of original and useful ideas it is strictly necessary that both forms of mind wandering occur during the convergent and divergent phase. Task related thought is a form of mind wandering, but the content of thought stays 'inside the box' as the drifting mind is still to some degree related to the task. By contrast, task unrelated mind wandering has limitless options when it comes to the content of thought. There are multiple examples of creative insights that occur during complete random thoughts (Baird, Smallwood, Mrazek, Kam, Franklin, & Schooler, 2012) Scientists like Newton, Einstein and Poincaré gained inspirational insights during thoughts that were unrelated to the task or activity at hand. A key question that arises from this notion is whether engaging in any type of mind

wandering increases the chance of creative solutions or whether the thoughts that produce original and useful ideas have particular features. This study approaches creative thinking as a process that consists out of multiple cognitive 'steps' and it questions in what way task unrelated thoughts and task related thoughts influence these steps with regard to the originality and/or usefulness of an idea.

It is relatively easy to give examples of creative ideas that resulted from task focus related thinking (Zedelius & Schooler, 2016). Task focus related thinking refers to thoughts completely in the 'here and now' and therefore related to the task at hand (Smallwood et al., 2003). This can apply to scriptwriters who are generating ideas for a story plot, marketing teams brainstorming for a creative commercial or parents in search for a creative solution to bad eating habits of their children. Approaching task problems with task focus related thoughts is a common way among all individuals and cultures. However, it is less evident whether a mind wandering shift of attention can have an impact on the production of creative solutions. Especially when the subject is not aware of this shift of attention. In other words, might completely self-generated mind wandering influence the originality and/or usefulness of an idea? Current research aims to explore the relationship between mind wandering and creativity and observe the mechanisms through which separate types of mind wandering (task related and task unrelated) facilitate creative processes (idea generation and idea evaluation).

Some creative ideas emerge from the experience of having an insight (Zedelius & Schooler, 2016), which is characterized by the spontaneous nature of the idea that seems to come completely out of the blue. Insights are also described as "Aha!" or "Eureka!" moments (Mednick, 1962; Zedelius & Schooler, 2016). Insight experiences are a result of unconscious associative processing, which seems to share a resemblance with divergent and task unrelated thinking. Zedelius and Schooler (2016) measured a tendency for attentional lapses to assess differences in mind wandering or mindful awareness. The findings indicated that a greater tendency to mind wander was related to insight problem solving. The connecting dots of idea generation, spontaneous thought and insight speak in favor of the possibility that task unrelated thought can contribute to the originality of a creative idea. Thus, having less task related thoughts and being more prone to task unrelated mind wandering can have certain benefits for creative problem solving and especially for using creative insight (Schooler, Mrazek, Franklin, Baird, Mooneyham, Zedelius & Broadway, 2014). Bridge to the next paragraph needed.

A reason to believe that task unrelated thought might improve originality is because ideas are chained together and can suddenly come up in mind through a series of associative processes in semantic memory (Chou, 2016). The meaning of creative production lies in making new associations that are useful and the most fertile ideas are the ones shaped by elements drawn from widely varying domains (Poincaré, 2014). When an individual is mind wandering task unrelated, it seems likely that more different and 'random' concepts can be activated during the cognitive process compared to task related thought. Creative thought may benefit from this associative hierarchy because a dispersed organization of knowledge should increase the possibility of making novel conceptual combinations (Beaty, Silvia, Nusbaum, Jauk & Benedek, 2014). Prior work (Baird et al., 2012) regarding self-generated thought also showed that individuals who engage in daydreaming generate more solutions to creative problems. Although it seems reasonable to expect that generating a higher amount of ideas should lead to a higher number of original ideas, it remains the case that the majority of all ideas generated through this process might be less original (Chou, 2016). Nonetheless, a wandering mind seems more capable of more novel and varying associations compared to a mind focused on the task.

Given the close relationship between mind wandering and executive functions, it can also be expected that task unrelated thought undermines the process of creative idea generation (Hao, Runco & Pina, 2015). The controlled-attention theory of creative cognition states that creative idea generation is a top-down process that requires involvement of executive functions (Beaty, Silvia, Nusbaum, Jauk & Benedek, 2014). Cognitive control processes, such as fluid intelligence, working memory capacity and inhibition have the ability to play important roles in creative thinking. However, the effect of these executive functions can be impaired by task unrelated mind wandering. Mind wandering results from the redirection of attentional resources from the primary task to the generation and maintenance of internal thoughts (Levinson et al., 2012). The resource-consuming nature of mind wandering makes it compete for control resources with the specific target task. Given that idea generation requires a large amount of control resources, mind wandering should impair the performance during idea generation. By contrast, another theory states that instead of recruiting attentional resources, mind wandering occurs as a temporary breakdown in control processes that are necessary for focusing on the task (Kane & McVay, 2012). In this framework, mind wandering definitely decreases the performance on the target task. So, considering the important roles of executive functions in idea generation, it is also not

excluded that task unrelated thought during creative idea generation might have negative effects on creativity.

In the framework of task focus, a greater disposition towards mindful awareness was found to be associated with increased analytic solving (Zedelius & Schooler, 2016). There seem to be similarities between convergent thinking and analytic thought, as it involves "*consciously and systematically searching for an idea or solution and rejecting inadequate ideas*". A convergent phase of thinking also entails evaluating ideas and dismissing all other options until the final solution is chosen with mindful awareness. This thought process is characterized by high cognitive control which enables a deliberate, analytic mode of information processing that facilitates the evaluation of the usefulness of generated ideas (Howard-Jones & Murray, 2003). Additionally, it allows people to focus on the task details and to select the relevant generated ideas (Gabora, 2010). Thus, this train of thought lies closer to idea evaluation and the usefulness of an idea. The aspect of mindful awareness corresponds to task related cognition and supports the expectation that task related thought/task focus has more influence on usefulness of a creative problem solution.

It is possible to state that task focus is more desired in creative problem solving since mind wandering can be disruptive to current goals (Smallwood & Andrews-Hanna, 2013). For example, task unrelated mind wandering interferes with the cognitive models we build while trying to comprehend a text. This might hinder the sufficient completion of a task when someone mind wanders and therefore fails to fully understand a task description. Moreover, in high demanding and complex experimental conditions task unrelated thoughts result in critical disruptions in task performance (Smallwood et al., 2003), including poor reading comprehension and absent mind forgetting. When the external environment demands attention, a person's mind-wandering state is likely to carry risks with regard to performance, cognitive problems or a lack of motivation. Especially in analytical cognitive processes, like idea evaluation, task related thought increases creative problem solving (Zedelius & Schooler, 2015). The attentional control of the executive network adds to the analytical processes that are necessary during creative idea evaluation (Ellamil, Dobson, Beeman & Christoff, 2012). The evaluative components of the creative process seem important for the usefulness of an idea, considering that the actual utility is assessed during subsequent evaluative phases (Ellamil et al., 2012). For idea generation, task focus related thought can boost originality because the mindful attention to a current task reduces the tendency towards

ordinary solutions to a creative problem. Given the nature of insight solving, analytical solving and idea evaluation, it seems likely that the impact of task focus related thought is more effective during evaluation, especially for usefulness.

In this study, we make a clear distinction between task related and task unrelated mind wandering. Their different characteristics may serve as a (mis)match with the cognitive process towards original and useful output. Past creativity research with regard to mind wandering has prominently investigated task focus versus mind wandering. However, while the difference between self-generated + task related thought and self-generated + task unrelated thought has been acknowledged (Smallwood & Schooler, 2015), it has not been thoroughly investigated yet. The question remains what can be expected from the occurrence of the widely researched task unrelated mind wandering and the less investigated task related mind wandering. The main difference between task focus related thought and task related thought in mind wandering (TRT) is that task focus aims on solving the task, while TRT resembles when someone is daydreaming about the task and not deliberately focusing on the task. The expectations concerning TRT and creativity are somewhat related to assumptions in past research (Howard-Jones & Murray, 2003; Gabora, 2010) concerning task focus and creativity. A mind that wanders task relatedly might be less detached from current reality than a mind daydreaming task unrelatedly. It has been shown that instances of task unrelated mind wandering can have consequences for the act of retrieval (Riby, Smallwood & Gunn, 2008). Retrieval of knowledge and cognitive resources can serve as an important asset to work towards a creative problem solution. The fact that task related mind wandering is at least to some extent related to the task at hand might be more beneficial for a solution that fits the problem. This has led to the expectation that task related mind wandering is beneficial for both the originality and usefulness of ideas, even though a contradictory relation between task unrelated mind wandering and originality is ought to be possible as well.

Objectives

By assessing ideas from both generative and evaluative phases, this study aims to determine the relation between mind wandering (task related and task unrelated) and creativity in terms of originality and usefulness. To develop the circumstances for a creative process, participants were exposed to a creative design task within the frame of marketing, social media and Tilburg University. The domain of the creativity task corresponds with the domain-knowledge of the participants to increase the likability of the task and the availability of requisite knowledge. The experiment used an approach closer to real-life creative activities compared to past research studies, which mostly asked participants to only imagine their ideas and designs during creativity tasks. The creative output, in terms of originality and usefulness, is measured by using experts' judgement with the method of Maximum Difference Scaling. In line with Zedelius and Schooler (2016), we emphasize the notion that different types of daydreaming (TRT and TUT) may facilitate creative processes (idea generation and idea evaluation). A positive relation is expected between task related thought and both originality and usefulness, while it is also strongly believed that task unrelated thought might contribute to creativity due to an effect on originality. This has led to the following hypotheses:

H1: Task related mind wandering is beneficial for both the originality and usefulness of ideas.

H2: Task unrelated mind wandering positively influences creativity through an effect on originality.

Method

Sample

The sample used to test the hypotheses consisted of 116 undergraduates attending Tilburg University. The 47 (40,5%) men and 69 (59.5%) women who agreed to participate in the study were recruited from Communication –and Information sciences studies. The sample consisted of 50 Bachelor students, 33 premaster students and 33 Master's students. Within the total group of participants, 93 individuals are from the age group 18 and 24 years old, while 22 participants are between 25 and 34 years old and one person was older than 35 years.

Procedure

Participants were recruited to participate in what was purported to be a study of social media marketing. During the study, participants were asked to work individually on the experimental task. Prior to the task, the participants were kindly asked to leave their mobile phone outside the experiment room. Participants were instructed to develop a social media campaign for Tilburg University - a creative social media campaign to increase the attractiveness of studying at Tilburg University and reach an audience as large as possible. Participants were requested to generate as many ideas as possible during the first phase of the experiment in the process of developing this social media campaign. They were then asked in the second phase to evaluate their ideas and eventually select a final idea by choice. Both the generated ideas and evaluated ideas were provided in written form. These ideas were assessed by a panel of expert judges with the use of MaxDiff analysis for originality and usefulness. By using this method, each participant was linked to originality and usefulness scores for their ideas, as well as to the amount of task related and task unrelated mind wanders they experienced. The experiment lasted a minimum of 35 minutes and a maximum of 45 minutes, with five minutes of focus on the task description, fifteen minutes of idea generation, fifteen minutes of idea evaluation and lastly one post-task question.

Experimental task

The creative problem solving task put the students in a role of responsibility for the invention of an effective strategy for a social media campaign for Tilburg University. The description of the task emphasized that summer is nearing and high school graduates of the near future will be anticipating on possible options to study at a university. Therefore, the essence of the social media

campaign is to increase the attractiveness of studying at Tilburg University and reach an audience as large as possible. The target audience involved high school graduates or HBO graduates that want to proceed on a university level.

Participants were encouraged to use their imagination, but had to include three concepts in their campaign; (1) summer, (2) international (referring to the international orientation of TU), and (3) Tilburg city. These concepts provide a basis for conceptual combination, which allows for idea generation and evaluation (Mumford et al., 2012). Participants were asked to come up with as many ideas possible during the first phase and start evaluating, dismissing and selecting ideas in the second phase. The experimenter informed the participants at the beginning of each phase that they would spend at least fifteen minutes on idea generation -and evaluation. To motivate the participants, they were told that the highest rated idea of all participants, in terms of originality and usefulness, might actually be executed in practice by the division of marketing and communication. To help the participants get started and familiarize themselves with the task, they were shown some example ideas per concept for the social media campaign prior to the start of the idea generation phase.

For the first experimental phase, participants were asked to come up with as many ideas as possible for each concept (*summer, international, Tilburg*). The experimenter emphasized that it was important for the participants to keep the social media aspect in mind while generating ideas. They were instructed to write down their ideas on post-it notes and were asked to only apply one concept per post-it note. Whenever the participants caught themselves mind wandering, they had to press the desk-bell in front of them and keep a score of every time this occurred. This action functioned as an action of awareness and a double check for alertness regarding wandering minds. In addition, the experimenter knocked on the door of the experiment room at one random moment in the idea generation phase. At this unannounced moment, the participants also had to report whether they were mind wandering (TRT/TUT) or not.

In the second part of the experiment, the participants were instructed to evaluate their ideas and work towards their final idea for the campaign. The only condition was that the final idea had to be a combination of the three concepts ideas, so that every concept is involved in the campaign. The participants had the freedom to elaborate on the idea, but they were told work it out in as many or little details as they preferred. Whenever the participants caught themselves mind wandering, they had to press the desk-bell in front of them and keep a score of every time this occurred. In

addition, the experiment leader knocked on the door of the experiment room at one random moment in the idea evaluation phase. At this unannounced moment, the participants also had to report whether they were mind wandering (TRT/TUT) or not.

Design

The study had a mixed linear model design as it aimed to explore the relations and interactions between (1) task related thoughts (TRT) and task unrelated thoughts (TUT), (2) originality and usefulness scores based on expert judges rating and (3) the divergent (idea generation) and convergent (idea evaluation) thinking phase. All participants experienced the idea generation phase, followed by the idea evaluation phase. The originality and usefulness scores were the predictive variables, while task related thought (TRT) and task unrelated thought (TUT) were the dependent variables.

Materials and setting

The experiment was conducted in a closed room located on the campus of Tilburg University. The available material in the room were a desk bell, a stack of post-it notes and a pen. Each participant was given the necessary papers with the task instruction and the forms for executing the task (see appendix 1).

Probes

Participants were asked to spontaneously provide self-reports, when they caught their mind wandering. This self-caught method of measuring (Smallwood & Schooler 2006) required participants to press the desk bell in front of them every time they noticed that they have been mind wandering. Then they had to report their wandering minds by keeping a tally score of the times their attention shifted to self-generated task related or task unrelated daydreams. This provides a straightforward assessment of the number of mind wandering episodes that reached meta-awareness during the experiment. The second applied way of probing was the probe-caught method. During both phases of the experiment, the participants were given a signal at a random moment to report whether they were mind wandering on that particular moment. They could report the answer by simply writing down ‘yes’ or ‘no’ in the appropriate indicated

box on the task form. The probe-caught signal was given by the experimenter by knocking on the door of the experimental room.

MaxDiff analysis by domain-experts

After the execution of the task by the participants, the results were judged by three domain-experts, all from the department of Marketing & Communication of Tilburg University. Their job task is to take care of the external online communication via the website and social media channels of the university. The purpose of chosing experts over non-experts was to increase the external validity of the assessment with regard to measured originality and usefulness. The method used to indicate the ratings and assessment of the ideas of the participants was MaxDiff analysis. In MaxDiff analysis (Louviere 1992), judges are asked to evaluate items (ideas) in sets of five at a time. Within each set, they choose the best and worst items in terms of originality and usefulness. It is assumed that the experts behave as if they re examining every pair of ideas in each subset to choose the most distinct or maximally different pair (Lee, Louviere & Soutar). In total, the domain experts were asked to evaluate 8 different constructs for 26 sets of items: 1) *Summer concept originality*, 2) *Summer concept usefulness*, 3) *International concept originality*, 4) *International concept usefulness*, 5) *Tilburg concept originality*, 6) *Tilburg concept usefulness*, 7) *final ideas originality* and 8) *final ideas usefulness*. Each set of items was a randomized reproduction of five out of fifteen items.

Results

For the four categorical variables (*Originality, Usefulness, Phase, Gender*), Chi-square tests were performed to calculate the relation between these dichotomous variables. For every tested relation with *Average TUT*, *Average TRT* or *Total ideas*, standard correlation tests were performed (TUT stands for task unrelated thoughts and refers to task unrelated mind wandering and TRT stands for task related thoughts and refers to task related mind wandering).[1] Table 1 presents means, standard deviations, correlations and Chi-square scores of the main variables.

[1] Even though task related thoughts were earlier in the paper divided into task related mind wandering and on-task focus, in this section the task related thoughts resemble mind wandering only. On-task focus was not assessed.

TABLE 1

Means, Standard Deviations, Correlations and Chi-Square scores

	Variable	Mean	s.d.	1	2	3	4	5
	variables			*Correlations*		*Chi-square scores*		
1.	*Average TRT*	2.40	1.58					
2.	*Average TUT*	2.04	1.66	.40**				
3.	*Originality* ***d***	1.12	0.90	-.07	.05			
4.	*Usefulness* ***d***	1.16	0.95	.03	.02	.32		
5.	*Phase* ***d***	1.15	0.36	-.19**	-.05	3.41	1.18	

d Coding for dichotomous variables: originality was coded as 1 for worst and 2 for best; usefulness was coded as 1 for worst and 2 for best; phase was coded as 1 for divergent and 2 for convergent.

***p ⩽ .05**

**** p ⩽ .01**

The correlation between *average TRT* and *average TUT* was .40 ($p < .01$). As Table 1 also shows, the correlation between *phase* and *average TRT* was -.19 ($p < .01$). As phase increases from 1 to 2, the average amount of TRT decreases.

Table 2 provides an overview of all the 783 ideas generated by the 116 participants during the experiment. The ideas are divided into original and useful, where the worst and best rated ideas by the expert judges are extracted from the total number of ideas. The value 'other' stands for ideas that were not rated as best or worst by any of the judges. The more worst rated ideas are ideas that were judged for originality, while the more best rated ideas are ideas that were rated for usefulness.

TABLE 2 Descriptives and Frequencies of total ideas

Ideas	**Original**		**Useful**	
	Frequency	Percent	Frequency	Percent
Worst	298	38.1	222	28.4
Best	212	27.1	263	33.6
Other	273	34.9	298	38.1
Total	783	100	783	100

Task related mind wandering

All hypotheses and models were tested with the analysis of mixed linear models where the dependent variable was either TUT or TRT. This means that *originality*, *usefulness* and other main variables were treated as predictors of the average amount of TRT or TUT. The parameters of the Mixed Linear Models were: Scaled Identity as covariance structure, participants as subjects, *phase*, *originality* and *usefulness* as repeated measures, participants as random intercept and Maximum Likelihood as estimation. **Model 1** revealed a negative relation between task related thoughts and *usefulness* and no significant interaction between task related thoughts and *originality*. A mixed linear model with task related thoughts (TRT) as dependent variable revealed the effect of *originality* $F(1, 281) = .414$, $p = .521$ and *usefulness* $F(1, 274) = 3.28$, $p = .071$ on the average amount of task related mind wanders (TRT). Results showed more task related mind wanders for worst usefulness ($M = 2.12$ $SE = .12$) than best usefulness scores ($M = 1.58$ $SE = .28$). The difference between …. was not significant, $p < .10$. The strongest effect in model 1 was the effect of *phase* $F(1, 262) = 9.74$, $p = .002$ on the average amount of task related mind wanders (TRT). Results show significantly more task related mind wanders in phase 1 ($M = 2.43$, $SE = .12$) than phase 2 ($M = 1.58$, $SE = .28$). Based on these findings, the hypothesis 1,…(restate the hypothesis), can be rejected.

Since *phase* was the main variable with the most prominent effect on task related thoughts, additional analyses were performed to deeper investigate the role of *phase* with regard to *originality* and *usefulness* in relation to task related mind wandering. **Model 2** tested the effect of *phase*, *originality* and the interaction *phase x originality* on task related thoughts. A mixed linear model analysis revealed a weak, yet not significant, effect of *phase* x *originality* on TRT $F(1, 268) = 4.04$, $p = .083$, indicating more TRT for worst original ideas in phase 1 ($M = 2.4$, $SE = .13$) than in phase 2 ($M = 2.09$, $SE = .39$). Given the separate effects of *originality* $F(1, 271) = 3.11$, $p = .079$ and *phase* $F(1, 261) = 9.02$, $p = .003$ on the average amount of task related thoughts, it is the significant effect of *phase* which explains the main effect on task related thoughts. In line with model 1, results reported more task related mind wandering during the divergent phase than during the convergent phase.[2]

[2] There is no model dedicated to the interaction of *originality x usefulness* and thus is not included in Table 3, since it did not reveal any significant effect and was therefore considered redundant.

In order to compare originality interactions with usefulness interactions on task related thoughts, **Model 3** tested the effect of *phase*, *usefulness* and the interaction between *phase* and *usefulness* on task related thoughts. Results showed significant effects for *usefulness* x *phase* $F(1, 269) = 5.44$, $p = .020$, *usefulness* $F(1, 264) = 8.55$, $p = .004$ and *phase* $F(1, 259) = 9.58$, $p = .002$ on the amount of task related mind wandering. Additionally, the *phase* x *usefulness* interaction revealed that during the convergent phase, participants with worst useful ideas ($M = 2.36$, $SE = .13$) reported significantly higher amounts of task related thoughts compared to participants with best useful ideas ($M = .88$, $SE = .38$). These findings indicate that usefulness does nots only depend on task related mind wandering, but the phase in which they occur as well. In contrast to *originality* (in model 2), *usefulness* does function as a predictor of task related mind wandering. As model 1 shows, the *usefulness* variable was trending towards significance. This tendency towards significance also seemed to apply for *originality* in model 2, but it did not appear to be the case in following analyses.

The next step in predicting task related mind wandering was to include all main variables and their two-way interactions in **Model 4**. As Table 3 shows, no new findings were revealed in model 4 compared to the previous three models. Lastly, **Model 5** was a full factorial analysis that included the effects of all separate variables, their two-way interactions and the three-way interaction *originality x usefulness x phase* on task related mind wanders. Similarly to previously reported models, there was an effect of *phase* $F(1, 261) = 11.12$, $p = .001$; *usefulness* $F(1, 265) = 6.91$, $p = .009$; and *phase* x *usefulness* $F(1, 270) = 3.91$, $p = .049$). The moderating effect of usefulness is displayed in Figure 1. All other effects and interactions were non-significant and irrelevant to the hypotheses.

Table 3

Hierarchical linear models with Task Related Mind Wanders as the Dependent Variable

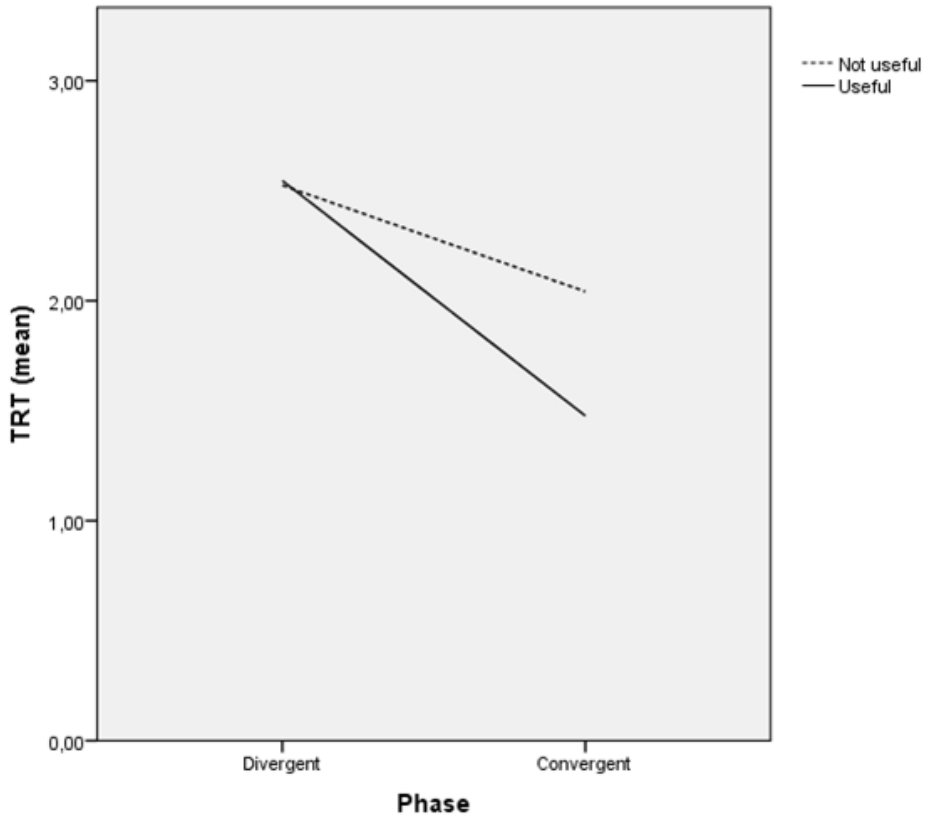
Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	1,408**	1.110**	.882**	.621**	.884**
Originality	.093	.976†		.689	-.007
Usefulness	.254†		1.440**	1.261*	.564**
Phase	.849**	1.300**	1.475**	1.730**	1.447**
Org x Usf ***a***				.033	1.437
Org x Phase ***a***		-.965†		-.677	.043
Usf x Phase ***a***			-1.289*	-1.122*	-.364*
Org x Usf x Phase ***a***					-1.496
RM variance ***a***	1.15	1.16	1.12	1.13	1.09
PPN variance ***a***	1.05	1.02	1.07	1.06	1.03

a **Table includes abbreviations: Org for originality; Usf for usefulness; RM for repeated measures; PPN for participants**

***p < .05**
****p < .01**

Figure 1

Usefulness as a moderator of the relation between phase and task related thoughts (TRT)



The main findings for analyses regarding task related mind wandering include the variables *phase* and *usefulness*. The graph displays the different amounts of task related thoughts between the phases and the effect on usefulness. The difference between the average amounts of TRT during the convergent phase is significantly related to the usefulness of the ideas in that phase, indicating a negative relation between task related thoughts and usefulness in the divergent phase. Therefore, hypothesis 1 that stated that *task related thoughts (mind wandering) is beneficial for both the originality and usefulness of ideas* can be rejected.

Task unrelated mind wandering

To examine the significance of the relation between task unrelated thoughts and originality, the interaction between the two variables was computed and entered in multiple expanding mixed linear models with task unrelated thoughts as the dependent variable. **Model 1** tested how *originality, usefulness* and *phase* each relate to task unrelated mind thoughts (TUT). Contrary to the hypothesis, results showed no significant effect of *originality, usefulness or phase* on task unrelated mind wanders. In total, six mixed linear models with task unrelated mind wanders as the dependent variable were fitted. None of the six models revealed a significant relation between task unrelated thoughts and originality.

The only conspicuous and unexpected finding was visible in models 2, 5 and 6, which revealed a significant effect of the *originality x usefulness* interaction on the average amount of task unrelated mind wanders (TUT). **Model 2** tested the effect of *originality, usefulness* and the interaction between originality and usefulness on task unrelated thoughts. A mixed linear model analysis showed a significant effect of *usefulness* x *originality* on TUT $F(1, 272) = 7.64$, $p = .006$. Given the separate effects of *originality* $F(1, 287) = .06$, $p = .809$ and *usefulness* $F(1, 284) = .185$, $p = .668$ on the average amount of task unrelated thoughts, it is the interaction effect of *originality* x *usefulness* which explains the main effect on task unrelated thoughts. Results revealed significant more task unrelated thoughts for participants with both *worst useful and worst original* ideas ($M = 2.20$, $SE = .16$), compared to *worst original and best useful* ($M = 1.77$, $SE = .14$), while scores for *best original and worst useful* ($M = 1.79$, $SE = .18$) and for *best original and best useful* ($M = 2.10$, $SE = .17$) were revealed as well. **Model 5** represents the variables *originality, usefulness, phase, originality x usefulness, originality x phase, usefulness x phase* and their effect on task unrelated thoughts. Again, the only significant effect was found for *originality x usefulness* $F(1,$

271) = 8.10, p = .005. However, the estimated marginal means differed from model 2. Results in model 5 revealed significant more task unrelated thoughts for participants with both *worst useful and worst original* ideas (M = 2.38, SE = .24), compared to *worst original and best useful* (M = 1.68, SE = .27), while scores for *best original and worst useful* (M = 1.74, SE = .28) and for *best original and best useful* (M = 1.80, SE = .24) were revealed as well. **Model 6** was a full factorial analysis that added the interaction *originality* x *usefulness* x *phase*. A significant effect was found for the same variable as in models 5 and 2; *originality* x *usefulness* $F(1, 275) = 4.07$, p = .045), where the estimated marginal means deviated from models 2 and 5 with significant more task unrelated thoughts for participants with both *worst useful and worst original* ideas (M = 2.45, SE = .26), compared to *worst original and best useful* (M = 1.57, SE = .31), while scores for *best original and worst useful* (M = 1.64, SE = .31) and for *best original and best useful* (M = 1.86, SE = .25) were revealed as well. Since participants with worst usefulness and worst originality score experienced significantly higher amounts of task unrelated thoughts, hypothesis 2 can also be rejected. In contrast to the expectation, originality did not have a positive relation with task unrelated mind wandering. All other effects and interactions were non-significant and irrelevant to the hypotheses.

Table 4

Hierarchical linear models with Task Unrelated Mind Wanders as the Dependent Variable

Independent variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Intercept	1.779**	2.102**	1.532**	1.467**	1.425**	1.55**
Originality	-.032	-.337	.643		.163	-.191
Usefulness	.159	-.311		.775	.249	-.106
Phase	.133		.480	.445	.754	.610
Org x Usf ***a***		.741**			.762**	1.478*
Org x Phase ***a***			-.736		-.566	-.200
Usf x Phase ***a***				-.664	-.620	-.234
Org x Usf x Phase ***a***						-.763
RM variance ***a***	1.10	1.07	1.10	1.09	1.07	1.08
PPN variance ***a***	.93	.91	.92	.93	.90	.90

a **Table includes abbreviations: Org for originality; Usf for usefulness; RM for repeated measures; PPN for participants**

***p < .05**

****p < .01**

Discussion

The goal of the current study was to gain insight regarding the effects of task related and task unrelated mind wanders on creativity. Based on a literature review, it was deemed essential to distinguish between different steps in the creative process (divergent thinking vs. convergent thinking) as well as between different styles of mind wandering (task related vs. task unrelated), to thoroughly investigate the relationship between mind wandering and creativity. Given previous findings on creativity using psychometric tasks, we proposed hypothesized that task related mind wandering is beneficial for both the originality and usefulness of ideas (H1) and that task unrelated mind wandering positively influences creativity through an effect on originality (H2). Using an experimental study with more external validity we revealed a more intricate relationship between mind wandering and creativity than is suggested by previous work.

A negative relation was found between task related mind wandering and the usefulness of an idea. It was expected that mind wandering and daydreaming that was to some extent still related to the task at hand would be beneficial for originality and usefulness. However, the more task related mind wanders individuals experienced, the less useful their ideas turned out to be. These types of thoughts of the participant are both task related and self-generated, because 'the task stimulus in of itself does not necessitate the thought' (Smallwood & Schooler, 2015). Therefore, the main difference between task focus and task related mind wandering, is that task related mind wandering is not perceptually guided. Smallwood et al. (2003) add to this notion by stating that task focus can be divided in two aspects where attention is directed towards (i) task completion or (ii) towards task related interference in the form of task reappraisal. This task interference/reappraisal shares a resemblance with the example of a participant with self-generated, not perceptually guided thoughts like "*GRR!?!?! What is the point of this task?*" (Smallwood & Schooler, 2015). When the content of task related mind wandering becomes somewhat frustrated or annoyed towards the task, it might harm the positive beliefs and motivations that usually contribute to creative problem solving (Dailey & Munford, 2006). On the other hand, more task related mind wandering can also simply mean that people were performing poorly and were thinking about that. Since subjects' motivation and beliefs concerning the usefulness are important for dealing with creative problem solutions (Mumford, Decker, Connelly, Osburn, & Scott, 2002), a lack of usefulness can be a predictor of task related mind wandering.

This study also revealed that more task related mind wanders occurred during the divergent phase than during the convergent phase. Thus, individuals that engaged in the divergent phase of the task experienced significantly more task related mind wanders. Divergent thinking is characterized by taking risks, shifting perspective, deviating from the usual, exciting or risky possibilities, a feeling of uncertainty and excitement (Cropley, 2006). This kind of thinking is more likely to instigate a moment of reflection on how one is performing the task than during the convergent phase where orthodoxy, logic, singularity and already present knowledge are applied (Colzato et al., 2012; Cropley 2006). When generating as many unique ideas, there are less boundaries for participants and their range of idea production. However, despite the perceived 'freedom' during divergent cognitive processes, the thought process can be more prone to uncertainties regarding adequate execution of the task. Divergent thinking is treated in contrast with convergent thinking, which usually leads to conventional and ''correct'' ideas and problem solutions (Runco & Acar, 2012). Idea production and evaluation in the convergent phase is based on more logic than during the divergent phase and is characterized by a single solution to be as valid as possible. The creative process of idea generation and evaluation is argued to be a sequential process in theory. However, as stated earlier, it seems more likely that the creative process works more reciprocally. Especially in the divergent phase where multiple ideas are generated, they might also be instantly evaluated by the participant whether the ideas sufficiently address to the task goal. These moments of brief evaluation can indirectly trigger thoughts on the current performance of the task, such as self-generated task interference, reflective reappraisal, irritation and other forms of interference. The interference refers to a shift away from the task focus and overcoming sources of interference means navigating beyond tightly knit concepts in the divergent state of mind (Beaty & Silvia, 2012). Overcoming the mind wandering interference requires executive functions and processes associated with the control of attention. Considering the nature of idea generation and divergent thought with its' shifting perspectives and unlimited range of concepts (Cropley, 2006), the control of attention can be challenged by task related mind wandering. This also supports the equal occurrence of task unrelated mind wandering in both phases of the experiment, while task related mind wandering happened significantly more during divergent thought. The convergent phase is more orthodox and predictable for an individual to experience, making it less of a confusing climate for task related mind wandering to occur. It can also be argued that the convergent phase simply demands more focus. Rather than thinking of

multiple different things, you need to centralize and think about one thing or solution. So, you would expect less task related mind wandering during convergent thought. Therefore, the characteristics of divergent thought might be fundamental for the occurrence of task related mind wandering.

Interestingly, the task related mind wanders that did occur in the convergent phase also seemed to play a role. Which bring us to the third finding; individuals with worst useful ideas during the convergent phase experienced significant higher amounts of task related mind wanders compared to participants with best useful ideas. Task related mind wandering in the convergent phase seems to be a sign of a bad task performance, resulting in no useful ideas. Just like creative ideas require both originality and usefulness, creativity cannot occur in the absence of convergent thinking (Simonton, 2015). Therefore, emphasizing the convergent train of thought is a prominent aspect of this study. The absence of usefulness in past creativity research has also been a driving factor for the research in current paper, since the usefulness criteria mainly defines the utility of each ideational combination (Simonton, 2015). The evaluative components of the creative process seem important for the usefulness of an idea, considering that the actual utility is assessed during evaluative and convergent phases (Ellamil et al., 2012). Convergent thinking is oriented toward deriving the single best option and is considered most effective in situations where an idea simply needs to be recalled from stored information by applying conventional and logical decision-making strategies (Cropley, 2006). As it appears, task related mind wandering hinders this process more than task unrelated mind wandering. More specifically, the occurrence of task related mind wandering during convergent thought seems to indicate something is going wrong in the process of idea production during the convergent phase. Thus, the interaction between worst usefulness and the convergent phase is a predictor of a high amount of task related mind wandering.

There were less notable findings with regard to task unrelated thoughts based on the performed analyses. Contradictory to the second hypothesis, there was no significant relation between task unrelated thoughts and originality. Prior to this study, it was expected that task unrelated thoughts and daydreams could be beneficial for creative problem solving through an effect on originality. These expectations were based on the majority of past research regarding mind wandering and creativity, where originality and novelty were emphasized as main indicators of creative output. However, these studies were mainly based on psychometric tasks that do not serve as a valid indicator for real-world creativity (Zeng et al., 2011). Under certain circumstances

cognitive focus on problems can undermine creativity, whereas distraction can enhance the creative process (Dijksterhuis & Meurs, 2006). Also, individuals with attention-deficit/hyperactivity disorder, who engage excessively in task unrelated mind wandering, tend to score higher than people without ADHD on laboratory measures and questionnaire-based assessments of creativity (White & Shah, 2006; 2011). Another study found that individuals experiencing REM sleep during an incubation interval showed more ability to integrate unassociated information in the service of creative problem solving (Cai, Mednick, Harrison, Kanady, & Mednick, 2009). The fact that ideas are chained together and can suddenly come up in mind through a series of associative processes in semantic memory (Chou, 2016), was considered a reason to believe that task unrelated thought might improve originality, prior to this study. The most fertile ideas are the ones shaped by elements drawn from widely varying domains (Poincaré, 2014), so when an individual is mind wandering task unrelated, it seems likely that more different and 'random' concepts can be activated during the cognitive process compared to task related thought. It was expected that creative thought would benefit from this associative hierarchy by enhancing the possibility of making novel conceptual combinations.

Given that we were not able to confirm a relation between originality and task unrelated thought, it may well be that something else than mind wandering explains the effects found in past research. What would it be? In addition, there is also a possibility that the task used in the our study did not instigate self-generated thoughts that could contribute to creativity. It is generally assumed that engaging in simple external tasks allows the mind to wander can facilitate creative problem solving (Baird et al., 2012). An example of an undemanding task is when participants have to determine whether target numbers are even or odd (Baird et al., 2012). Yet, the task that was employed in our study was a high demanding task and may have been less suitable for elicitation of task unrelated mind wandering. The task was challenging for participants and required more focus and attention than the average low-demanding 'cognitive autopilot' activity, where the mind is more likely to drift away and perhaps leads to sudden unique insights or 'eureka' moments. Therefore, it turns out that originality cannot be considered an indicator of task unrelated thoughts in this case. Perhaps, the statistical outcome could have been different if the task was less demanding and/or included an incubation period.

The only significant finding regarding task unrelated thoughts concerned the interaction between originality and usefulness. Results showed significantly more task unrelated mind

wandering for participants with both worst useful and worst original ideas, while either usefulness or originality did not significantly relate to task unrelated thoughts. This might imply that people with more task unrelated thoughts generate ideas of a lower quality. However, considering the fact that the separate variables equally were not related to task unrelated mind wandering, caution with assumptions is advised and further research is needed. This unexpected finding raises the question whether the participants who scored worst on both usefulness and originality shared other characteristics or (cognitive) circumstances that lead to worst rated ideas. Task unrelated thoughts often refer to daydreams that are predominantly future focused and linked to personally relevant future goals (Baird et al., 2011). Added to this, individuals with high working memory capacity are more likely to engage in this type of mind wandering. As this study did not include any of these factors, it is reasonable to consider the option that the minds of some participants were already occupied with personal concerns before engaging in the task. A mind that is occupied with task unrelated content can hinder categorical organization of stimuli or task elements, regardless the nature of the task (Smallwood et al., 2003). Thus, task unrelated mind wandering on itself does not necessary decrease creativity, but preoccupied minds might function at the expense of the task focus and the overall task performance of an individual. Moreover, alternative explanations might also derive from factors like mood, affect, thought content or style of thinking and will be discussed in the following section.

Limitations and implications for further research

Even though this study specifically focused on the effects of task related and task unrelated mind wandering on creativity, the role of absent factors possibly contributing to creativity or affecting the creative process cannot be ignored. A few factors that may have had influence on the findings shall be mentioned. A limitation of the study is that mood was not assessed or included in the experiment. In some of the previously conducted experiments, mood and affect have extensively been studied in relation to creativity (see Baas et al., 2008). There is mixed evidence, stating that positive mood can enhance creativity through cognitive flexibility while negative mood can increase creativity via a different route (Zedelius & Schooler, 2016). If follow-up studies include mood assessments before, during and after a comparable experiment, it might lead to new insights regarding task related thoughts, task unrelated thoughts, originality and usefulness. Not just mood on itself can influence creativity, but the interplay between mood and the content of daydreams

and mind wandering can facilitate or block creativity.

The second limitation of this study is that it does not reveal any information regarding the content of the task related and task unrelated mind wander episodes of individuals. Mind wandering was classified as either task related or task unrelated, while the content of the mind wander episodes could have varied in many more than two ways. According to Killingsworth and Gilbert (2010), task unrelated mind wandering is often associated with negative mood. However, when daydreams are experienced as very captivating (Franklin, Mrazek, Anderson, Smallwood, Kingstone & Schooler, 2013) or serve as positive mind wandering during an unpleasant task (Spronken, Dijksterhuis, Holland & Figner, 2015) or include social content and involving close others (Poerio, Totterdell, Emerson & Miles, 2015), they are associated with increased happiness and seem to enable creative insights. Current study showed that task related mind wandering relates to the usefulness of an idea. The content and mood associated with these task related thoughts could contribute to a more accurate interpretation of this discovered link. Thus, examining mood, content and their interplay dynamics is highly advised for further research.

A potential methodological limitation concerns the use of self-report measures of mind wandering in the experiment. With respect to creativity, self-report is generally considered the most valid method of measurement for a person's creativity at a particular moment (Bledow, Rosing & Frese, 2013). A limitation of the self-report measurement of mind wandering is that it examines only consciously accessible shifts away from the task focus. However, cognitive shifts like mind wandering are only partially consciously accessible (Dijksterhuis & Meurs, 2006), which suggests that only a fragment of the wandering minds is captured. Note that a probe-caught method of mind wandering was included in the experiment as well. However, the minimal occurrence of one probe per phase leaves room to suggest that the overall influence of task related and task unrelated mind wandering on creativity may be more pronounced. On the other hand, a high rate of probes may decrease the 'freedom' for the mind to start wandering and thereby creating a counterproductive effect.

The lack of awareness exhibited by some wandering minds brings us to the last limitation; the difference between intentional and unintentional mind wandering or daydreaming. When it comes to self-generated attentional shifts, there is a distinction between deliberate and spontaneous mind wandering (Seli, Carriere & Smilek, 2014). Spontaneous thoughts that are stimulus-independent occur unintentionally and without awareness, whereas some creative individuals

deliberately engage in mind wandering because they experience it as a potential source of inspiration (Zedelius & Schooler, 2016). It is reasonable to expect that intentional and unintentional thoughts have different characteristics that might influence creative production. In contrast to unintentional mind wandering, intentionality seems more likely to provide a navigated and structured stream of thought in someone's cognition. The deliberate nature of thought is more likely to involve positive thoughts regarding personal goals (Zedelius & Schooler, 2016), while unintentional mind wandering is more likely to instigate negative and ruminative thought that associates with the 'unhappy mind' of Killingsworth & Gilbert (2010). Given that creativity can be achieved through distinct routes and the intentionality of mind wandering raises contradicting predictions (Zedelius & Schooler, 2016), it might serve as a rewarding factor to include in further research.

In future research, task related and unrelated mind wandering can serve as a baseline of mind wandering distinction. When factors like mood, style of thinking, thought content and intentionality are added in the analyses of mind wander episodes, more accurate findings and interpretations can be done. The outcomes of the current study suggest that a deeper focus on the causalities between mind wandering variables, such as the negative relation between usefulness and task related mind wandering during the convergent phase, may be beneficial. To obtain a broader understanding of the creative process, certain relevant variables have to be tested by a method that decomposes the multifaceted concepts that mind wandering and creativity are (Zedelius & Schooler, 2016). The creative process needs to be approached as a cognitive operation consisting out of multiple steps, not just a unitary abstract concept. Investigating the relations and mechanisms between types of mind wandering and possible contributing factors to creativity is necessary to increase knowledge regarding creative potential.

The present research points towards the importance deeper investigation with usefulness as an equal indicator of creativity, together with originality. Where the majority of past research emphasized factors such as originality, divergence, novelty and uniqueness as prominent signs of creativity, current article evidently exposes usefulness as a significant factor. To continue this line of research, follow-up studies should avoid to use traditional, divergent, psychometric tests. Zeng, Proctor, and Salvendy (2011) argued that "the lack of problem contexts in prevalent divergent thinking tests makes it impossible to clearly identify fundamental goals that solutions should meet". Research with more complex realistic tasks hence may increase the relevance of usefulness for

creativity evaluations (Runco, Illies & Eisenman, 2005). Recent work (Diedrich, Benedek, Jauk & Neubauer, 2015) concerning originality and usefulness lead to the conclusion that novelty can be regarded as a first-order criterion and usefulness as a second-order criterion of creativity. However, to successfully implement creativity in real-world settings and problem contexts, we argue that usefulness weighs equally for a sustainable creative idea.

Moreover, a focus on the dynamics between originality and usefulness, and the mechanism responsible for these dynamics may lead to new insights and to reinterpretations of findings in creativity research. The discovered relation between task unrelated thoughts and worst rated ideas (worst useful and worst original) was unexpected and interesting at the same time. However, a fixed or highly accurate conclusion cannot be drawn for the existing relation based on the analyses that revealed it. The finding did reveal that dividing creativity into originality and usefulness not only leads to remarkable new insights on usefulness, but even an interaction between originality and usefulness. The interactive effect of novelty and usefulness on creativity has been studied recently and 'the analyses revealed that although novelty and usefulness positively predict creativity in a multivariate analysis approach, they still play quite different roles for the evaluation of creativity' (Diedrich et al., 2015). Current study investigated the interaction as well, but with mind wandering as the dependent variable and a complex realistic task, finding a negative relation with task unrelated thoughts. Therefore, further exploration on the interaction is necessary to better understand what it exactly means.

Conclusion

The goal of this study was to provide insights into the relation between task related and task unrelated mind wandering, on the one hand, and the production of original and useful ideas. For this aim, it was necessary to distinguish between alternative styles of mind wandering and different stages within the creative processes, in order to fully understand the relationship between the concepts of mind wandering and creativity. Next to that, we made use of a task with a realistic problem context.

The outcomes of this study suggest that there is a relation between task related mind wandering and a low degree of usefulness of the generated ideas. The results confirmed that focusing on usefulness can lead to new insights into the mechanisms of the creative process.

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Appendix 1

TILBURG UNIVERSITY

Understanding Society

Consent form

Title experiment: Your Social Media Idea
Experiment leader: Jasper F.M.G. Schilder

Dear participant,

You are invited to participate in a research study conducted by Jasper Schilder from Tilburg University, within the faculty of humanities. The experiment will ask for your input regarding a creative idea for a social media campaign for Tilburg University. This means you will generate, evaluate and detail ideas. The duration of the experiment will be between 30 and 40 minutes.

Your provided information is anonymous and will be used strictly for research purposes only. If you have any questions about the study or experiment whatsoever you are free to send an e-mail to: . You are not allowed to have your phone with you during this experiment and will therefore kindly be requested to hand in your mobile device before the experiment.

Your signature indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation without penalty, that you will receive a copy of this form, and that you are not waiving any legal claims.

Signature Participant: Signature experiment leader:

Date: Date:

Task description

Dear participant,

The summer is coming closer, which means that many high school graduates and HBO graduates will be looking for a new study at a university level. For Tilburg University it is important to profile and promote ourselves in a way that will attract as many new and enthusiastic students as possible.

We are striving towards a successful and attractive campaign with regard to receiving many applications and registrations of graduates all over the Netherlands and beyond! The interesting part is, we want you to help us. We are interested in your idea(s) for a creative social media campaign to increase the attractiveness of studying at Tilburg University and reach an audience as large as possible.

We want you to involve three key concepts in your strategy for the campaign; (1) **summer**, (2) **international** (referring to the international orientation of TU) and (3) **Tilburg city**. Also, it might help to ask yourself the question '**What would convince/convinced me to study at TU?**'. This can relate to the campus life, the pleasant interaction between students and teachers, our approach to science, or any other core values. We encourage your imagination and originality, but keep in mind the practical usefulness of your idea.

The task will consist out of two parts; (a) a phase to generate ideas and (b) a phase to evaluate your ideas and choose a final idea and work it out in more detail. For both parts you have to spend a minimum of fifteen minutes on the task. After completing the task, there will be a chance that your idea/strategy will (partly) be used by Tilburg University as the promotional social media campaign of 2016. It is allowed to write down your ideas in Dutch. #goodluck!

When you have read the description and understand the task, please inform the task leader for further instructions.

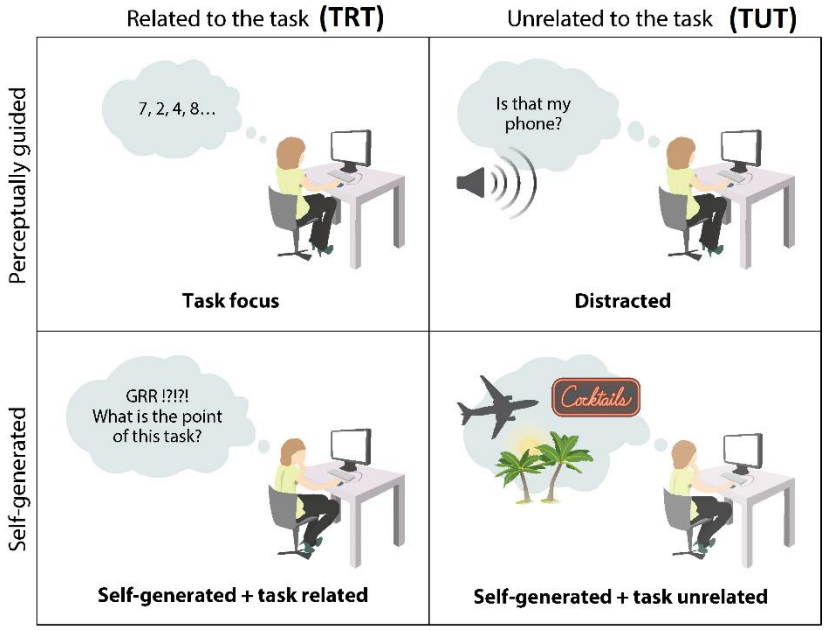
PLEASE NOTE:

There is a chance that you might start to mind wander (dagdromen) during the task. Whenever you catch yourself mind wandering, press the desk bell in front of you and report it by keeping a tally (turven) of every time you catch yourself mind wandering. For your clearance, we will make a distinction between different types of mind wandering: task related thoughts (TRT), and task unrelated thoughts (TUT).

TRT	𝍸
TUT	𝍸

Task related thought
During this experiment you have to tally TRT when you catch yourself daydreaming <u>about the task</u> and **not** when you are deliberately focusing <u>on the task</u> solution/idea. (see image)

Task unrelated thought
Task unrelated mind wandering is generally considered a shift of focus away from a primary task to self-generated daydreams. These types of 'zone outs' are episodes of mind wandering.



Smallwood J, Schooler JW. 2015. Annu. Rev. Psychol. 66:487–518

Thirdly, during both phases you will be asked one time if you were mind wandering at that randomly chosen moment. You can provide the answer to that question in the intended box on the answer form that looks like this:

Yes	TRT	✘
	TUT	
No		

This may look like a lot of information, but it comes down to: good luck with the task, but whenever you catch yourself mind wandering please report it by tallying (turven). And after the randomly timed question, also please report by choosing 'yes' or 'no'.

That is all. Enjoy the task and let the creative juices flowing!

Before we start the task, we have some quick questions for you

What is your age?
0 Under 12 years old
0 12-17 years old
0 18-24 years old
0 25-34 years old
0 35-44 years old

What is your gender?
0 Male
0 Female

Are you a student at Tilburg University?
0 Yes
0 No

Are you a Master –or a Bachelor student?
0 Master
0 Bachelor
0 Premaster

Is your current or former study within the frame of Communication and/or Marketing and/or Social media?
0 Yes
0 No

To help you get started we will provide you with examples of varying ideas for each of the three key concepts in the social media campaign task:

[Summer]
- TU cooperates with Ben & Jerry's during the open days to set up a photo contest. Students are challenged to capture their ultimate summer moment while posing with a B&J ice cream somewhere on campus.
- There will be a question & answer session with Jody Bernal via TU Twitter where students can ask questions that can only be answered with either yes or no (que si, que no)

[International]
- The banners and promo-pictures online will depict students from differing nationalities.
- During the open days TU will serve international-oriented food in the mensa (Greek, Indian, Spanish tapas, etc.)

[Tilburg city]
- TU will set up a like-and-share contest via Facebook during the open days where people can win a tour in the Schrobbeler Brewery for six persons.
- Guus Meeuwis will act as the face of the promotional campaign to emphasize and show the charm of the Tilburg way of life

Generate as many (unique) ideas as possible for the social media campaign. Write each idea down on a separate post-it note and stick it to this page. **Please write clearly and readable!**

Self-caught mind wandering

TRT	
TUT	

Question-caught?

Yes	TRT	
	TUT	
No		

Evaluate your ideas of the previous phase and decide which final idea you want to propose and write it down on this paper. You may elaborate on it and work it out in as much detail as you want. **Please write clearly and readable!**

Self-caught mind wandering

TRT	
TUT	

Question-caught?

Yes	TRT	
	TUT	
No		

Post-experiment question

To what extent would you recommend Tilburg University to a friend?

Definitely	0
Very Probably	0
Probably	0
Possibly	0
Probably Not	0
Definitely Not	0

Thank you for your participation!

You may inform the experiment leader when you are done.