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Wandering body, wandering mind? The relationship between bodily movement, creativity and mind wandering

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Running head: Wandering body, wandering mind?

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Sammendrag

Det har lenge vært tenkt at kreativitet kan være relatert til mind wandering (dagdrømme). Tidligere forskning har vist at bevegelse av kroppen er relatert til både kreativitet og mind wandering. I dette eksperimentet undersøkte vi spørsmålet om mind wandering og kreativitet ville øke samtidig under en aktiv betingelse sammenlignet med en kontrollbetingelse uten aktivitet (hvile). Eksperimentet inkluderte 30 studenter (fra 19 til 32 år, 18 kvinner og 12 menn) fra UiT – Norges Arktiske Universitet. Deltagerne ble randomisert fordelt til gjentatte målinger på en kreativitetstest (Guilford’s Alternate Uses; GAU) og en standard evaluering av mind wandering frekvens (Sustained Attention to Respond Task; SART) med og uten å gå på en tredemølle. Vi klarte ikke å reprodusere tidligere funn om at kreativitet økte under aktivitet sammenlignet med hvile ($t(29) = 1.345$, $p = .09$), og fant ingen signifikant økning i selvrapportert mind wandering under aktivitet sammenlignet med hvile ($t(29) = .671$, $p = .55$). I tillegg fant vi ingen signifikant korrelasjon mellom mind wandering og kreativitet hverken under aktivitet ($r = -.15$, $p = .09$), eller hvile ($r = -.06$, $p = .76$).

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Abstract

It has long been hypothesized that creativity may be related to mind wandering. Recent work has shown that bodily movement is related to both creativity and mind wandering. In the current experiment, we examined the question as to whether mind wandering and creativity would be simultaneously enhanced during an active walking condition relative to an inactive control condition. The experiment included 30 students (between the age of 19 and 32, 18 females and 12 males) from the UiT – Norway's Arctic University, which was randomized to repeated measures on a creativity test (Guilford's Alternate Uses; GAU) and a standard assessment of mind wandering frequency (Sustained Attention to Respond Task; SART) with and without walking on a treadmill. We failed to replicate the previous finding that creativity was enhanced during walking relative to rest ($t(29) = 1.345$, $p = .09$), and found no significant increase in self-reported mind wandering frequency during walking compared to rest ($t(29) = .671$, $p = .55$). In addition we found no significant correlation between mind wandering and creativity during the WALK condition ($r = -.15$, $p = .09$), or the REST condition ($r = -.06$, $p = .76$).

Keywords: mind wandering, creativity, activity, SART, GAU

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Preface

In the start off August 2014, I was on the lookout for a new supervisor because my original supervisor was on her way into maternity leave. First, I wanted someone to supervise me on the old project that I had with my first supervisor. I was recommended to talk to Matthias Mittner, a very knowledgeable person in the field of cognitive psychology and statistics. In a conversation with him, I learned that he had an enormous interest for a phenomenon called mind wandering. He gave me some articles to read before I decided if I wanted to start a new project or continue with the old.

The science on the field on mind wandering is still small, but the research that has been done is very respectable. Through reading some of the good articles on the field, I decided to take on a new project with Matthias Mittner as supervisor. He is very good in his area and I saw it as a good possibility to learn something new. Mittner had some very good ideas to projects before we started, and I picked the one I thought was the most interesting. From there we cooperated with finding the best-suited design for the study.

I completed the testing of the participants, and we both scored the GAU forms to estimate inter-rater reliability. I gave Mittner the variables I wanted to be tested against each other and he conducted the analysis. When none of the data gave any significant results, Mittner proposed conducting Bayesian statistics. He helped me to understand what I needed to know about the Bayes factor, and he computed the analysis. Beside from the couple of articles Mittner gave me in the start, I did the literature search and review on the articles and books that is used in the thesis. During the writing of the thesis Matthias gave me valuable feedback and ideas, and on how to properly formatting the paper.

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Student

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Supervisor

Acknowledgments

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Wandering body, wandering mind? The relationship between bodily movement, creativity and mind wandering.

A concept receiving increased attention in the psychological scholarly literature is mind wandering. Mind wandering is often described as a phenomenon where the mind is drifting away from a task, and results in unrelated inner thoughts, fantasies, feelings etc. Creativity on the other hand is commonly described as a persons' capacity to produce novel ideas, inventions, objects or products to engage in successful problem solving. Research has shown that there may be a connection between these two as mind wandering seems to enhance creativity (Baird et al., 2012). There also seems to exist a link between mind wandering and activity (Carriere, Seli, & Smilek, 2013; Seli, Carriere, Thomson, Cheyne, Martens & Smilek, 2014), and activity and creativity (Oppezzo & Schwartz, 2014). This study aims to find similar results to what were found in the aforementioned research regarding creativity and mind wandering increasing in relation to activity.

Definitions of mind wandering

Mind wandering is colloquially known as daydreaming, which may occur when performing simple tasks such as sitting in boring lectures or by reading simple or uninteresting text. It is common to picture mind wandering as a teenager that rest her head on her hand and look up in the roof with a dreaming glance. Teenagers are not the only ones that let their mind wander and most adults will admit that they daydream too. When daydreaming, one has the impression that ones' mind drifts from the task, and can stop at any other task-irrelevant thought without the daydreamer even noticing and often one has no knowledge of how long one's mind was wandering.

Mind wandering as a phenomenon has been the subject of research within many different areas and disciplines. The issue is that in the past, this phenomenon has been known under many different names. Among those are task-unrelated thoughts (Smallwood, O'Connor, Sudberry, Haskell, & Ballantyne, 2004), task-unrelated images and thoughts (Giambra, 1995), stimulus-independent thought (Antrobus, 1968), mind pops (Kvavilashvili & Mandler, 2004), and zone outs (Schooler, 2002). They all describe similar phenomena as the mind is drifting away from a task, and results in unrelated inner thoughts, fantasies, feelings etc. (Smallwood & Schooler, 2006).

Some researchers extend the definition and underline the consequences. For example, Seli, Cheyne and Smilek (2013) describe mind wandering as related to periodic task disengagement frequently resulting in costly errors and accidents as well as difficulties in a variety of context from education to workplace. Other, as Callard, Smallwood, Golchert, and Margulies (2013) characterized mind wandering as a self-regulated mental activity were the activity was largely generated by the individual, rather than in direct response to experimenters' instruction or specific external sensory output.

Mind wandering often occurs without intention (Giambra, 1995) or even awareness that one's mind has drifted (Schooler, 2002). Many could think of mind wandering as mainly a negative phenomenon that takes away attentional resources from more important tasks, for example, from educational or work based tasks. However, research indicate enhanced creativity as a result of mind wandering (Baird et al., 2012).

Definitions of creativity

People who are artists, such as painters and authors, are commonly thought to be creative. To be highly creative is often thought to go hand in hand with having an exceptional personality. These people stand out in the crowd, but creativity exists on a continuum. This means that all people possess creativity to varying degrees, not only those “exceptional” individuals. Creativity has been defined in many ways but most psychologists agree that it describes a person’s capacity to produce novel ideas, inventions, objects or products and to engage in successful problem solving (Martin, Carlson, & Buskist, 2013).

The theory of creativity proposed by Sternberg and Lubart (1991) describe three features of creativity that highly creative individuals possess. The first feature is the ability the individual has in their domain and their knowledge of the domain (domain-relevant skills). The second feature is their personality, cognitive style or other individual differences that promote creativity (creativity-relevant processes). The last feature are factors in the internal drive that motivate the individual, and these can be influenced by the individuals environment (intrinsic task motivation) (Sternberg & Lubart, 1991). Later, Sternberg (2002) states that there exists a more fundamental characteristic of creativity than what the psychological measurements can find, which he refers to as the decision to be creative.

There has always been a belief that exists a connection between creativity and intelligence (Guilford, 1967). Research shows that creative people are thought to produce products of high quality and novelty, and intelligent but not so creative people can produce products of high quality but not particularly novel (Sternberg, 2001). Testing creativity is included when measuring intelligence. A part of being intelligent is commonly thought to be a person who is a problem solver, and to produce ideas and innovations, which is also the definition of creativity.

The history of mind wandering

Even though modern research on mind wandering is still in an early phase, mind wandering as a phenomenon has been investigated much earlier. For instance, already in 1890 William James wrote about the stream of consciousness in his *Principles of Psychology* (James, 1918). He saw the consciousness as a totality and the stream was characterised by five factors: Any thought or feeling is a part of a personal consciousness, it has an object, the consciousness is selective, and it is always changing, but also continuous and unbroken. The stream of consciousness describes the constant stream of changing thoughts and feelings that a human has in a conscious state.

Long before the term mind wandering became an area of interest for researchers in psychology, William James's concept about a "stream of consciousness" received attention from researchers. Although at the time, more so from researchers in literature history than those studying psychology (Teigen, 2004). Antrobus, Singer, and Greenberg (1966) used this idea to propose a model to describe the relationship between the production of spontaneous cognitive events (like daydreaming) and the response to a continuous external stimuli. Their results found that self-reported daydreaming and other task unrelated thoughts decreased as the rate of the external stimuli increased.

Because of the behaviourist movement in the first half of the 20th century, psychological research on self-regulated mental activity was limited. In addition, the field was dominated by meta-theories (theory of theories), which resulted in the exclusive legitimacy of behaviourist methodologies in many departments (Teigen, 2004). Many peer-reviewed journals made it difficult to publish articles based on a cognitive view (Callard et al., 2013). John Antrobus (1968) was one of those who pioneered and stood against the pressure from behaviourism, by measuring the production of stimulus-independent thought (e.g. fantasy and imagery) as a function of the rate at which information was presented (presentation of a tone).

The results showed that stimulus-independent thought decreased as a linear function as the information rate of presented auditory signals.

When scientific literature on the subject of mind wandering was still scarce, the relevant research often relied on self-report and survey based studies. Among others, Nisbett and Wilson (1977) underlined the importance of viewing the responses on self-reports while being aware of the effect of face-value. Face-value is a term used to refer to how people have a need to see themselves as good (Babcock & Loewenstein, 1997). There is a possibility that some of the reports that the participants make could be painted by the desire to perceive themselves as good and saving face.

The importance of this effect is underlined by Giambra's work on the topic. Leonard Giambra has an impressive collection of published articles in the period 1977-1980 about daydreaming in context of a clinical perspective as well as a normal thought process. Many of these were researched with a retrospective questionnaire. In 1995, Giambra and his colleagues examined one method for studying a phenomena that he has called task-unrelated imagery and thoughts (TUIT), using a different measuring method. They used a GO/NOGO continuous performance task, a method thought to measure subliminal behaviour and to report TUIT. Their results showed that this method was a reliable approach to quantification of this phenomenon (Giambra, 1995).

After settling on a new method for measuring the phenomenon that controls for face-value effects, other changes were at hand. The lack of a common name and context make the literature search on mind wandering unnecessary difficult. For instance Jonathan W. Schooler (2002) wrote an article about zone outs, and Kvavilashvili and Mandler (2004) wrote about mind pops. In 2006, Smallwood and Schooler wrote an influential research article "The Restless Mind", trying to unite all the earlier concepts under one: Mind wandering. They believed that if the phenomenon had an understood and agreed upon name, it would help it to be included in the mainstream attention of psychology (Smallwood & Schooler, 2006). They also provided research of literature that demonstrated that mind wandering readily lends itself to empirical investigation and directly maps onto a simple model of executive control, thinking that this evidence would also increase the overall attention to the phenomenon.

Since 2010, there have been more research articles published using the term mind wandering than other terms that convey a similar meaning (e.g. stimulus independent thought, day dreaming, fantasy proneness) (Callard et al., 2013). In 2012, there were 46 articles published using the term compared to 2010 when there were only 15. The number of published articles in the field has increased, showing a renewed scientific interest in the phenomenon (Callard et al., 2013).

There is now a trend of mind wandering research moving into the field of cognitive neuroscience and neuroimaging, particularly in relation to the default mode network. Mason et al. (2007) investigated the neural operations that supports mind wandering using both thought sampling and brain imaging (fMRI). Results demonstrated that mind wandering is associated with activity in a default network of cortical regions that are active when the brain “rests” (default network), meaning that cortical regions in the default network play a general role in the production of mind wandering.

Christoff, Gordon, Smallwood, Smith, and Schooler (2009) found that activation in medial prefrontal default network regions, was observed both in association with subjective self-reports of mind wandering and performance error. They also observed that mind wandering was more pronounced when the subjects were unaware of it. An observed parallel recruitment of executive and default-network regions (two regions that are known to work in opposition) indicates that mind wandering can evoke a unique mental state where the two opposite regions work in cooperation (Christoff et al., 2009). Additionally, research conducted by Mittner et al. (2014) shows that what they refer to as “attention state” of a subject can not only be read in the network activity in the brain, but also in the pupil diameter and in its response.

Mind wandering has had a steady development in science, and with the increasing supply of computer science and brain reading devices, it will probably continue doing so. Creativity is a phenomenon that has aroused an interest in science as it has in philosophers. While it had an early beginning as a phenomenon, it also developed to become an important aspect of intelligence and cognition.

The history of creativity

The earliest conception of creativity in the Western views had a biblical perspective, one thought that some chosen ones were blessed with the gift of creativity (Albert & Runco, 1999). Charles Darwin’s evolution theory states that everything alive is a result of evolutionary progress (Teigen, 2004). Which was good for the development of the science on creativity, because psychological research on creativity cannot exist until it is recognized as a natural phenomenon that needs explanation. Darwin tried to explain creativity by speculating if the human creativity abilities were developed from the need of adaptations in survival (Albert & Runco, 1999), and this got more attention a century later focusing on reproducing goals (Miller, 2000).

Adlophe Quételet was a physicist, astronomer and mathematician. He also was a pioneer in application of probability and statistics to the study of human phenomena, such as creativity. He was the first to conduct a scientific study of the relation between age and creativity, and he developed the concept and mathematical formula of the normal distribution (Teigen, 2004).

Francis Galton, the cousin of Charles Darwin, is known to students of psychology for his early work on the nature or nurture discussion in developmental psychology, and for his use of quantity measurements (Albert & Runco, 1999). He was the author of the first genuine classic in the history of creativity research: *Hereditary Genius: An Inquiry into Its Laws and Consequences* (Galton, 1869). He proposed that creativity (seen as geniality) was passed down in the family. After receiving criticism, he published another book called *English Men of Science: Their Nature and Nurture*. This contributed to the science of creativity, because it studied highly creative individuals directly and investigated the developmental factors underlying creativity.

In the 20th century prior to World War II, creativity as a research topic faced a decline (Albert & Runco, 1999). This was probably due to the development of schools of psychology. They all had different fundamental questions and none with enough fundamental knowledge to take on creativity. For example, Freud and the psychoanalytic branch in this period mentioned creativity and compared it with daydreaming (Teigen, 2004), and Wolfgang Kohler (1924) and the gestalt branch investigated chimpanzees creativity in problem solving. Creativity was temporarily put aside as a central topic with the science on the human mind. It had to make way for other branches, like behaviourism.

It was after World War II that creativity became significant in psychological research (Albert & Runco, 1999). The human mind was again a topic of investigation. Psychologists were now able to create new measurement strategies and statistical analysis that enhanced the ability to investigate phenomena as complex and elusive as creativity (Teigen, 2004). Guilford developed measures that assess various kinds of divergent thinking (the capacity to generate a great variety of responses to a given set of stimuli). One of these tests was the Unusual Uses test, which asks participants to come up with as many uses as possible for ordinary objects. The responses can then be scored for fluency (number of responses), flexibility (number of distinct categories to which the responses belong), and originality (how rare the response is relative to others taking the test) (Guilford et al, 1978).

The last decade of the 20^{th} century, a so called “creative cognitive approach” emerged. High creativity has always been thought to correlate with high intelligence, and this approach describes creativity as a mental phenomenon that results from the application of ordinary cognitive processes (Smith, Ward, & Finke, 1995). Creativity has moved from being something extraordinary and an unusual cognitive process, to be an ordinary cognitive aspect. This view allowed for investigating creativity in a laboratory setting.

How to measure mind wandering

Mind wandering as a phenomena is hard to assess for varying reasons. One of the main reasons is that is has no physical characteristics that, seen in isolation, can be used to measure when or how much mind wandering occurs. The measuring method used in empirical investigations can be divided into two broad categories, probe-caught and self-caught mind wandering. Probe-caught mind wandering is measured when the participants are interrupted during a task and asked to report their experiences (e.g. through a computer or verbal report). Self-caught mind wandering is measured when participants are asked to monitor their awareness for off-task episodes. This requires individuals to be aware of the content of their own experiences (Schooler et al., 2011).

As mentioned in the section on the history of mind wandering, there is a trend in measuring mind wandering by using self-report methods. Since humans have a need to perceive themselves as good (Babcock & Loewenstein, 1997) this could be an interfering variable in the data, and thus, could make the self-reporting as a measurement by itself non-desirable. For example, mind wandering during a task can, from a social setting, have a negative view. A continuous performance task which measures the participants unconscious mind wandering together with self-report can increase the likelihood of measuring mind wandering since performance in a prolonged test is not as based on the bias for the need to perceive themselves as good.

One of the well-known continuous performance task is the Sustained Attention Response Task (SART) adapted by Robertson, Manly, Andrade, Baddeley, and Yiend (1997). The SART is a GO/NOGO continuous performance task where the NOGO stimuli appears infrequently. The task is often assumed to measure sustained attention and mind wandering. Errors done on the NOGO stimulus, called commission-errors are normally seen as evidence of slips caused by failures of sustained attention (mind wandering). There are also other performances that are reported by the SART data that could indicate mind wandering (Cheyne, Solman, Carriere, & Smilek, 2009).

The first SART performance that could indicate mind wandering is the speeding of response time (RTs), especially on GO stimuli that precedes NOGO stimuli. That fast RT indicates mind wandering is supported by various results. For example it has been observed that there is a negative correlation between overall RTs and total NOGO errors across subjects (Cheyne, Carriere, & Smilek, 2006), when subjects responds fast they do more NOGO errors. There also seems that shorter mean in RT in the trials prior to NOGO, seems to lead to SART errors (Manly, Robertson, Galloway, & Hawkins, 1999), and shorter RTs prior to commission error than to prior correct NOGO response (Cheyne et al., 2006). There also seems to be an association between task-unrelated thought and speeded RTs during SART performance (Smallwood et al., 2004). Target probability decreases GO RTs decrease and errors increase (Manly et al., 1999), presumably because infrequent NOGO trials provide opportunities for increased mind wandering, and shorter RTs and more errors with absence of awareness during probe-caught mind wandering (Smallwood, McSpadden, & Schooler, 2007).

The second SART performance that can indicate mind wandering is responses to anticipation of the presentation of a GO stimulus, responses to GO stimuli that are too fast to be real responses. Anticipations are qualitatively different from normal RTs. Extremely fast RTs (less than 100 ms) have been noted in the SART data and they are too fast for the participant to have processed the stimuli and therefore responding without the relevant stimuli monitoring (Cheyne et al., 2009). Cheyne et al. (2009) noticed that these extremely fast RTs also could provide some information about task disengagement.

The third SART performance that could indicate mind wandering is a failure to respond to GO stimuli (omission error). This error requires a deep off-task mind wandering because the mind has to override the automatic response frequency entirely. Omission error tend to increase along with NOGO errors in the second half of the SART task when attentional engagement is thought to be low (Manly et al., 1999).

The question if a response is an anticipation or an omission error must be determined by the temporal parameters of the task. When the performance approaches the limits of acceptable variations in response speed or precision, the data suggest that they either brought back from that limit or they pop out of that range into extremely fast (automaticity) or very slow (in the limit non-response). Cheyne et al. (2009) suggest these three SART performances which could indicate mind wandering are potentially valid indicators of attentional disengagement, this also includes the known commission error.

How to measure creativity

Many have developed tests intended to measure creativity, but there is more than one category of creativity, and not one solitary test that can measure creativity by definition. This is because creativity is multivariate (Guilford, 1967). Creativity is often legitimately attributed to divergent-production abilities, such as this test measures, but there are at least 29 abilities in this category. Which measurement required is dependent on which kind of creativity you want to measure.

Guilford (1967) developed many different tests that measure creativity. Plot titles, where the participants get a story, and asked to give it a title. Quick response are a word-association test scored for uncommon answers. Figure concepts, where the participants were given simple drawings of objects and individuals and asked to find qualities or features that are common by two or more drawings. The test Unusual Uses is scored by how many unusual uses are reported for everyday objects. Remote association, where participants are asked to find a word between two given words. Remote consequences, where participants are asked to generate a list of consequences of unexpected events, such as loss of gravity. Some tests measure compound remote-association (CRA) by asking for a single word that combines with each of three words, other measure divergent creativity such as Guilford Alternate Uses (GAU).

The Guilford Alternate Uses is a test that is developed from the original test of *Unusual uses*, to measure a factor of “flexibility of thinking” in an investigation of creativity thinking. Later the factor was classified in the structure-of-intellect (SI) model in the cell for divergent production of semantic classes (DMC) (Guilford, Christensen, Merrifield, & Wilson, 1978).

The test contains two forms (B and C) divided into two parts with three objects each (total 12 objects between the two forms), with a statement of its ordinary use. The participants are to list up to six other alternate uses for the object, in a time range of four minutes for each part (see Table 1 for an example). The separation of the time between the parts of the test is to help the participants to distribute their time evenly among the parts.

Table 1

Example of an item in Guilford Alternate Uses given in the instruction manual.

Newspaper (used for reading):	
1.	Start a fire
2.	Wrap garbage
3.	Swat flies
4.	Stuffing to pack boxes
5.	Line drawers on shelves
6.	Create a kidnap note

Note. This item is not included or scored in the actual test.

When scoring the test, each response should be marked with (1) acceptable or (0) unacceptable. An acceptable alternative should be possible for the object. This alternative should be different from the given use, different from the other alternative uses of the object, and is not vague or general. All acceptable alternative uses count as one, and are summarized to give the response data for the subject.

What causes mind wandering?

There can be many reasons that may cause the mind to wander. There are those who discuss that mind wandering is the result of temporarily depleted executive resources. For example, the executive failure hypothesis state that the goal of every task and activity fall in one of two categories: concrete or abstract (McVay & Kane, 2010; Watkins, 2008). A concrete goal could be “buy some apples”, and an abstract goal could be “make a good impression”. The concrete goals provide an effective guidance for completion causing minimal mind wandering, and the abstract goals lead to increasing mind wandering (Watkins, 2008). The concrete goal has a very clear description of what is expected, it is easy to do and it is easy to focus on the task. The abstract goal has an unclear path of completing the goal, for instance, to make a good impression is very subjective dependent. It is hard to do, and that makes it hard to focus. Naturally, the construal of the goals is related to many different factors. Examples are, task demands (simple task can have abstract goals, but hard task need to have concrete goals), goal progress, self-esteem, mood and executive control (McVay & Kane, 2010; Watkins, 2008)

In the field of educational psychology, Smallwood, Fishman, and Schooler (2007) described education as a dynamic interchange between the internal and external worlds and that mind wandering occurs when the individuals attention is directed towards its personal thoughts and feelings. They saw that different levels of task engagement triggered different levels of mind wandering. Superficial engagement (signal detection) caused frequent mind wandering, moderate engagement (list learning) caused moderate mind wandering and deep engagement (reading) caused infrequent mind wandering. Thus, tasks that rely heavily on controlled processing will leave few working-memory resources available for mind wandering (Smallwood & Schooler, 2006), so mind wandering will occur more frequently when the task is simple and automatic than if it is demanding.

Many studies have investigated mind wandering that occurs during reading. The study of Smallwood, McSpadden, and Schooler (2008) gave results indicating that the narrative of the text can predict the reported mind wandering. For example, when the narrative gave a clue of the villain’s identity it resulted in readers that were more successful. McVay and Kane (2012) found that mind wandering was a significant mediator in the relationship between the working memory capacity and reading comprehension. This means that mind wandering reduced the working memory capacity and thus influences the reading comprehension.

Metacognition describes the knowledge and insight one has in its own thought processes, and are greatly connected to mind wandering. Allen et al. (2013) found that task-unrelated thoughts are damaging to task performance, and that fluctuations in attention between self-generated and external task-related thoughts is a characteristic of individuals with greater metacognitive monitoring capacity. Meaning that achieving a balance between the internally and externally oriented thoughts could optimize task performance. There seems that the mind is only spontaneously aware of engaging in mind wandering (Allen et al., 2013), meaning that the mind can be unaware of its wandering from a task.

Further, results indicated that depressed students showed an increase in mind wandering across a wide range of tasks (Smallwood et al., 2004)**,** and it is proposed that this could be a result of the groups restrain to adopt metacognitive strategies for controlling their attention.

There also seems to be a connection between mind wandering and mood. Smallwood, Fitzgerald, Miles and Phillips (2009) conducted a study which results indicated that, compared with a positive mood, participants who had been primed with a negative mood did more errors in a continuous performance task. This prevented them from adjusting their behaviour following a lapse, and a greater amount of preoccupation with self-relevant concern. There was no difference between negative and neutral conditions. This study proves that the state of mind also seems to be linked to mind wandering. They also underlined the possibility that positive affective states also trigger mind wandering, and that the effects are showed in Smallwood et al. (2009) study are not unique for negative mood.

Mind wandering enhancing creativity – Baird, Smallwood, Mrazek, Kam, Franklin and Schooler.

Solutions to problems and inspiration have a tendency to come to mind when people are engaged in thoughts or activities that are not aimed to solve the problem. For example, new ideas and solutions come when walking to work, or while playing the violin. Little research has been done to investigate this phenomenon, but some interesting results have been published.

Baird et al. (2012) investigated whether the performance on a creativity test was associated with the level of difficulty of the task. They used an incubation paradigm to assess whether performance on validated creativity problems (the Unusual Uses task, see *measuring creativity*) could be facilitated by engaging in either a demanding or an undemanding task. After the participants completed the baseline UUT, they were assigned to one of four tasks: a demanding task, an undemanding task, rest and no-break. The tasks were thought to maximise the mind wandering of the participants. A computer screen showed the tasks, and the participants were to respond on the stimuli shown. The demanding task showed numbers from one to nine. The non-targets were coloured black and the target numbers were shown infrequently. In the undemanding task the target numbers were also in different colours. The participants were also to determine whether the stimuli was even or odd. Then they completed another UUT test to measure post-task creativity, and a subscale to assess propensity to mind wandering.

The results showed that engaging in an undemanding task during an incubation period led to improvements in performance on previously encountered problems compared with the other conditions. The context which improved performance after the incubation period was associated with higher levels of mind wandering but not with a greater number of explicitly directed thoughts about the UUT (Baird et al., 2012). These results show that there is a possibility that simple external tasks that allow the mind to wander may facilitate creative problem solving.

Activity

The body reacts on behalf of the mind, and the mind is influenced by the body's signal. One can say that there is a connection between mind and body. Research have documented several ways that activity can influence cognition, e.g. that physical activity can have a protecting effect on cognitive decline (Kramer, Erickson, & Colcombe, 2006). Most of this research defines activity as aerobic activity (running), but there is also an effect of moderate activity (walking) on cognition.

Creativity and activity – Oppezzo and Schwartz's study

With four experiments, Oppezzo and Schwartz (2014) demonstrated that walking has a positive effect on creative thinking. They stated that the effect is not caused by the increased perceptual stimulation of moving through an environment, but of the walking.

In the first experiment, the participants completed a divergent creativity task (GAU; Guilford Alternate Uses test) first when sitting and then when walking on a treadmill. To determine if walking had an effect on creative ideation alone, and not to cognition in general, they asked the participants to complete a convergent thinking task (CRA; compound remote-association test) when sitting and walking. The researches states that the distinction between the free-flowing divergent thinking of GAU and the tight constraint satisfaction of CRA, creates a good measurement to determine whether walking has a whole effect on cognition or if it has a selective effect of one kind of thinking. Their results showed that walking had a large effect on creativity, and the average increase was 60%. The participants did worse on the CRA when walking compared to sitting, indicating that the creativity outcome of GAU is not because of global facilitation.

In the second experiment, they used the same sit-then-walk condition as the first. They included a second condition where the participants would sit in both sessions, and a third where the participants walked first, then sat. They used the GAU to measure divergent creativity, and the CRA was excluded from this experiment. Results confirmed the conclusion from the first experiment that walking enhances creativity, and concluded that practice cannot explain the effect. Those who walked did better than those who sat, and those who only sat did not improve across sessions.

In the third experiment, the researchers exchanged walking on a treadmill with walking outside. A fourth condition involved two sessions with walking. The results again confirmed the previous conclusion, walking increased the divergent creativity outcome. The effect of walking did not reduce when participants walked twice. To separate the effects of moving outdoors from the effects of walking indoors, they conducted a fourth experiment where the participants either walked or were pushed in a wheelchair outdoors. Even though they changed the measured creativity to analogical creativity by using BSE (Barron's symbolic equivalence task) they found results supporting that walking enhance creativity, and that walking rather than being outdoors was the cause of that effect. The researchers stated that while research indicates that being outdoors has many cognitive benefits, walking has a very specific benefit: The improvement of creativity.

Mind wandering and activity – Seli, Carriere, Thomson, Cheyne, Martens and Smilek

Carriere et al. (2013) investigated whether the individual differences in the tendency to be inattentive and to mind wander in everyday life, was related to the tendency to make spontaneous and involuntary movements (fidgeting). Fidgeting (superfluous body movement) is commonly thought of an indication of boredom, irritation and a lack of attentional engagement. Their results showed that the behaviour of the mind was strongly tied to the behaviour of the body, in ways that perhaps extend beyond natural intuitions. They also concluded that fidgeting behaviour is linked to decreased attention span and spontaneous mind wandering. The researchers expressed that it seemed that an individual who has a mind that tends to spontaneously wander away from a task has a body that tends to wander as well.

Seli et al. (2014) took these results further and investigated the hypothesis that failures of task-related control that occur during episodes of mind wandering, are associated with an increase in extraneous movements (fidgeting). They measured mind wandering by probes during a metronome response task (MRT) where the participants had to synchronize their response (pressing a button) with a tone. This they did while sitting on a Wii Balance Board that measured their level of activity.

Their results showed that relative to on-task periods, only deep mind wandering was accompanied by increases in fidgeting. They suggested that mind wandering is associated with cost on both primary-task performance and secondary-task goals, and those costs may depend on the degree of mind wandering.

Thesis statement

Since mind wandering enhance creativity (Baird et al., 2012), and creativity is increased by activity (Oppezzo & Schwartz, 2014), it opens for the possibility that mind wandering is a variable that is caused by activity, and works as an integrated factor in increasing creativity.

Prior research show that mind wandering is positively correlated to activity in form of fidgeting (Carriere et al., 2013; Seli et al., 2014). We though by manipulating the activity variable and introduced a control group in a study we would find results that would determine the causality between mind wandering and activity.

The statement is that there is a possibility to find results that show that during activity, mind wandering and creativity is simultaneously enhanced compared with rest.

Study

Purpose. The purpose of this study is to examine if mind wandering measured by SART and flexibility of thinking as creativity measured by a GAU test would both be enhanced simultaneously during a walking condition on a treadmill relative to an inactive control condition. We replicated the studies of activity increasing creativity by Oppezzo and Schwartz (2014) and mind wandering by (Seli et al, 2014). The experiment included randomized repeated measures on a creativity test (Guilford’s Alternate Uses; GAU) and a standard assessment of mind wandering frequency (Sustained Attention to Respond Task; SART) with and without walking on a treadmill.

We tested three hypothesis in this study. First, if mind wandering increases during activity. Second, if creativity increases with activity. Finally, if mind wandering and creativity were correlated.

Method

Power analysis and participants

The recruiting ended when our goal of 30 participants was met. We calculated the goal by using a priori power analysis where the effect-size was estimated to be around 0.5 (moderate effect-size). The effect size describes the effect in the population. The bigger it is, the easier it will be to find. The probability for a Type I error (false positive) was set to a recommended 5% ($\alpha = .05$), and the probability for a Type II error (false negative) was set at 80% ($\beta = .8$). The results from the analysis, checking for T-test with difference between two different means (matched pairs), showed a sample size of 34.

The study included 30 Norwegian students from the UiT- Norway's Arctic University between the ages 19 and 32 years (M = 22.8, SD = 2.9). Of these, 12 were male and 18 were female. 11 of the participants had completed a bachelor degree in psychology or similar, 2 were students in the third year bachelor, and the remaining 17 were students in the first year in psychology study.

The participants were recruited through the university's network page, and from Facebook. All participants volunteered to take part in the experiment. Participating in the study was accepted as a required task completion needed to take an exam later in a method subject. The first year bachelor students received a form which confirmed their participation in the study. All participants received a lottery ticket for participating and a chance to win a bigger price (gift card for the local cinema).

Design

This study was designed as a quantitative experiment with a within-subject design. It included SART and GAU testing as depended variables and with activity as a manipulated factor. The participants were to participate two times, and were counterbalanced to either walking or standing session first, and GAU form B or C. The two sessions were at least 12 hours apart to prevent a learning effect, and maximum three days apart.

The SART and GAU

This study used the Sustained Attention to Response Task (SART) to test the participants mind wandering. This was adapted from Robertson et al (1997). The SART is a GO/NOGO continuous performance task in which the NOGO stimulus appears infrequently. Errors by the participants are thought to be caused by failures of sustained attention (Robertson et al., 1997).

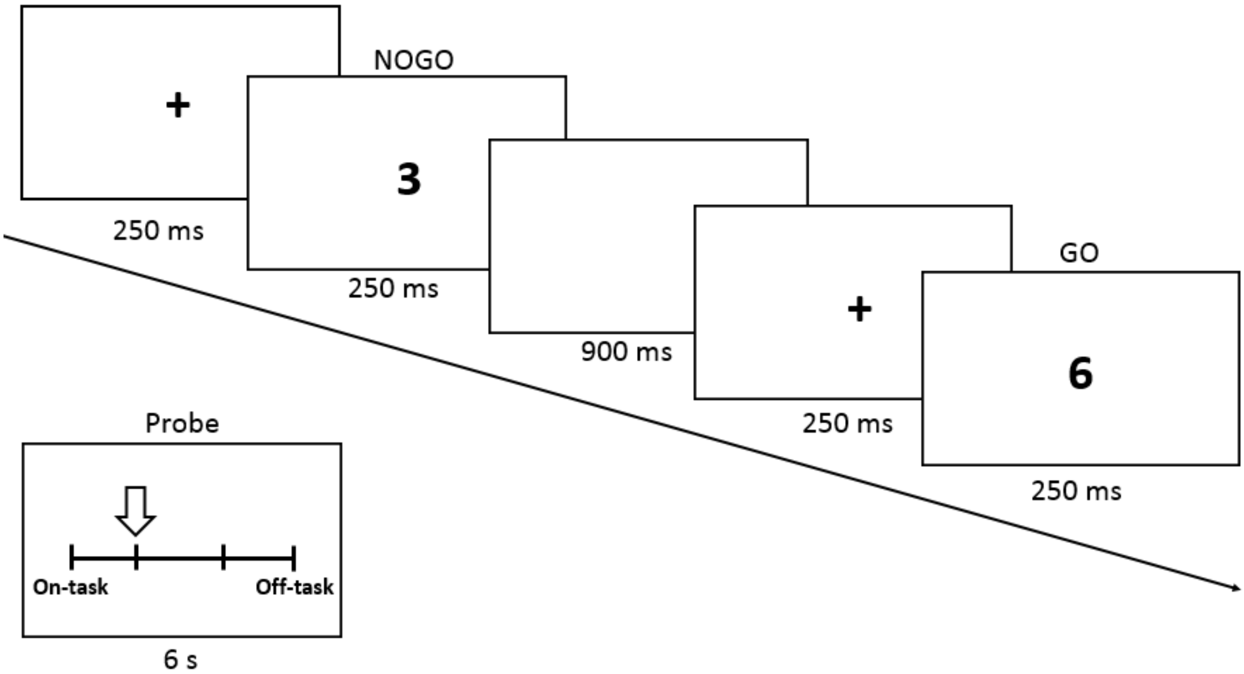
The test is computer based. A screen shows one number at a time between one and nine, and the participant is to push a button as a response at every number except the number three. The number three is therefore the NOGO stimulus, and appears infrequently. All other numbers are GO stimuli, and these numbers appear on the screen with a two second interval. This is a reaction time task so the participants are to react as fast and correct as possible. The reaction time over the test is then averaged and the total number of correct and incorrect responses are then summarized.

The SART also included a scale, with four levels that the participants were to determine their focus in the test (self-reported probe). ON-TASK and OFF-TASK were on opposite side of the scale. An arrow that could be moved with help of two buttons indicated their focus, there was not a possibility for a neutral answer. ON-TASK was described as total focus on the task, and OFF-TASK was when the participants either thought about task related (judging their performance) or on other things (for example a book they had read or what they are going to have for dinner).

This test was performed by Microsoft Windows pc with the help of the program PsychoPy. The SARTs parameters were programmed to show the space before the stimulus for 250 ms, and the stimulus itself for additional 250 ms. After showing the NOGO stimulus there was 900 ms space. The probe lasted for 6 seconds (see figure 1).

Figure 1

Illustrates the parameters of the SART in this study.



To measure creativity we used the Guilford's Alternate Uses task (GAU) developed by Guilford et al (1969). The test consist of two forms (B and C), both with two pages with a total of six everyday objects. The task is to list up as many as six other uses for the objects that itself or pieces of it can be used for. Each alternative use for the object need to differ from each other to be an accepted use. The use has to be specific and possible to perform. The participants get four minutes on each part of both forms (eight minutes total on each form).

To score the tests we used the scoring key provided by the test developers. We marked all the stated uses as either acceptable (1) or unacceptable (0). The use has to be possible to the object, different to the given use, and different as the other stated alternative uses. Vague or very general uses were not be rated as acceptable, but some given by the scoring key were accepted (some examples of responses that are too vague to be accepted: to have fun with, to break, to make something, to get, to use parts). Alternative uses that are interpretations of the object are also acceptable. For example, a “button” is not only appearing on clothing, and can be a symbol for a campaign or a club.

Analysis

This study uses different test to investigate the hypothesises. One of the testes is T-test. This study uses this test to determine if two sets of data are significantly different from each other. T-test is a statistical hypothesis test that follows a Student’s *t* distribution if the null-hypothesis is supported. The paired t-test (a repeated measures t-test) is used here because of the repeated measures in the test, because the same participants complete both the WALK and the REST condition.

Another test, Pearson’s product-moment correlation is used in this study to measure the correlation between the results from GAU and SART. Pearson’s product-moment correlation (Pearson’s *r*) measures the covariance of two variables divided by the product of their standard deviations. The correlation coefficient ranges from -1 to 1, where 1 implies a perfect correlation between the variable (when A increases so does also B) and -1 implies a perfect negative correlation (when A increases B decreases).

The study use Bayesian statistics to decide the probability of the alternative hypothesises compared to the null-hypothesises. Bayesian statistics make it possible to compute the probability of a hypothesis conditionally on observed data. It works directly with statistics, and can quantify the evidence for the null hypothesis. This means that it measures the possibility that the data conducted from the study is because the alternative hypothesis is true, the null hypothesis is true, or that there is too much noise in the data to see any tendencies. The value of the Bayes factor describe how much the alternative hypothesis is supported compared to the null-hypothesis. See Rouder, Speckman, Sun, Morey, and Iverson (2009) and Morey and Rouder (2011) for more information.

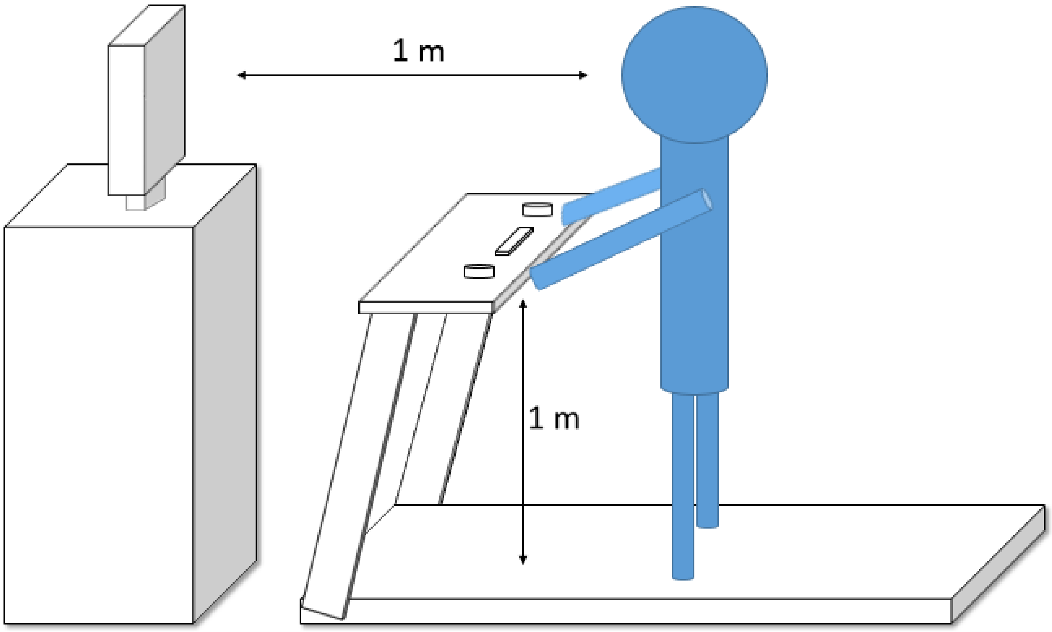
Procedure

The participants were recruited one by one as they contacted the experimenter and they were randomly distributed to either the walking or standing condition first. Which GAU form they would have to fill out first was also randomized across subjects. They were informed about which session they would participate in when they showed up for testing. The date for the next session was agreed upon when the first testing ended. We allowed a maximum of three days between sessions because of the limited flexibility of the students' days, and a minimum of one day.

A treadmill with a computer screen in front, and a keyboard on top of it was placed in a laboratory room at the university for the testing (see figure 2). The location and the setting was not changed through the collection of the data.

Figure 2

Shows the set-up of the computer screen, keyboard and treadmill, and the dimensions between them.



The participants were sent an e-mail describing where and when to meet, and were told to meet with the experimenter outside the laboratory. If they were doing a walking session, the experimenter helped them decide which speed on the treadmill would be comfortable to complete the task. We allowed a speed between 2 km/h and 5 km/h. This was estimated to be normal walking speed. We did not want the participants to feel fatigue and feel the activity as a strain, so they could complete the task.

The experimenter did not leave the room for safety reasons, and was there to answer any questions about the testing procedure while the instructions were given on the screen. While the participants completed the SART test, the experimenter sat in the back of the room and remained passive to the testing. To keep the participants from feeling observed and stressed by the presence of the experimenter, she occupied herself with reading and writing faced away from the treadmill.

The instructions for the SART were given on the computer screen. The instruction contained the information that there would be showed numbers on the screen between one and nine. The participants would hit any of the marked keys on the keyboard as a response on every number, except the number three. They were also instructed to respond as quickly and correctly as possible. The screen also gave instructions about the ON-TASK/OFF-TASK scale (measuring probe answers), and told the participants to place an arrow on that scale to describe their focus when performing the task. ON-TASK was described as total focus on the task, and OFF-TASK was when the participants either thought about task related (judging their performance) or on other things. There were given four rankings of the probe answers, and therefore not giving a possibility to answer neutral. At the end, the instructions gave the participants a trial at both responding to the numbers and the on-task/off-task question.

The SART was then completed by the participants either while walking or standing on the treadmill. After the SART was finished, they were told to sit at a desk for the GAU test (in both conditions). The experimenter gave standardized instructions included on the tests' manual on how to complete the task and gave an example. The participants were asked to evaluate some everyday objects, write down up to six other uses for the object, and to not use much time on each. They were also told that the alternative uses should be different from each other and were given an example of an unacceptable use. The participant then completed the test with the experimenter in the room timing the experiment. They got 4 minutes to complete each part of the GAU test (8 minutes total). The GAU forms were marked with ID and session number, but no information about the independent variable in that session.

When the participants completed the walking session, they were asked to fill out a form, which asked for the demographic information for each participant. Questions including age, sex, education and treadmill speed. After the second session, the experimenter gave the participants a lottery ticket and a signature on a participating form for the first year students. They were thanked for their cooperation.

Analysis procedure

To estimate inter-rater reliability, both the experimenter and the instructor scored the GAU forms separately. In addition, unique GAU results were counted for each participant. The participants got points by giving alternative uses that was not given by any of the other participants. If two or more participants gave the same use for a specific object, the response did not count as unique for either (Oppezzo & Schwartz, 2014). To compare the mean between the variables from SART and GAU to the conditions we used the *R* software for statistical computation (R Core Team, 2015). Paired t-tests were used to assess significance of the difference of the means, correlation tests using Pearson's *r* were used to investigate correlations between propensity of mind wandering and creativity, and Bayes factors were calculated using the BayesFactor package in *R* (Morey & Rouder, 2015).

Three hypothesis were tested in this study: (1) Mind wandering increases with activity, (2) creativity increased while walking, and (3) that mind wandering and creativity are correlated between subjects. As mentioned before, the SART gives several measurable variables that can indicate mind wandering: commission error, omission error, RT and probe (Cheyne et al., 2009). To analyse if any of these give results indicating mind wandering the variables in the different condition were tested in a paired two-way t-test, for example: the mean of the number of commission errors during condition WALK, compared to the number of commission errors during condition REST. All these variables were tested this way. This study also included Bayesian statistics and calculated the Bayes factor on each of the variables. The Bayes factor gives the odds-ratio (probability of the null-hypothesis divided by probability of the alternative) and can quantify evidence both for the null- and the alternative hypotheses (Wetzels et al., 2009). Bayes factors are categorized into different types, indicating if they mirror evidence in favour of the null- or the alternative hypothesis. The Bayes factor in favor of the null-hypothesis is called BF_{01} and the one in favour of the alternative is called BF_{10} (where $BF_{10} = \frac{1}{BF_{01}}$). For example, if we find a Bayes factor of BF_{10}=5, than the alternative hypothesis would be 5 times as likely given the data compared to the null-hypothesis. See table 2 for a classification scheme.

Table 2

Classification scheme for Bayes factor for testing null-hypothesis against the alternative hypothesis. Includes the changes done by Wagenmakers, Wetzels, Borsboom, and van der Maas (2011).

Bayes factor, BF_{01}	Interpretation
>100	Extreme evidence for H_0
30 – 100	Very strong evidence for H_0
10 – 30	Strong evidence for H_0
3 – 10	Substantial evidence for H_0
1 – 3	Anecdotal evidence for H_0
1	No evidence
1/3 – 1	Anecdotal evidence for H_1

1/10 – 1/3	Substantial evidence for H_1
1/30 – 1/10	Strong evidence for H_1
1/100 – 1/30	Very strong evidence for H_1
< 1/100	Extreme evidence for H_1

Note. Originally was "anecdotal" "worth no more than a mention", and "extreme" was "decisive".

The GAU results were separated into two groups: all accepted GAU results (any alternative use that are acceptable) and unique GAU results (alternative uses that only one participant reported and are unique from the rest). Inter-rater reliability was calculated using Intraclass Correlation Coefficient (ICC). The paired one-tailed t-test was used to compare both groups of GAU results to the conditions, for example: the mean of the number of all accepted GAU results in condition WALK, compared to the mean of the number of all accepted GAU results in condition REST. Bayes factor for these two variables was also calculated. For all accepted GAU results the alternative hypothesis was tested against the null-hypothesis (this calculation was directed this way because of a small p-value, see the results section). For the unique GAU results the null-hypothesis was tested against the alternative hypothesis.

Pearson's *r* was used to calculate the correlation between mind wandering and creativity. The probe answers variable as indication of mind wandering, and the accepted GAU results variable as a measure of creativity were used to measure the correlation. The other variables (commission error, omission error, RT and unique GAU results) were not included in testing the hypothesis if mind wandering and creativity are correlated.

Results

The two-tailed paired t-test on the means of the number of commission error during the conditions WALK compared to condition REST revealed no significant differences ($t(29) = .80$, $p = .42$). The Bayes factor for the comparison of the two condition on commission error showed a substantial evidence for no difference between the commission errors in the different condition ($BF_{01} = 3.83$). In addition, the difference of mean of omission error in the two conditions were not significant ($t(29) = 1.64$, $p = .11$). The Bayes factor of omission error during both conditions showed an anecdotal evidence for no difference ($BF_{01} = 1.54$). Analysis also showed no significant difference between the mean of reaction time (RT) in the conditions ($t(29) = .67$, $p = .51$. The Bayes factor showed a substantial evidence for no difference between the RT in the different condition ($BF_{01} = 4.18$). There was also no significant difference between the self-reported probe score in the WALK and REST condition ($t(29) = .60$, $p = .55$). The Bayes factor for the probe scores was the strongest, but still only showed a substantial evidence for a difference in scores between the conditions ($BF_{01} = 4.36$). See table 3.

Table 3

Results of the analysis to find if mind wandering increases during activity (SART-results and probe).

Variables	Paired T-test				Bayes factor
	T	df	*p*	95% CI	
commission error (WALK vs. REST)	.801	29	.42	-2.89 6.63	3.83
omission error (WALK vs. REST)	1.647	29	.11	-.69 6.43	1.541
RT of GO trials (WALK vs. REST)	.671	29	.50	-.01 .02	4.18
probe score (WALK vs. REST)	.598	29	.55	-.11 .20	4.36

Note. Two-tailed paired t-test. Bayes factor is analysed by testing null-hypothesis against the alternative hypothesis (BF_{01}).

The inter-rater reliability measured by the Intraclass Correlation Coefficient (ICC) showed an acceptable level of agreement between the two raters of GAU score both during the WALK condition (*ICC*(A,1) = .88, $F_{(29, 17, 1)}$ = 18.5, p < .01) and REST condition (*ICC*(A,1) = 0.85, $F_{(29, 27, 7)}$ = 13.2, p < .01). See figure 3 for graphs. Comparison of the means of all accepted GAU results in both WALK and REST conditions showed no significant difference (t(29) = 1.34, p = .09). The Bayes factor showed strong substantial evidence that the alternative hypothesis is true (BF_{10} = 8.72). The comparison of the means of the unique scores of GAU also showed no significant difference between the conditions (t(29) = -1.38, p = .91). The calculation of the Bayes factor showed strong substantial evidence for the null-hypothesis (BF_{01} = 9.35). See table 4.

Figure 3

Shows the graphs of the inter-rater reliability in both WALK and REST condition.

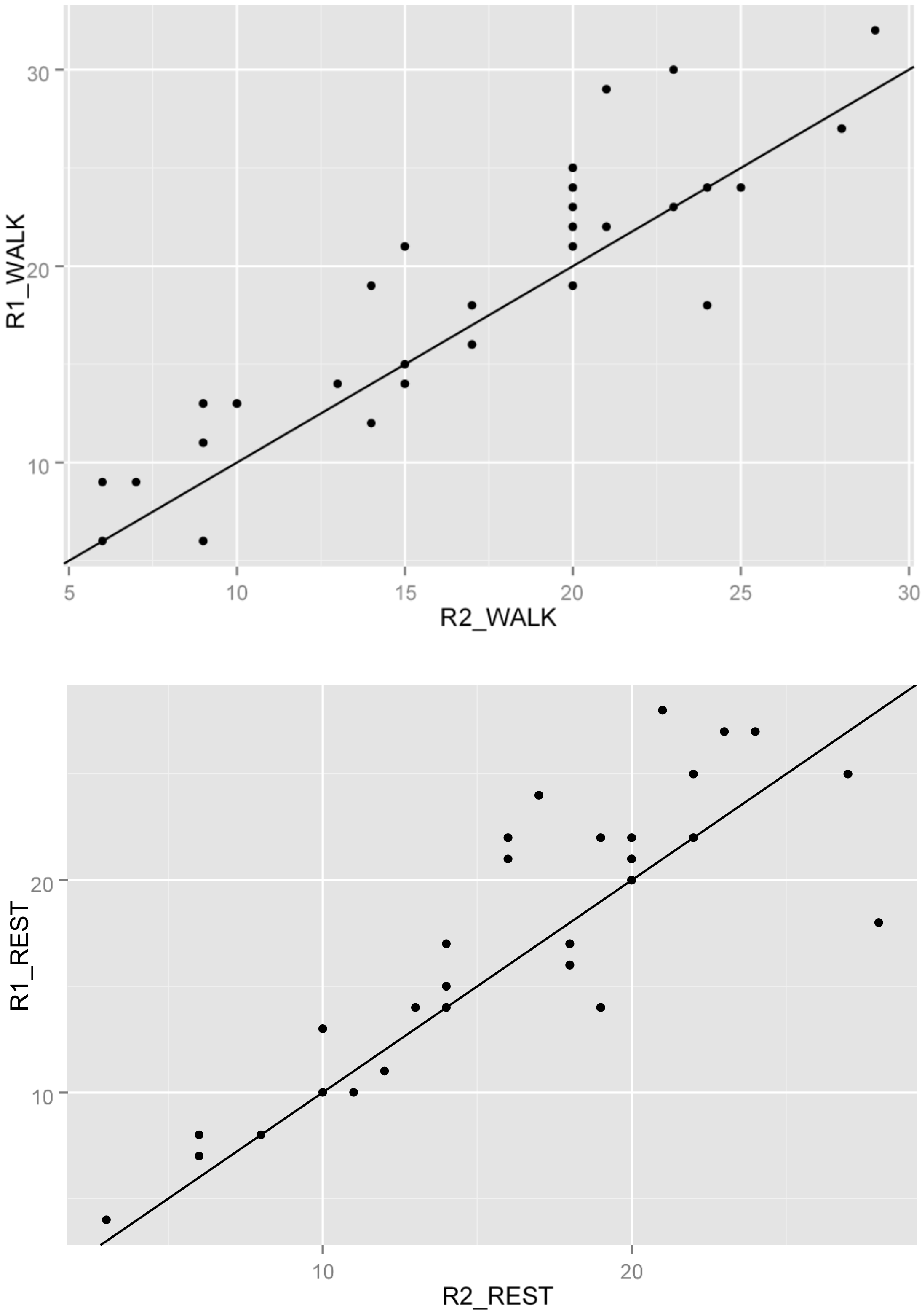


Table 4

Results of the analysis to find if creativity increases during activity (GAU-results).

	Paired T-test				Bayes factor
Variables	T	df	*p*	95% CI	
Accepted GAU (WALK vs. REST)	1.345	29	.09	-.26 Inf	8.72*
Unique GAU (WALK vs. REST)	-1.38	29	.91	-.81 Inf	9.35**

*Note. One-tailed paired t-test. *Is tested as BF_{10} ** Is tested BF_{01}*

The Pearson's r analysis showed no significant correlation whatsoever (see table 5) between the GAU score and probe answers in the WALK condition (*r* = *-.15*, *p* = .43), nor in the REST condition (*r* = -.06, *p* = .76).

Table 5

Results of analysis to find if participants with higher GAU score also have higher introspective mind wandering scores (probe answers and all accepted GAU results).

	Pearson's *r*			
Variables	r	df	p-value	95% CI
Probe - GAU (WALK)	-.15	28	.428	-.484 .222
Probe - GAU (REST)	-.06	28	.759	-.410 .308

Discussion

The study had three hypothesises: (1) Mind wandering increases with activity, (2) creativity increased while walking, and (3) mind wandering and creativity are correlated between subjects.

The results from the SART did not confirm the hypothesis of mind wandering increasing with activity. There was no significant difference on responses to the NOGO stimuli between the conditions WALK and REST, meaning that the participants responded when the number three was on the screen indifferent in both conditions. Nor was there a significant difference between not responding to GO stimuli in the two conditions, the participants did not withhold a response to all GO numbers more in one condition than the other. The analysis also showed no significant difference between the reaction time during WALK and REST. There was also no significant difference in self- reported mind wandering between the conditions. Overall, no significant difference between the variables that indicate mind wandering during activity compared to inactivity were found, and the study has been unsuccessful in showing that mind wandering increases with activity and confirming the hypothesis. The Bayes factor, though small, showed evidence for supporting the null-hypothesis, suggesting that it is more likely that there is no difference between the conditions given the data.

The analysis of all accepted GAU results in both WALK and REST conditions gave an acceptable inter-rater reliability, but neither of the GAU results (all accepted or unique) showed a significant different result after activity and inactivity. The participants did not seem to have increased “flexibility of thinking” after a walking session. The results show that the study failed to find support for the idea that creativity increases with activity thus failing to confirm the second hypothesis. The Bayes factor showed strong substantial evidence that there is a difference between all accepted GAU results in the two conditions (keeping the alternative hypothesis). This means that there is something there, but the study was not consistent enough and/or had too few participants to give a significant result. There was also strong substantial evidence that there is no difference between the unique GAU results in the two conditions (keeping the null-hypothesis).

The third and last hypothesis postulates that mind wandering increases simultaneously with creativity. The results from the analyses with Pearson's *r* showed no significant correlation between probe scores and creativity. This means that the study failed to find that participants with higher GAU score also had higher introspective mind wandering scores.

In conclusion: The study failed to replicate the findings of Seli et al. (2014), Oppezzo and Schwartz (2014) and Baird et al. (2012). These studies show that there exists a connection between mind wandering and activity (Seli et al., 2014), creativity and activity (Oppezzo & Schwartz, 2014), and mind wandering and creativity (Baird et al., 2012). This research did not replicate the prior results and this may be because of the small sample, or inconsistence in the procedure compared to the other studies.

However, there was one particular result in our study that could be of interest. We saw all accepted GAU results in the conditions going the anticipated way (increasing in the activity condition, compared to rest), and this had a low p-value (p =.09), but still not significant. This indicates that there would possibly be something significant given a sufficient number of participants, and could have replicated the results of Oppezzo and Schwartz (2014). These GAU results had also the highest Bayes factor in favour of the alternative hypothesis.

Comparison of the study to previous research

The study conducted by Seli et al. (2014) looked at the association between mind wandering and activity, but their procedure differ in some ways from this experiment. The activity variable in that study was described as fidgeting and was measured by using a Wii Balance Board, which the participants sat on. They used the Metronome Response Task (MRT) to measure the sustained-attention and collected the probe answers from the participants where they reported their level of task-attentiveness. The biggest difference between these studies was that the activity variable was manipulated in our study, and measured in the prior study.

Seli et al. (2014) measured if self-reports of mind wandering were associated with an increase in fidgeting, and our study made the participants complete the test with and without walking on a treadmill. Our study did not control for any fidgeting the participants did under the REST condition while standing on the treadmill, nor the level of activity in the WALK condition during the self-reported mind wandering. The participants were not asked to hold the body as still as they could, as the participants in the prior study was (Seli et al., 2014). Compared with sitting, the standing could hurt the participant's joints if they were to stand as still as possible. In addition, the prior study used Metronome Response Task (MRT) to measure the sustained-attention (Seli et al., 2014), and this current study used the SART, which are both sustained-attention tests, but differ in some aspects.

Seli et al. (2014) saw that mind wandering and activity were connected, but could not conclude that mind wandering was caused by activity. Our current study had a theory that activity on the treadmill caused mind wandering to occur more easily, but there are many levels of activity, and they can span from twining fingers to climbing mountains. A problem that arises is defining what too little or too much activity in a study like this is. It is possible that different levels of activity could have different influences on mind wandering, because high levels of activity could take away more cognitive attention from the task.

There is also a possibility that mind wandering causes activity. As shown in Seli et al. (2013) study, only deep mind wandering was accompanied with activity. Indicating that when the mind wanders it takes attention away from the task, and makes the participants more "forgetful" about sitting still, leading to more fidgeting.

In our study the activity variable did not occur naturally with mind wandering and it was constant during the WALK condition. This study wanted to show that activity causes mind wandering, but there were no significant results suggesting such a relationship between the two, and no strong evidence from the Bayes factor for the opposite hypothesis either, for that matter. This however should not be taken to mean that the possibility of such a relationship should be excluded or ignored in further research.

In Oppezzo and Schwartz (2014) study of the positive effect of walking in creative thinking, they measured the GAU results while the participants either sat, walked on a treadmill, walked outdoors or pushed in a wheelchair outdoors. The participants in our study completed the GAU test after the SART while either walking or standing on a treadmill indoors. There could be a possibility that if the participants in our study also had to either walk or sit while completing the GAU it would give results that would be in accordance with the prior study of Oppezzo and Schwartz (2014).

Both of the prior studies by Seli et al. (2014) of mind wandering, and by Oppezzo and Schwartz (2014) of creativity, include sitting as the rest condition. One might then ask whether standing, as was done in our study, can be defined as a "rest" condition. Standing is undoubtedly requires more activity from the subject, and might not be as qualitatively different from an activity condition as sitting is. A normative, single-group study investigated if there was a difference in electromyographic activation of specific muscles in the pelvic area while in standing postures compared to sitting postures. The results of the study showed that muscles that stabilize the erect postures are not active in passive postures like sway standing and slope sitting (O'Sullivan et al., 2002).

The participants in our study did not have the opportunity to engage in slope standing or to support their body while responding to the SART. This could mean that the standing condition did not cover the desired REST condition. This also could be one of the possibilities to why this study did not get significant results.

The study by Baird et al. (2012) which investigated the connection between mind wandering and creativity by letting the participants complete tasks of different levels of demandingness and measured their performance on creativity problems (the Unusual Uses task, UUT). Our study did not increase or decrease the SARTs difficultness. There is a possibility, supported by the data of Baird et al. (2012), that the SART was too difficult to let the participants engage in the cognitive aspects that take place to improve task performance.

In all of these three studies they used a bigger sample: 82 and 125 participants contributed to the results from the two studies in Seli et al. (2014), a mean of 46 across the four studies of Oppezzo and Schwartz (2014) and 145 participants in the study of Baird et al. (2012). Our sample is small compared to these, with the size determined by a simple power analysis.

Limitations and weaknesses

As mentioned, there are some limitations and weaknesses to this study. One of the biggest weaknesses is the small sample. In order to find significant result with a small sample it is necessary to have a strong effect size. The other is the weakness in the REST condition, as discussed; it might not be giving the desirable level of rest. The logistics of the laboratory where the tests were conducted meant that the participants could not sit during the REST condition, as discussed above.

There are also other weaknesses and limitations in the study. Generalizability applies to the question if the results in a study can be transferred to situations and people other than those originally investigated. One must be cautious to generalize these finding, in both our study and prior studies. One reason is that all the participants in this study were university students. The students from this study were exclusively psychology students, a lot of whom are used to participating in studies/experiments and know more about the testing procedure relative to other students, and especially to the general population. The results that our study show are limited to this group of students. The population of student do not automatically represent the world population, and effects that are seen in the student population should not transfer without consideration to other populations.

In addition, participation was voluntary and the participants were recruited via Facebook or the university's network, which means they were not randomly recruited. The first year students were very motivated compared to the rest, because of the subject requirement needed to be completed before the students could take the exam. These students could have different aspects with themselves than if the study was to include other student groups.

The MA students who volunteered can also be thought of as biased. These students were involved in their own projects which also included data collection, and there is a high possibility that they participated out of altruistic motives knowing the stress caused by recruiting enough participants. This would also reduce the representativeness to population of the results.

Finally, the description on the university's student page described the study as a study that investigated mind wandering and creativity, and that the participants were required to walk on a treadmill on one of the conditions. There could be the possibility that people that were creative, active, and more or less prone to mind wandering felt more drawn to partake in this study. This again could have impact on what part of the population that felt drawn to the study and resulting in data that were not representative to the population.

Confounding variables

As in all experiments, there will exists confounding variables. A confounding variable is an extraneous variable in an experimental design that correlates with both the dependent and independent variable, and could make either a false conclusion or too much variation in the data. Different confounding variables can explain some of the reason that this study did not get significant results. The solution to this problem is to control for confounding variables either by matching them, by randomizing them, or by statistical control.

Individual differences. Individual differences, such as creativeness can give large differences in the data. In our GAU results it was clear that the participants showed individual differences: Some scored high on accepted responses on both GAU forms, and some participants scored low on both. Barron (1955) found a possibility that creative people seemed to be more complex, dominant and impulsive. Garwood (1964) also found that creative people tend to be more dominant, he also concluded them to be more sociable and self-accepting, but less socialized, less affectionate, and less interested in making a good impression and could possess less self-control. Studies have also showed that highly creative people are more sociable and like to help others more than average (Windholz, 1968). Wade (1971) found creative adolescents to be a hobbyist, a collector, a musician, an artist, and a frequent sportsman. These adolescents read as much as others, watch TV less, and generally expose themselves to more highly diversified activities than their less creative peers. All of these differences in the participants might interact with the results. Our non-persistent GAU score indicates that there are relations to the aspects of the individual's proneness for creativity, that we have not controlled for in the study.

Experience with the objects could decide the amount of alternative uses suggested. For instance, Iscoe and Pierce-Jones (1964) found a difference between race on the item "newspaper". The African Americans were better to propose more uses for newspaper because they had more experience and need for it (isolation, starting a fire, packing food). These are probably due to culture and socioeconomic status, but this finding could be transferred to this study. The participants are young adults and students, and many of the items listed in the GAU could be items that students often do not use, and others they might use more often.

Time effects. Time of the day is a confounding variable that could very possible influence the data, making them unstable. Sleep has an impact on memory (Barrett & Ekstrand, 1972), the testing of the participants occurred between 9 am to 3 pm. This means that those participants who were tested in the morning were more rested, compared to those who were tested later. Some of the participants who were tested in the afternoon had been to lectures, and were probably tired. In addition, some of the participants had worked out before coming for testing.

Observation effects. Reactivity is a phenomenon were participants alter their response or behaviour due to the awareness that they are being observed. In this study the experimenter had to stay in the room when the participants walked on the treadmill because of safety issues, and to keep the continuality of the experiment the experimenter was in the room also in the REST condition. Even though the experimenter did not observe the completion of the test, there could be a possibility that their mere physical presence influenced the SART results, and making the data unstable (Svartdal, 2009).

Mood. The mood of the participants was not controlled for in this study. Still, there seems to be a connection between negative mood and mind wandering. Studies has seen that positive mood was associated with better ability to adjust performance after a lapse. Negative mood seemed to reduce the amount of attentional commitment to the task, and it may because it increases the focus on task irrelevant personal concerns (Smallwood et al., 2009). Others have found that mind wandering cause of negative mood, and not the consequence (Killingsworth & Gilbert, 2010). Which mood the participants was in when they completed the SART is an interesting aspect to look on in further studies.

Frustration. Frustration during a task interrupts the cognitive flow, leading to a negative cognitive loop that causes more errors (Baker, D'Mello, Rodrigo, & Graesser, 2010). The experimenter experienced frustration of varying degrees during the SART from the different participants. The test generated different levels of frustration that could have an impact on the results. A frustrated mind is not very focused, and for example, one might think that participants who got frustrated over not successfully withhold response on NOGO errors, had leads to even more mistakes. It might even be thinkable that the frustration carries over to the GAU test.

Future studies

This study did not get significant results, but can be a source of inspiration and used as an idea to build new research on. There are some varying factors future studies should be aware of if trying to replicate this study done on the subject of mind wandering and creativity, and their relation to activity.

First, studies should recruit more participants than the power analysis proposes. This way, one can counteract participant attrition, and it supports the results by reducing the chance for the results to appear from coincidence. It also helps reducing the impact experiment noise can have. It also make it easier for the researchers to discover outliers in the data. On the downside, it increases the time and cost of the experiment.

It could also be a good idea to control for mood and time effects that could influence the participants. Research has shown that mind wandering is affected by mood (Smallwood et al., 2009), and time of day indicates the weariness of the participants. Questions regarding this could be included in a survey that the participants complete before each condition.

One of the factors that might be the most important to reconsider is to design the REST condition which lets the participants have a resting body posture. As it has been discussed, standing is not quite relaxing as sitting (O'Sullivan et al., 2002). If the activity variable was measured/performed in way that there is no need for a second person in the laboratory for safety caution, it could affect the results and reduce the noise from the data.

There also are other analysis that future research can look into. For instance, a more detailed look into the thought probes and behaviour in the SART data. For example, whether anticipations, commission and omission errors are more common before or after thought probes.

Implications

How mind wandering and creativity increases with activity is an interesting question to answer, because results that confirm a positive correlation between creativity and activity can, for example, have an impact on how the society construct the classroom and education systems for children and adolescents. The increase in the population is not compatible with the increase of schools and the development of education systems, and this result in an increasing number of pupils on every teacher. To manage this number of pupils and teach them the required curriculum the pupils are restricted to classroom lectures. P.E and recess are the only times the pupils can be active. The pupils have to sit still by their desk and have their attention directed to the blackboard. If studies show a positive correlation between mind wandering, creativity and activity it could become the foundation to force the society to think differently on how to improve learning and teaching conditions.

On the other hand, some researchers investigate how to decrease mind wandering during classroom lessons. They suggest that the school system could decrease mind wandering in classrooms by letting the students participate in deep engagement with the lessons, and by introducing metacognitive training by changing the relationship between individuals and their thoughts (Smallwood, Fishman, et al., 2007). These results that have educational effects in mind could also possibly generalize to work oriented development, to increase effectiveness and happiness in the work station.

Research on mind wandering and activity help us understand occurrences that not only happen to the normal population, but also the more uncommon cases. One example is a case were excessive daydreaming gave a patient distress, a nearly obsessive-compulsive behaviour to daydreaming. The interesting about this case is that the patient had walked in circles shaking a string for sometimes hours at a time, while imagining creative stories (Schupak & Rosenthal, 2009).

In addition, knowledge on mind wandering can have an impact on the knowledge on how depression works. It is already known that when peoples mind wandered frequently, they were less happy when their minds were wandering, and that what they were thinking was a better predictor of their happiness than what they were doing (Killingsworth & Gilbert, 2010).

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