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The Impact of Cognitive Stimulation through Artificial Intelligence on the Creative Performance of Adaptors

Master Thesis - Innovation and Entrepreneurship

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Name	Henco Schaap
Student number	1011010
Supervisor	dr. M.M. Weiss
Second examiner	dr. V. Blazevic

Abstract

This study investigates the effect of cognitive stimulation through Artificial Intelligence (AI) on the relationship between the extent of adaptive cognitive style and creative performance. Building upon the Adaptation-Innovation theory, which positions individuals on a continuum from adaptive to innovative cognitive style, this research investigates the potential of cognitive stimulation through AI to trigger adaptors to think beyond their usual frameworks and reach higher levels of creative performance. A between-groups experiment was conducted, with participants randomly assigned to either the AI manipulation group or the control group. The study employs a questionnaire to measure cognitive style based on the Kirton Adaption-Innovation theory and a creative task to assess creative performance. The AI manipulation group receives pre-generated AI input, while the control group completes the task without any assistance. The impact of cognitive stimulation through AI on creative performance is analysed based on the fluency and originality of ideas generated. The findings of this study contribute to the understanding of conditions that enhance the creative performance of adaptors and explore the potential of AI in enhancing creative performance. The study found no moderating effect of cognitive stimulation through AI on the relationship between the extent of adaptive cognitive style and creative performance. The potential impact of cognitive stimulation by AI on creative performance may be hampered by an adaptive cognitive style that resists new technologies.

Keywords: *cognitive stimulation, artificial intelligence, creative performance, Adaption-Innovation theory, cognitive style*

1. Introduction

Innovation is indispensable for an organization to survive and maintain a competitive advantage (Gumusluoglu & Ilsev, 2007; Hughes et al., 2018). Innovation is largely driven by creativity, which is the capacity of people to come up with original and useful ideas (Anderson et al., 2014; Woodman et al., 1993). Since then, there has been a lot of interest in research into the factors that foster individual creativity within organizations (Zhou & George, 2001; Probst et al., 2007; Amabile et al., 1983; Baer et al., 2003). According to one research tenet, cognitive style can explain a person's creative performance (Torrance, 1974; Simonton, 1988; Kirton, 1984). The term 'cognitive style' refers to persistent individual differences in how people perceive the world, think about it, approach problems, learn, make decisions, and interact with others (Aggarwal & Woolley, 2019).

The Adaption-Innovation theory (KAI) by Kirton has received a lot of attention in the study of cognitive styles (Shalley et al., 2004). According to Kirton (Kirton, 1976; Kirton, 1980; Kirton, 1984), people can be classified along a continuum from being an 'innovator' to being an 'adaptor'. People with more innovative cognitive styles (innovators) are more likely to challenge presumptions and look for fresh ways to approach issues. On the other hand, those with an adaptive cognitive style (adaptors) prefer to work within the existing frameworks and use established methods to solve problems (Kirton, 1984). Adaptors are perceived as less creative because they prefer to stick to pre-existing frameworks, making it more difficult for them to engage in divergent thinking and produce unique and creative ideas (Baer et al., 2003; Carnabuci & Diószegi, 2015; Shalley et al., 2004). Yet, Kirton (1984) suggests that adaptors are also able to be highly creative if the conditions in which they operate trigger them to think outside the box. This is in line with other research, which is not necessarily focussed on KAI, that suggests the conditions in which individuals operate, can positively influence their creative performance (Amabile & Pillemer, 2012; Zhou, 2003; Nijstad & Stroebe, 2006). Besides Baer et al. (2003), Tierney et al. (1999) and Carnabuci & Diószegi (2015), however, little to no research has studied conditions specifically enhancing adaptors' creativity. This results in a lack of knowledge about conditions stimulating the creative performance of adaptors. The absence of knowledge about these conditions presents an obstacle for organizations aiming to tap into their innovative capabilities. This knowledge gap impedes the ability to provide targeted the right conditions, hindering adaptors' contributions to innovation and limiting overall organizational success.

A possible condition to enhance the creative performance of adaptors is ‘cognitive stimulation’ through idea-generating groups, such as brainstorming sessions (Paulus, 2000). Cognitive stimulation within idea-generating groups exists of “cognitive benefits that accrue only from the active exchange of knowledge or ideas in groups” (Paulus, 2000, p.245). One of these unique benefits is the ‘mutual stimulation of associations’ (Paulus, 2000). This is the phenomenon whereby one concept or idea activates others that are connected to or associated with it in a person's mind (Paulus, 2000). This increases the likelihood of coming up with ideas that an individual would not have come up with on his or her own. As a result, cognitive stimulation may act as a catalyst to help adaptors think outside of their usual perspective and generate more novel and creative ideas, thereby improving their creative performance.

There is, however, a problem inherent to idea-generating groups called ‘cognitive interference’. Cognitive interference refers to “a number of processes in groups that directly constrain the cognitive processes of idea generation” (Paulus, 2000, p. 241). According to Nijstad (2002), production blocking is a significant cause of cognitive interference. When group members are required to take turns sharing their ideas, production blocking occurs. This causes delays and distractions that can hinder the flow of ideas and lower creative performance (Nijstad & Stroebe, 2006).

A solution has yet to be found to solve the paradox of cognitive stimulation and interference. However, with the recent rise of Artificial Intelligence, (AI) a very promising technology has emerged. AI may be capable of assisting people with creative work and providing ideas that would be challenging for an individual to come up with on their own (Mikalef & Gupta, 2021; Jarrahi, 2018; Townsend & Hunt, 2019). Especially, ChatGPT-3, a transformer-based language model, can process and produce language for diverse purposes, including creative output, and can support the creative process by providing semantic stimulation and generating novel ideas (Bouschery et al., 2023; De Carvalho Botega & Da Silva, 2020; Georgiev & Georgiev, 2018). The potential of AI to provide cognitive stimulation without the need for individuals to participate in idea-generating groups seems particularly promising to enhance the creative performance of adaptors. This results in the following research question: *How does cognitive stimulation through artificial intelligence moderate the relationship between individuals with an adaptive cognitive style and their creative performance?*

A between-groups experiment with a 2x2 design was carried out because isolation is crucial for determining how cognitive stimulation provided by AI affects adaptors' creative performance. The participants were randomly assigned to either the AI manipulation group or

the control group. The experiment involved participants completing a questionnaire to measure their cognitive style based on KAI, followed by a creative task. The collected data were analyzed using multiple regression analysis.

Researching conditions that enhance adaptors' creative performance is important due to several reasons. Firstly, there is a substantial lack of research regarding the enhancement of the creative performance of adaptors despite the extensive research on cognitive style, particularly on the Kirton Adaption-Innovation (KAI) theory. Prior research has largely concentrated on quantifying and comprehending creative outputs (Shalley et al., 2004), neglecting to investigate the circumstances that encourage creativity in people with an adaptive cognitive style. By filling in this gap, this study adds to the body of knowledge on improving adaptors' creative performance and offers a novel viewpoint to foster adaptors' creative performance.

Secondly, this research extends our understanding of the role of artificial intelligence (AI) in augmenting creative performance, specifically in the context of adaptors. Recognizing AI's potential to enhance creative performance can lead to the development of AI applications that support creative performance across diverse fields. Moreover, this study establishes criteria for AI applications to effectively support and optimize adaptors' creative performance.

Lastly, this research carries practical implications for business and management practices. KAI has been proven to have major consequences for creativity and problem-solving in a variety of fields (Shalley et al., 2004; Armstrong et al., 2011). By examining the conditions underlying the enhancement of adaptors' creative performance, organizations can gain valuable insights into adaptors' behaviours and outcomes that impact their operations (Armstrong et al., 2012). This understanding enables businesses to foster a more innovative and productive workforce. Managers can identify and address barriers to creativity, such as the lack of triggers for adaptors to think outside their usual patterns. These insights contribute to improved business outcomes, including increased competitiveness (Sarooghi et al., 2015).

This thesis' remaining sections will be organized as follows. A theoretical framework will be presented after an initial presentation of a literature review. The applied methodology will then be explained. Thirdly, the findings of the experiment will be examined and discussed. The conclusion, along with theoretical and managerial implications and suggestions for further study, will be presented at the end.

2. Theoretical background

2.1 Creativity and cognitive style

Creative performance, which is the production of creative ideas by an individual (Oldham & Cummings, 1996), depends on multiple factors. For an individual to be able to deliver creative output, they have to leverage their domain-relevant skills, creativity-relevant skills and intrinsic task motivation (Amabile, 1983). These factors are interconnected and are influenced by the social setting in which an individual operates. This environment in an organizational setting consists of resources, managerial practices, and organizational motivation to innovate (Anderson et al., 2014). The three intra-individual components of creativity must all be present to promote creative performance, as well as a supportive social environment (Amabile, 1996).

This study focuses on cognitive style, which is linked to creativity-relevant skills (Amabile, 1996). According to Amabile (1996), creativity-relevant skills encompass a wider range of cognitive processes and abilities that support creative thinking and problem-solving. A large body of research has been dedicated to the effect of an individual's cognitive style on their creative performance (Shalley et al., 2004; Carnabuci & Diószegi, 2015). According to this research, someone's cognitive style influences their perception and approach to problems which will positively affect their creative performance if they pursue new cognitive pathways or divergent thinking (Carnabuci & Diószegi, 2015; Woodman et al., 1993; Tierney et al., 1999). Additionally, it affects how they perceive themselves as using their creativity-related skills (Woodman et al., 1993). To maximize a person's creativity-related skills, it is crucial to understand their cognitive style and how a social environment factor may help to reinforce it.

2.2 Adaptive cognitive style

Kirton's Adaption-Innovations theory has received the most attention to understand the relationship between cognitive style and creative performance (Armstrong et al., 2011; Shalley et al., 2004). The theory states that individuals have a natural orientation towards creative problem-solving (Kirton, 1976). An individual's natural orientation, in other words, cognitive style, can then be placed on a continuum from a highly adaptive cognitive style to a highly innovative cognitive style. Measuring someone's cognitive style on the KAI continuum is not a question of creativity level, but a question of creativity style (Kirton, 1984). According to Kirton, the range of creativity is the same for both innovators and adaptors; it's just that they approach problems in different ways. Adaptors are those who use available information to find

a creative solution within given paradigms and prefer “doing things better” rather than innovators who prefer “doing things differently” (Kirton, 1976, p. 622). Kirton, therefore, states that there is no better cognitive style when it comes to creative performance. However, because adaptors prefer to adhere to pre-existing frameworks, they find it more challenging to engage in divergent thinking and generate original and creative ideas (Baer et al., 2003; Carnabuci & Diószegi, 2015; Shalley et al., 2004). As a result, adaptors tend to display lower levels of creative performance than innovators (Shalley et al., 2004; Tierney et al., 1999; Kirton, 1980; Baer et al., 2003). Other researchers assign these differences to fundamental traits of innovators, such as greater fluidity to associate freely, having a flexible style and creative personality (Armstrong et al., 2011). Amabile (1983) also speaks about the ability to break cognitive set or explore new cognitive pathways. Kirton (1984) is aware of these disadvantages of the cognitive style of adaptors and states that adaptors have to be triggered to be ‘dug out of their system’ to reach a higher level of creative performance.

Three previous studies have proven the statement by Kirton to be right and successfully enforced the creative performance of adaptors. First, Tierney et al. (1999) found that adaptors were more creative when they had high-quality ties to their supervisors. Secondly, Baer et al. (2003) concluded that the creative performance of adaptors in simple jobs was positively influenced by extrinsic rewards and that adaptors even outperformed innovators in this setting. Finally, Carnabuci & Diószegi (2015) concluded that adaptors with relatively many structural holes in their social network had an increased innovative performance in which creativity played a crucial role.

2.3 Cognitive stimulation

The three studies by Baer et al. (2003), Tierney et al. (1999) and Carnabuci & Diószegi (2015) offer support for Kirton’s claim that adaptors can increase their creative performance. The enhancing conditions that were found can be placed in Amabile’s social environment which gives reason to look for new ways to enhance the creative performance of adaptors in this environment. One promising aspect of the social environment is the influence of team-level creativity on individual creativity (Amabile, 2012). Much of this team-level creativity takes place in collaborative groups, such as work teams or brainstorming sessions. To find creative solutions, these groups actively share their knowledge and innovative ideas. For instance, brainstorming groups were created to encourage idea-sharing within groups (Stroebe et al., 2010). Individuals who participated in such idea-generating groups experienced a variety

of cognitive benefits that could only result from this exchange (Paulus, 2000; Nijstad et al., 2002). 'Cognitive stimulation' is the term used to describe these advantages (Paulus, 2000). While these studies focused on cognitive stimulation by exposing participants to real teams, Nijstad et al. (2002) found that cognitive stimulation can also take place when people are in some way exposed to new ideas and/or information.

Cognitive stimulation is created by exposing individuals to external stimuli in the form of unfamiliar creative ideas (Nijstad, 2002; Paulus, 2000). The actual stimulation originates from the dismissal of creating search cues and search memory for relevant information and thus freeing up cognitive capacity (Nijstad, 2002). Two possible effects are then possible (Nijstad, 2002). In the case of exposure to semantically diverse ideas, one activates knowledge that would otherwise be inaccessible and create broader ideas. In the case of exposure to semantically homogeneous ideas, one would be more productive and gain in-depth ideas, which Paulus (2000) calls 'Novel Associations'. Crucial for individuals to gain benefits from novel associations is paying 'attention' to others' ideas (Paulus, 2000; Brown et al. 1998). In addition, Paulus (2000) mentions four other factors contributing to cognitive stimulation (diverse cognitive styles, conflict, heterogeneity and incubation). These factors, however, are only applicable in actual collaborative groups. For example, heterogeneity refers to the presence of differences and knowledge bases within groups (Paulus, 2000). Since there are no other group members in solitary idea-generating session, this factor is irrelevant. Therefore, this research will focus on novel associations.

2.4 Cognitive interference

Nijstad et al. (2002) and Paulus (2000) also mention the drawbacks of team-level idea generation to creative performance, which is called cognitive interference. Cognitive interference occurs when external stimuli constrain a chain of reasoning (Nijstad et al., 2002). Resulting in "shorter trains of thought, the loss of potential ideas, and increased switch between semantic domains" (Nijstad et al., 2002, p. 537). Cognitive interference mainly occurs when a person is thinking about one idea while being distracted by an external idea. This causes the person to lose focus on the original idea and become unable to further develop it.

Cognitive interference consists of three factors, which are production blocking, task-irrelevant behaviours and cognitive load (Paulus, 2000). Paulus does not provide much information regarding these last two factors. Production blocking, however, has been proven as the major factor of cognitive interference (Diehl & Stroebe, 1991; Nijstad et al., 2003; Stroebe

et al., 2010). ‘Production Blocking’ refers to the phenomenon that occurs in group brainstorming sessions where individuals are prevented from expressing their ideas due to others already speaking or interrupting them (Diehl & Stroebe, 1991; Paulus, 2002; Nijstad et al., 2003). Production blocking interferes with idea generation in two ways (Nijstad et al., 2003). First, it delays the idea-generation process because individuals have to process the externally provided ideas resulting in less available cognitive capacity to develop their own ideas. Second, if the delays are of long duration, “the generation of semantically related ideas within a category is disrupted. This leads to shorter clusters of semantically related ideas and fewer ideas per category” (Nijstad et al., 2003, p. 546).

2.5 Overcoming cognitive interference

Cognitive interference has such a strong effect on idea-generating groups that it ‘outperforms’ cognitive stimulation, resulting in groups being less productive in idea-generation than individuals on their own (Diehl & Stroebe, 1991; Girota et al., 2010; Gallupe et al., 1991; Stroebe et al., 2010; Brown et al., 1998). However, Paulus and Yang (2000) argue that the paradox between cognitive stimulation and interference is not supported by different theoretical perspectives and that group idea-sharing should still lead to significant cognitive stimulation.

There have been several attempts to overcome cognitive interference (Gallupe et al., 1991; Diehl & Stroebe, 1991). One method, called electronic brainstorming (EBS), succeeded (Stroebe et al., 2010). In this method, production blocking is overcome by letting members use computers in which they can develop their own ideas at any time, while they have access to other members’ ideas through the computer. By using computers, there is no more turn-taking or verbal interruption possible. Electronic brainstorming groups turn out to be more productive than regular brainstorming groups. They are, however, still less productive than individuals working separately (Dennis & Valachich, 1993). In addition, the ideas created in the EBS method are not necessarily high of quality. Stroebe et al. (2010, p. 198) explain this, “if people drew their ideas from a pool of ideas, which contained an equal number of original and unoriginal ideas, the probability of original and unoriginal ideas to be drawn would be the same”.

Paulus and Yang (2000) also successfully investigated another method to overcome cognitive interference which is called brainwriting. “In contrast to the oral sharing of ideas in groups during brainstorming, brainwriting involves a group of people silently writing and

sharing their written ideas” (Heslin, 2009, p. 130). The non-vocal aspect of the method made it possible to eliminate production blocking, reduce social pressure, and provided enough time to process ideas (Paulus & Yang, 2000). Cognitive interference was, however, not fully dismantled since memorization of the written ideas made it more difficult to generate new ideas at the same time (Paulus & Yang, 2000). In addition, the experiment was only experimental and generalizability was not assured. Another disadvantage of brainwriting is that it requires lots of resources, which makes it hard to bring to practice.

2.5 Solving the Paradox with Artificial Intelligence

Even though EBS and brainwriting cases were not definitive solutions to cognitive interference, the studies demonstrated the possibility of overcoming cognitive interference while maintaining cognitive stimulation. In addition, the EBS case also demonstrated the potential of new technologies. The EBS study was conducted in 1994 when the use of computers was a relatively new technology to enhance creativity (Gallupe et al., 1991). More than 30 years later, another new technology has emerged in the form of AI (Makridakis, 2017). AI demonstrated enormous creative performance by beating the best Chess and Go players and was even able to display limitations in human creativity (Gobet & Sala, 2019). AI is defined as “the ability of a system to identify, interpret, make inferences, and learn from data to achieve predetermined organizational and societal goals” (Mikalef & Gupta, 2021, p. 3). AI does this by using large datasets to train itself and make decisions based on this data.

AI is a broad concept that covers a variety of tools and uses. It is crucial to first clarify the kind of AI that can be used for this research. According to Enholm et al. (2002), AI can be divided into two categories: ‘AI for automation’ and ‘AI for augmentation’. The study finds AI for augmentation particularly relevant due to its ability to provide fresh viewpoints that assist humans in overcoming cognitive limitations (Enholm et al., 2021), leveraging massive data to enhance input and generate recommendations in creative fields (Mikalef & Gupta, 2021).

An AI application is required to put AI into practice. Any created system that can independently offer insights and/or take action based on these insights to achieve a set of goals is considered to be an AI application (Mikalef & Gupta, 2021). As previously mentioned, it is crucial to choose an application that nonverbally exposes adaptors to unique and semantically homogeneous and heterogeneous ideas that can be accessed without the need for turn-taking to cognitive interference and maintain cognitive stimulation.

A suitable application for this purpose is Chat-GPT3. Chat-GPT3 is a transformer-based language model which makes use of Natural Language Processing (NLP). NLP is defined as “the process through which machines can understand and analyze language as used by humans” (Jarrahi, 2018, p. 2). ChatGPT-3 can process and produce language for a range of purposes, including creative output (Bouschery et al., 2023). Transformer-based language models can generate original and useful ideas for a problem statement (Bouschery et al., 2023). Based on the settings of the model, it is also possible to produce more radical or more incremental outcomes (Bouschery et al., 2023). All of this can be done whenever the user asks the model, which prevents turn-taking. In addition, AI applications like ChatGPT-3 are capable of supporting the creative process by providing semantic stimulation and creating novel ideas (De Carvalho Botega & Da Silva, 2020; Georgiev & Georgiev, 2018).

2.6 Hypothesis

To enhance creative performance, it is crucial for individuals with a more pronounced adaptive style to break free from their usual thinking patterns and explore new cognitive pathways (Kirton, 1984; Amabile, 1983). One promising condition is the influence of team-level creativity on individual creativity, which can be facilitated through collaborative groups that actively exchange knowledge and creative ideas, leading to cognitive stimulation and resulting in cognitive benefits for individuals (Amabile, 2012; Stroebe et al., 2010; Paulus, 2000; Nijstad et al., 2002). By providing adaptors with new and diverse ideas, cognitive stimulation catalyzes exploring different cognitive pathways, potentially leading to higher levels of creative performance. However, a persistent challenge in leveraging cognitive stimulation has been cognitive interference, which hampers the full benefits of cognitive stimulation (Nijstad et al., 2002; Paulus, 2000; Diehl & Stroebe, 1991). Encouragingly, past research has demonstrated the potential of EBS and brainwriting methods in overcoming cognitive interference (Stroebe et al., 2010; Paulus & Yang, 2000). By incorporating advancements in AI technology, which can generate a wide range of creative and nonverbal ideas while removing social barriers, it becomes clear that AI holds great promise in delivering the advantages of cognitive stimulation (Mikalef & Gupta, 2021; De Carvalho Botega & Da Silva, 2020; Bouschery et al., 2023). Leveraging AI as a tool can ultimately enhance the creative performance of adaptors, allowing them to reach higher levels of creative performance.

Based on the presented arguments, we predict the following:

Hypothesis 1: The extent of adaptive cognitive style has a negative direct relationship with creative performance.

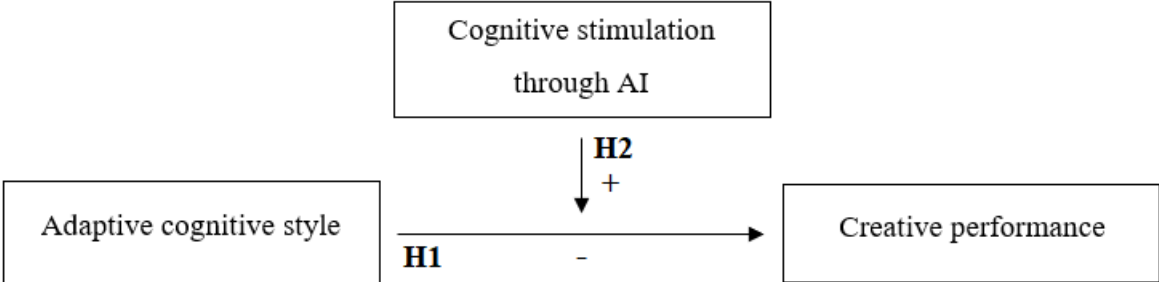
Hypothesis 2: The presence of cognitive stimulation through AI mitigates the negative relationship between the extent of adaptive cognitive style and creative performance.

2.7 Conceptual model

The conceptual model in Figure 1 illustrates the proposed hypotheses.

Figure 1

Conceptual model explaining the relationship between adaptive cognitive style and creative performance when moderated for cognitive stimulation through AI.



3. Methodology

3.1 Research design

A 2 (cognitive style: adaptor vs. innovator) x 2 (cognitive stimulation: AI vs. non-AI) between-subjects design was used in the experiment to test the hypothesis. With the help of this design, it was possible to identify and quantify the impact of AI on the respondents' creative performance and compare the results to those of the control group (Field & Hole, 2002). The participants were divided into the manipulated and control groups at random. Before engaging in a creative task, they were all required to complete a survey in which they had to provide answers to questions about their cognitive preferences. Respondents' participation was voluntary, and they consented to the confidentiality of their responses.

3.2 Sample

3.2.1 Sample

To be able to measure a medium effect based on an α -level of .05 and to obtain a test power of .80, 85 participants were needed (Cohen, 1990). This was achieved by recruiting 86 respondents for this study and 125 respondents recruited for the thesis circle overall. 47 Participants were allocated to the AI manipulation group and 50 participants to the control group. By using Qualtrics software, it was made sure that the respondents were randomly distributed over both groups to cancel out unsystematic differences in the creative performance of the respondents (Field & Hole, 2002).

Family, friends and social networks were mainly used to gather respondents. This is a form of non-probability sampling called convenience sampling. Convenience sampling refers to a method in which participants are selected based on their easy availability and accessibility (Field, 2017). A limitation of this technique is its selection bias because participants are not randomly selected and may not accurately represent the larger population (Field, 2017). The external validity of this research is therefore not assured. Due to cost-effectiveness, however, convenience sampling was still used in this research. Using convenience sampling also resulted in most of the respondents being Dutch. 25 Respondents over the whole thesis circle were obtained by using platforms such as Surveyswap in which students respond to each other surveys.

3.2.2 Demographics

All of the respondents were over the age of 18 with 81% of the respondents being between the age of 18 and 24. 67% Of the respondents were male, 4% were female and 29 % identified as ‘other’. 32% Of the respondents had completed high school as their highest level of education completed, followed by Wo bachelor (26%) and Hbo bachelor (22%). In addition, 67% percent of the participants were students and 29% were employed for wages. The overrepresentation of young people and students was probably due to the use of convenience sampling. Further, 40% of the respondents completed the survey at home, 22% at work and 23% at school or university. The respondents completed the survey in May and June 2023.

3.3 The survey

The survey was divided into three parts. First, all participants were asked to complete a questionnaire to measure their cognitive style based on KAI. This allowed the researchers to place respondents on the continuum from innovator to adaptor.

Next, all participants were instructed to complete a product improvement ($\alpha = 0.73$) task in which they were asked to make a stuffed bunny, of which a picture was shown, more fun to play with for children (Urban et al., 2021). The respondents had to write down their ideas which were used to assess their creative performance.

The manipulation group received pre-generated AI input which they could use while the control group had to complete the task without any further help. All of the participants had 10 minutes to list as many ways as possible to improve the bunny. The participants were also asked to briefly explain their suggestions. The three parts combined took around 20-30 minutes for respondents to complete.

Before publishing the survey, 6 people completed the survey to gather feedback to improve the survey. This resulted in multiple aspects of the survey being improved. When the survey was improved, the responses were deleted.

3.4 Measures

3.4.1 Cognitive style

Cognitive style was measured by using the ‘originality’ subscale of the KAI inventory (Taylor, 1989a) consisting of 13 items ($\alpha = 0.81$). This choice was made because literature shows that using all three subscales of KAI to measure someone’s cognitive style is

'questionable' due to the modest correlations between the subscales (Taylor, 1989b). In practice, this means that different individuals with different scores on the subscales could still receive the same KAI score. Since the originality score is the strongest predictor of creative performance and the other two subscales appear to be measures of working style and social interaction style (Payne, 1987), this paper focuses on the originality subscale of KAI. In addition, if all three subscales were included in the survey, a very lengthy and time consumable questionnaire would have been the result which could have had an unwanted impact on the answers to the creative task. To measure the 13 items of the KAI originality scale, a 1 (strongly disagree) to 5 (strongly agree) scale was used (Kirton, 1976). The final variable of the KAI score was measured by adding up the item scores per respondent and dividing them by 13. Resulting in a KAI score between one and five for every respondent.

3.4.2 Creative performance

Creative performance was assessed on 'originality' and 'fluency'. "Fluency refers to the number of unique, nonredundant ideas or problem solutions that are generated" (Baas et al., 2008, p. 781). Fluency was measured in this study by giving a point to each idea provided to improve the bunny per participant. "Originality refers to the uncommonness and infrequency of an idea and reflects the ability to approach a problem or situation in a new way" (Baas et al., 2008, p. 781). In this study, originality was measured by giving a point to each idea generated by a participant which appeared five percent or less within the total of ideas generated. Two separate variables were created to test for originality and fluency in the analysis. In addition, to increase inter-rater reliability, the three researchers worked together in awarding points to each idea to minimize the potential influence of individual biases or differences in interpretation.

3.4.3 Artificial Intelligence

The treatment group was manipulated by exposure to AI-generated input. The input was generated by giving ChatGPT-3 the following prompt: "Can you complete the following task? The product improvement task is a verbal task using non-verbal stimuli. Students were presented with an image of a stuffed animal (bunny) and asked to list different ways how the bunny could be improved to make it more fun to play with". ChatGPT-3 came up with 15 ways to improve the bunny of which six were selected and presented to respondents. This selection was made upon selecting semantically diverse and similar suggestions from ChatGPT-3. The following suggestions were selected: 'add more colours', 'add movement', 'add accessories', 'add a surprise element', 'add learning elements', and 'add a storybook or character

background'. A one-sentence explanation per suggestion from ChatGPT-3 was added as well. The suggestions were listed together and presented to each respondent during the task.

To make sure the respondents had read and were aware of the possibility to use the AI-generated suggestions, a manipulation check was added. The respondents had to answer two 'yes' or 'no' questions in which they were asked if they had read the suggestions and if they were aware of the possibility to use the suggestions.

3.4.4 Control variables

To rule out other possible explanations of the moderation of AI on creative performance, control variables were integrated into the analysis (Field & Hole, 2002). We controlled for age (in years), gender (1 = 'female', 2 = 'male', and 3 = 'other') education according to the Dutch school system (1 = 'no education or primary', 2 = 'high school', 3 = 'Mbo', 4 = 'Hbo Bachelor', 5 = 'Hbo Master', 6 = 'Wo Bachelor', 7 = 'Wo Master', 8 = 'PhD'), occupation (1 = 'student', 2 = 'self-employed', 3 = 'employed for wages', 4 = 'retired', 5 = 'looking for a job', 6 = 'other'), prior experience in creative tasks ('no', 'yes, less than five times', and 'yes, and more than five times'), location and distraction (1 = 'not distracting' to 10 = 'extremely distracting'). Especially, education and prior education in creative tasks could have a systematic influence on the outcomes of the experiment.

Educational level was controlled for because it reflects domain-relevant skills, such as knowledge and technical skills, which can influence creative performance (Amabile, 1988; Tierney et al., 1999). Education results in practised pathways which increase the number of response possibilities to a creative task (Amabile, 1988). In addition, educational level is connected to innovative behaviour (Scott & Bruce, 1994). Therefore it is important to control for educational level since it has the potential to explain creative performance.

3.5 Reliability and validity

Internal reliability of the used originality subscale was proven by Kirton (1976) and Taylor (1989b) with respectively 0.81 and 0.82. By further directly copying Kirton's items and transforming them into survey questions, content validity is assured as well. Finally, Taylor (1989b) also confirmed the validity of the originality subscale by subjecting it to factor analysis.

3.6 Data analysis

The collected data were analysed using multiple regression analysis to investigate the relationship of education, KAI score, AI, and the interaction term on creative performance in terms of originality and fluency. By using multiple regression analysis, it was possible to assess the unique contributions of each independent variable while controlling for the effects of other variables in the model. This approach enabled the researchers to specifically determine the effect of AI on the creative performance of adaptors. IBM SPSS Statistics 27 was used to execute the multiple regression analysis.

3.7 Data preparation

Before being able to analyse the data, data preparation was necessary. The first step was to delete missing or incorrect values. Eight participants were deleted from the dataset because they had not read or were not aware of the possibility to use the AI input. Another three participants were deleted due to not following the instructions of the creative task resulting in irrelevant answers, such as “Do not use AI in children’s toys!”. Combined, eleven responses were deleted resulting in 36 valid responses for the manipulation group.

Second, nine items of the KAI scale were reverse-coded to measure the construct on the same continuum as the other four items (1 for indicating adaptors, 5 for indicating innovators).

Third, the KAI score variable was created in which the separate scores of respondents on the 13 items were added up to create one overall score per participant. Next, the newly created KAI score variable was centred which made interaction effects possible, remove collinearity, and increase comparability and interpretation (Field, 2017).

Finally, since the whole thesis circle collected the data together, another condition was present in the dataset besides the manipulation and control group. This condition was filtered out once the dataset was prepared and ready for analysis.

3.8 Research ethics

To prevent damaging the quality and trustworthiness of this research, the Netherlands Code of Conduct for Research Integrity (KNAW et al., 2018) is followed. The code provides a normative framework which is expressed by five principles.

Honesty means reporting the research process accurately, taking opposing viewpoints and counterarguments seriously, being transparent about margins of uncertainty, refraining

from making unfounded claims, refraining from fabricating or falsifying data or sources, and refraining from overstating the positive or negative impact of the results (KNAW et al, 2018). This will be obtained by adequate reporting, elaborating decisions and providing data for clarity.

Scrupulousness refers to “using methods that are scientific or scholarly and exercising the best possible care in designing, undertaking, reporting and disseminating research” (KNAW et al., 2018 p. 13). This will be done by justifying methods used, using scientific sources only, making use of peer review and following APA guidelines for citations. In addition, to make sure the data is collected and treated ethically, informed consent will be ensured as well as confidentially treating the collected data. All of this will be done in line with the APA guidelines (APA, 2017). A format provided by Radboud University was used and customized to ensure that every relevant aspect was touched upon in the informed consent.

Transparency refers to a clear line of reasoning and verifiable steps in the research process (KNAW et al., 2018). Transparency will be obtained by discussing every research step taken and publishing the data upon which the research is built.

Independence refers to not allowing non-scientific or non-scholarly factors to influence the method used, the evaluation of the data, the weight given to alternative statements, or the evaluation of other people's research or research proposals (KNAW et al., 2018). Independence will be maintained by having no other party having an influence on my research than Radboud University,

Responsibility means taking into account the legitimate interests of human and animal test subjects, as well as those of commissioning parties, funding bodies, and the environment, in recognition of the fact that a researcher does not work in isolation. Conducting research that is of importance to science and/or society is another aspect of responsibility (KNAW et al., 2018). Responsibility will be obtained by providing solid scientific ground for both societal and scientific relevance, letting respondents perform a non-damaging task and having continuous consultation with my supervisor.

4. Results

4.1 Descriptives

Table 1 shows the means and standard deviations of the variables, and Pearson's correlation coefficients between the variables. Regarding the means, originality has a mean of 1.37 with a standard deviation of 1.557. Fluency has a mean of 4.73 with a standard deviation of 2.328. This tells us that the average respondent has around five ideas of which roughly one was original. The standard deviations of both variables show that respondents are more spread out regarding originality since the standard deviation is relatively bigger than the standard deviation of fluency. In other words, the average respondent found it harder to come up with original ideas than with more ideas. The mean of the KAI score is also of interest since the mean is closer to one than to five, showing a slightly higher representation of adaptors than innovators in the sample. For all descriptive statistics, please see Table 1.

Pearson's correlations were conducted to examine the relationships between the constructs. Notably, Table 1 shows that education (.324**) and AI (.383**) correlate positively and significantly with originality. In contrast, education (.152) and AI (-.052) do not significantly correlate with fluency. Further, in line with expectations, KAI correlates significantly to originality (-.252*) and fluency (-.254*). The correlation is negative which is expected since the mean of KAI shows a tendency towards more adaptive cognitive style characteristics in the sample resulting in a negative relationship with creative performance. For all correlations please see Table 1.

Table 1

Descriptive statistics and correlation matrix.

	Mean	SD	N	1	2	3	4	5
Originality	1.37	1.557	86	1				
Fluency	4.73	2.328	86	.524**	1			
Education	3.94	1.817	86	.324**	.152	1		
KAI	2.66	0.427	86	-.252*	-.254*	.039	1	
AI	0.43	0.498	86	.383**	-.052	.145	-.083	1

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

4.2 Assumptions

To make sure the coefficients and parameters of the regression analysis are unbiased, several assumptions have to be met. First, the independent variable and the dependent variable must be metrically scaled (Field, 2017). This is true for both the independent variable (KAI) and the dependent variables (originality and fluency) as explained in the methods section. All variables are therefore appropriate to use in regression analysis.

Second, it is important to have a linear relationship between the KAI variable and originality and fluency to perform a linear regression (Field, 2017). To check this assumption, scatterplots in which the relationship between these variables was inspected. These plots show a linear relationship.

Third, the residuals of the model should be normally distributed to prevent the model from differing from the observations (Field, 2017). Although there is some deviation, inspecting the probability-probability plot shows a sufficient normal distributed residual line.

Fourth, homoscedasticity is also checked for by using a scatterplot to ensure constant variance of the residual terms (Field, 2017). The generated scatterplots show no reason to worry about heteroscedasticity.

Fifth, multicollinearity is checked for to prevent too high correlations between the independent variables. The VIF values, indicating multicollinearity, lie around one and two which is sufficient (Field, 2017).

4.3 Regression analysis

Multiple regression analysis will be conducted to test the hypotheses. The first hypothesis of this study is ‘The extent of adaptive cognitive style has a negative direct relationship with creative performance’. The second hypothesis is ‘The presence of cognitive stimulation through AI mitigates the negative relationship between the extent of adaptive cognitive style and creative performance’. The relationships between the independent variables (KAI score), the moderating effect (interaction) and the dependent variable (creative performance) will be examined under the control of education. In addition, the relationship between AI and creative performance will be analysed. Adjusted R square was used to determine the explained variance in the independent variable. In addition, the standardized coefficients were used to measure the relative importance or contribution of each independent variable in the regression model. First, the analysis will report the results of the regression

analysis with creative performance measured in terms of originality. Second, the results of the regression analysis with creative performance measured in terms of fluency will be reported.

4.4 Creative performance in terms of originality

The overall regression model is shown in Table 2. The overall model was found to be statistically significant, accounting for 26% of the variance in originality ($R^2 = .261$, $F(4, 81) = 8.502$, $p = .001$). Originality was significantly predicted by the highest level of education ($r = .269$, $p = .006$). Originality was not significantly impacted by the respondents' KAI scores ($\beta = -.085$, $p = .532$). Additionally, AI was found to be a highly significant predictor of originality ($\beta = .324$, $p = .001$). Finally, originality was not significantly predicted by the interaction term ($\beta = -.208$, $p = .130$). As a result, neither Hypothesis 1 nor Hypothesis 2 are supported.

Table 2

Multiple regression analysis regarding creative performance in terms of originality

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Education	2.831	.006	.269				
Independent variables							
KAI	-0.627	.532	-.085				
AI	3.422	.001	.324				
Interaction	-1.531	.13	-.208				
Overall model				8.502	4, 81	.001	.261

4.5 Creative performance in terms of fluency

Table 3 presents the overall regression model. The overall model was found to be statistically significant ($R^2 = .067$, $F(4, 81) = 2.514$, $p = .048$) explaining 6.7% of the variance in fluency. The highest level of completed education nonsignificantly predicted fluency ($\beta = .165$, $p = .126$). In addition, the KAI score of respondents did not have a significant effect either ($\beta = -.165$, $p = .284$). Furthermore, AI did not significantly predict fluency ($\beta = -.098$, $p = .358$). Lastly, the interaction term did not significantly predict fluency ($\beta = -.144$, $p = .348$). Thus, Hypothesis 1 and Hypothesis 2 do not receive support.

Table 3*Multiple regression analysis regarding creative performance in terms of fluency*

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Education	1.545	.126	.165				
Independent variables							
KAI	-1.079	.284	-.098				
AI	-0.924	.358	-.098				
Interaction	-0.944	.348	-1.44				
Overall model				2.514	4, 81	.048	.348

4.6 Robustness check

To assess the internal reliability of the initial regression model, a robustness check will be conducted in which the other control variables (age, gender, occupation, previous experience, location and distraction) will be integrated into the analysis. The belonging tables with results are included in Appendix A.

First, creative performance in terms of originality was checked. For age, gender, occupation, location and distraction, the control variables had a nonsignificant relationship with originality. The interaction variable, however, turned marginally significant for each control variable ($p = < .10$). The corresponding estimated regression coefficients (β) consistently centred around $-.250$, indicating a negative relationship between originality and the control variables. Further, the regression model was also controlled for previous participation in a similar creative task. The results were nearly the same as for the initial model with no significant effect found for the interaction variable ($\beta = -.228$, $p = .110$).

Secondly, the robustness of creative performance in terms of fluency was controlled for. The same control variables as mentioned above were used. This resulted in none of the overall regression models being significant, which is a difference from the initial regression model. In addition, the results of the interaction variable remained nonsignificant for all control variables.

5. Discussion

The study found no evidence that the extent of adaptive cognitive style holds a relationship with creative performance in terms of originality or fluency. Neither is this relationship moderated by cognitive stimulation through AI. Therefore, both hypotheses are rejected. This is not in line with earlier research as it was expected that a lower KAI score (adaptor) would negatively affect the direct relation with creative performance (Kirton, 1976; Shalley et al., 2004; Tierney et al., 1999; Baer et al., 2003). In addition, it contradicts findings in research by Tierney et al. (1999) and Carnabuci and Diószegi (2015) in which cognitive style was directly related to creative and innovative performance. The research by Bear et al. (2003), however, did not find a direct relationship between cognitive style and creativity. When comparing these three studies, a possible explanation for this can be found in the complexity of the environment in which the creative performance of adaptors is measured. Bear et al. (2003) measured the performance of adaptors in a relatively simple environment, while the other studies applied a more complex environment. This complexity of the creative task used in this study is more or less in line with the research by Bear et al. (2003), suggesting that a low-complexity environment positively influences the creative performance of adaptors relative to innovators.

Regarding cognitive stimulation through AI, the results showed mixed outcomes in terms of its direct relationship with creative performance. A direct positive relationship was observed with originality, indicating that exposure to cognitive stimulation through AI has a positive influence on the generation of original ideas (Bouschery et al., 2023; De Carvalho Botega & Da Silva, 2020). This positive impact on originality aligns with the expectation that AI can support the creation of original ideas. However, it was unexpected that AI had no impact on the number of ideas generated (fluency). This lack of impact on fluency may be attributed to the nature of the creative process, suggesting that while AI facilitates originality, it may not necessarily enhance the speed or quantity of idea generation. Factors such as perseverance and achievement motivation specific to fluency (Baas et al., 2008; Rietzschel, 2007) might still play a dominant role in determining the speed and quantity of idea generation. AI may, therefore, primarily contribute to the quality and novelty of ideas rather than the absolute quantity.

Furthermore, when examining the relationship between cognitive style and creative performance moderated by cognitive stimulation through AI, no significant relationship was found with originality or fluency. These results indicate that cognitive stimulation through AI does not appear to influence the relationship between cognitive style and creative performance. This unexpected outcome suggests several possibilities. Firstly, it could be explained by the

characteristics of adaptors, who tend to be less receptive to new technologies (Kirton, 1980; Kirton, 1976). Due to their nature, adaptors may be confined within their existing system, hindering their ability to recognize the opportunities provided by new stimuli (Kirton, 1976). It is possible that adaptors, when presented with the opportunity to leverage AI during the creative task, remained within their usual framework and overlooked the potential benefits of AI, resulting in a lack of cognitive stimulation and unimproved creative performance. Secondly, for cognitive stimulation to be effective, regardless of its source, respondents must pay close attention to the provided ideas (Paulus, 2000; Brown et al., 1998). Although respondents were asked if they read the AI-generated ideas, it is uncertain if they paid sufficient attention to them and incorporated them into their creative process. If respondents did not adequately engage with the AI-generated ideas, the intended cognitive stimulation may not have been received.

All of the relationships above were controlled for by the highest level of completed education. The highest level of completed education demonstrated a positive relationship with creative performance in terms of originality but not in terms of fluency. This indicates that the higher the level of completed education, the more original the generated ideas become. This was in line with the expectations of the study. It supports Amabile's (1996) claim that it influences creative performance through domain-relevant skills. In the context of this study, it shows that completed level of education is possibly a greater determinant of creative performance than the cognitive style someone possesses.

Finally, the initial results maintained the same when controlling for previous experience. In addition, the other control variables (e.g. age), did not demonstrate a direct relationship with originality or fluency either. Interestingly, however, when controlled for these variables, the interaction term in relationship to originality turned negative. Indicating that the relationship between cognitive style and creative performance in terms of originality can be negatively influenced by cognitive stimulation through AI. Even though this was a marginally significant result, these findings contradict the expected outcomes. A potential explanation for this result can once again be found in the characteristics of adaptors. If adaptors were less acceptable of AI and did not leverage the opportunities while innovators did, the innovators would gain an advantage over adaptors, resulting in a bigger gap between the originality of the creative performance resulting in a disadvantage for adaptors.

6. Conclusion

This study aims to answer the following research question: *How does cognitive stimulation through artificial intelligence moderate the relationship between individuals with an adaptive cognitive style and their creative performance?*

In summary, the study found that cognitive style, measured by KAI, did not relate to creative performance in terms of originality or fluency. Cognitive stimulation through AI had a positive impact on idea originality but did not affect idea fluency. The interaction between cognitive style and cognitive stimulation through AI did not influence creative performance. The highest level of completed education positively predicted originality. Controlling for other variables did not alter the results. Notably, the interaction term for originality became negative when considering these control variables, indicating a potential negative effect of cognitive stimulation through AI on the relationship between cognitive style and originality.

The research question can now be answered. The study found no evidence of a moderation effect of cognitive stimulation through AI on the relationship between adaptive cognitive style and creative performance, indicating that cognitive stimulation through AI does not enhance or weaken the creative performance of adaptors.

The theoretical implications of this study suggest that cognitive style, as measured by the KAI score, may not be a strong predictor of creative performance. The findings highlight the potential influence of the complexity of the creative task on creative performance, the role of education in fostering originality, and the potential limitations of cognitive stimulation through AI in enhancing creative fluency. These insights contribute to a better understanding of the interplay between cognitive style, cognitive stimulation through AI, and creative performance.

6.1 Practical implications

Based on this conclusion, some practical implications can be considered. Firstly, when evaluating individuals for creative roles, cognitive style on its own may not be a reliable criterion. Therefore, in the selection of employees for creative tasks, managers should not solely focus on cognitive style but also have an eye for factors like education. The study demonstrated the positive relationship between the highest level of completed education and idea originality. In addition, for organizations, it seems worth investing in education and developing domain-relevant skills to enhance creative performance, particularly in terms of generating original ideas.

Secondly, cognitive stimulation through AI demonstrated a positive impact on idea originality. Organizations can leverage AI tools to support creative processes and foster the generation of novel ideas. However, it should be noted that AI may not influence idea fluency, which implies that human factors like perseverance and motivation still play a crucial role. This emphasizes the need for organizations to balance AI integration with other employees' characteristics that drive idea generation.

Thirdly, when AI is introduced in organizations, they should be aware of the possible difference between employees in adopting AI. Employees with an adaptive cognitive style may have more difficulty in adopting AI into their existing working methods than innovators. Therefore, managers are advised to provide support during this process. This can include educating employees on the capabilities of AI, encouraging active engagement with AI-generated ideas, and promoting an open mindset towards leveraging AI for creative purposes.

6.2 Limitations and future research

The study has some limitations. The first limitation can be found in the KAI scale which was used to measure cognitive style. The used KAI scale only represented the 'originality' subscale within the KAI inventory and not measured the 'efficiency' and 'conformism' subscales. The study may therefore have overlooked important factors that could influence the relationship between cognitive style and creative performance. This could result in different outcomes in the relationship between cognitive style and creative performance. This limitation restricts the generalizability of the findings and calls for future research to incorporate all three subscales of KAI to provide a better understanding of its impact on creative performance.

Second, the sample was over-represented by respondents who had completed or were still studying at a high level of education. This restricts the generalizability of the study's findings to a broader population. The relationship between adaptive cognitive style and creative performance under the moderation of cognitive stimulation may vary across different educational backgrounds. In addition, this relationship could not be interpreted by using results from other studies regarding the creative performance of employees, since Tierney et al. (1999) and Baer et al. (2003) also had a high representation of high education levels. It would be interesting if future research investigated the relationship between employees and their creative performance in the context of education level to gain a more comprehensive understanding of the topic.

A third limitation of the research is the incomplete manipulation check. This study checked for the presence of AI by asking respondents if they had read the AI-generated ideas and if they were aware that they could use them. The results of the study, however, could have been better interpreted if the researchers also knew to what extent the adaptors had actually received the intended cognitive stimulation through AI. This would have removed the risk of adaptors ultimately deciding to not use the AI-generated input and made it possible to better measure the effect of cognitive stimulation through AI on the creative performance of adaptors. Future research could therefore employ more robust methods to measure the extent to which participants utilized the AI-generated ideas in their creative process.

The final limitation of the study is the limited possibilities to integrate AI, specifically ChatGPT-3, into the survey. The used software Qualtrics, which was chosen because it enabled randomization within the thesis groups and is supported by Radboud University, did not provide the tools to integrate the functionalities of ChatGPT-3 into the survey. Therefore, the AI-generated ideas had to be provided to the participants in a static way. This disallowed participants to ask ChatGPT-3 for new ideas, further elaborate on provided ideas; or discuss the provided ideas. This minimized the possibility to imitate team-level idea generation upon which cognitive stimulation is built. Future research could use research methods that allow for complete integration of ChatGPT-3, or similar AI applications, to better imitate cognitive stimulation. This would provide a better understanding of how AI can effectively stimulate cognitive stimulation and its effects on the creative performance of adaptors.

References

- Aggarwal, I., & Woolley, A. W. (2019). Team Creativity, Cognition, and Cognitive Style Diversity. *Management Science*, *65*(4), 1586–1599.
<https://doi.org/10.1287/mnsc.2017.3001>
- Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology*, *45*(2), 357–376.
<https://doi.org/10.1037/0022-3514.45.2.357>
- Amabile, T. M. (1988). A model of creativity and innovation in organizations. *Research in Organizational Behavior*, *10*(10), 123–167. <https://ci.nii.ac.jp/naid/20000708825>
- Amabile, T. M. (1996). *Creativity In Context: Update To The Social Psychology Of Creativity*. <https://ci.nii.ac.jp/ncid/BA28033699>
- Amabile, T. M., & Pillemer, J. (2012). Perspectives on the Social Psychology of Creativity. *The Journal of Creative Behavior*, *46*(1), 3–15. <https://doi.org/10.1002/jocb.001>
- Anderson, N., Potočnik, K., & Zhou, J. (2014). Innovation and Creativity in Organizations. *Journal of Management*, *40*(5), 1297–1333.
<https://doi.org/10.1177/0149206314527128>
- APA. (2017). *Ethical principles of psychologists and code of conduct*. <https://www.apa.org>. Retrieved June 19, 2023, from <https://www.apa.org/ethics/code>
- Armstrong, S. J., Cools, E., & Sadler-Smith, E. (2012). Role of Cognitive Styles in Business and Management: Reviewing 40 Years of Research. *International Journal of Management Reviews*, *14*(3), 238–262. <https://doi.org/10.1111/j.1468-2370.2011.00315.x>
- Baas, M., De Dreu, C. K. W., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus? *Psychological Bulletin*, *134*(6), 779–806. <https://doi.org/10.1037/a0012815>

- Baer, M., Oldham, G. R., & Cummings, A. L. (2003). Rewarding creativity: when does it really matter? *Leadership Quarterly*, *14*(4–5), 569–586.
[https://doi.org/10.1016/s1048-9843\(03\)00052-3](https://doi.org/10.1016/s1048-9843(03)00052-3)
- Bouschery, S. G., Blazevic, V., & Piller, F. T. (2023). Augmenting human innovation teams with artificial intelligence: Exploring transformer-based language models. *Journal of Product Innovation Management*. <https://doi.org/10.1111/jpim.12656>
- Brown, V. R., Tumeo, M., Larey, T. S., & Paulus, P. B. (1998). Modeling Cognitive Interactions During Group Brainstorming. *Small Group Research*, *29*(4), 495–526.
<https://doi.org/10.1177/1046496498294005>
- Carnabuci, G., & Diószegi, B. (2015). Social Networks, Cognitive Style, and Innovative Performance: A Contingency Perspective. *Academy of Management Journal*, *58*(3), 881–905. <https://doi.org/10.5465/amj.2013.1042>
- Cohen, J. (1990). Statistical power analysis for the behavioral sciences. *Computers, Environment and Urban Systems*, *14*(1), 71. [https://doi.org/10.1016/0198-9715\(90\)90050-4](https://doi.org/10.1016/0198-9715(90)90050-4)
- Davenport, T. H., Guha, A., Grewal, D., & Bressgott, T. (2020). How artificial intelligence will change the future of marketing. *Journal of the Academy of Marketing Science*, *48*(1), 24–42. <https://doi.org/10.1007/s11747-019-00696-0>
- De Carvalho Botega, L. F., & Da Silva, J. C. (2020). An artificial intelligence approach to support knowledge management on the selection of creativity and innovation techniques. *Journal of Knowledge Management*, *24*(5), 1107–1130.
<https://doi.org/10.1108/jkm-10-2019-0559>
- Dennis, A. R., & Valacich, J. S. (1993). Computer brainstorming: More heads are better than one. *Journal of Applied Psychology*, *78*(4), 531–537. <https://doi.org/10.1037/0021-9010.78.4.531>

- Diehl, M. R., & Stroebe, W. (1991). Productivity loss in idea-generating groups: Tracking down the blocking effect. *Journal of Personality and Social Psychology*, 61(3), 392–403. <https://doi.org/10.1037/0022-3514.61.3.392>
- Enholm, I. M., Papagiannidis, E., Mikalef, P., & Krogstie, J. (2021). Artificial Intelligence and Business Value: a Literature Review. *Information Systems Frontiers*, 24(5), 1709–1734. <https://doi.org/10.1007/s10796-021-10186-w>
- Field, A. P. (2017). *Discovering Statistics Using Ibm Spss Statistics*.
<https://dl.acm.org/citation.cfm?id=2502692>
- Field, A. P., & Hole, G. J. (2002). *How to Design and Report Experiments*.
<http://ci.nii.ac.jp/ncid/BA63703031>
- Gallupe, R. B., Bastianutti, L. M., & Cooper, W. E. (1991). Unblocking brainstorming. *Journal of Applied Psychology*, 76(1), 137–142. <https://doi.org/10.1037/0021-9010.76.1.137>
- George, J. M., & Zhou, J. (2002). Understanding when bad moods foster creativity and good ones don't: The role of context and clarity of feelings. *Journal of Applied Psychology*, 87(4), 687–697. <https://doi.org/10.1037/0021-9010.87.4.687>
- Georgiev, G. P., & Georgiev, D. (2018). Enhancing user creativity: Semantic measures for idea generation. *Knowledge Based Systems*, 151, 1–15.
<https://doi.org/10.1016/j.knosys.2018.03.016>
- Girotra, K., Terwiesch, C., & Ulrich, K. T. (2010). Idea Generation and the Quality of the Best Idea. *Management Science*, 56(4), 591–605.
<https://doi.org/10.1287/mnsc.1090.1144>
- Gobet, F., & Sala, G. (2019). How Artificial Intelligence Can Help Us Understand Human Creativity. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.01401>

- Gumusluoglu, L., & Ilsev, A. (2009). Transformational leadership, creativity, and organizational innovation. *Journal of Business Research*, 62(4), 461–473.
<https://doi.org/10.1016/j.jbusres.2007.07.032>
- Heslin, P. A. (2009). Better than brainstorming? Potential contextual boundary conditions to brainwriting for idea generation in organizations. *Journal of Occupational and Organizational Psychology*, 82(1), 129–145.
<https://doi.org/10.1348/096317908x285642>
- Hughes, D. L., Lee, A. Y., Tian, A. W., Newman, A., & Legood, A. (2018). Leadership, creativity, and innovation: A critical review and practical recommendations. *Leadership Quarterly*, 29(5), 549–569. <https://doi.org/10.1016/j.leaqua.2018.03.001>
- Jarrahi, M. H. (2018). Artificial intelligence and the future of work: Human-AI symbiosis in organizational decision making. *Business Horizons*, 61(4), 577–586.
<https://doi.org/10.1016/j.bushor.2018.03.007>
- Kirton, M. (1976). Adaptors and innovators: A description and measure. *Journal of Applied Psychology*, 61(5), 622–629. <https://doi.org/10.1037/0021-9010.61.5.622>
- Kirton, M. (1980). Adaptors and Innovators in Organizations. *Human Relations*, 33(4), 213–224. <https://doi.org/10.1177/001872678003300401>
- Kirton, M. (1984). Adaptors and innovators—Why new initiatives get blocked. *Long Range Planning*, 17(2), 137–143. [https://doi.org/10.1016/0024-6301\(84\)90145-6](https://doi.org/10.1016/0024-6301(84)90145-6)
- KNAW; NFWO; NWO; TO2-federatie; Vereniging Hogescholen; VSNU (2018): *Netherlands Code of Conduct for Research Integrity*. DANS.
- Makridakis, S. (2017). The forthcoming Artificial Intelligence (AI) revolution: Its impact on society and firms. *Futures*, 90, 46–60. <https://doi.org/10.1016/j.futures.2017.03.006>
- Mikalef, P., & Gupta, M. (2021). Artificial intelligence capability: Conceptualization, measurement calibration, and empirical study on its impact on organizational

- creativity and firm performance. *Information & Management*, 58(3), 103434.
<https://doi.org/10.1016/j.im.2021.103434>
- Nijstad, B. A., & Stroebe, W. (2006). How the Group Affects the Mind: A Cognitive Model of Idea Generation in Groups. *Personality and Social Psychology Review*, 10(3), 186–213. https://doi.org/10.1207/s15327957pspr1003_1
- Nijstad, B. A., Stroebe, W., & Lodewijckx, H. F. M. (2002). Cognitive stimulation and interference in groups: Exposure effects in an idea generation task. *Journal of Experimental Social Psychology*, 38(6), 535–544. [https://doi.org/10.1016/s0022-1031\(02\)00500-0](https://doi.org/10.1016/s0022-1031(02)00500-0)
- Nijstad, B. A., Stroebe, W., & Lodewijckx, H. F. M. (2003). Production blocking and idea generation: Does blocking interfere with cognitive processes? *Journal of Experimental Social Psychology*, 39(6), 531–548. [https://doi.org/10.1016/s0022-1031\(03\)00040-4](https://doi.org/10.1016/s0022-1031(03)00040-4)
- Oldham, G. R., & Cummings, A. L. (1996). Employee Creativity: Personal and Contextual Factors at Work. *Academy of Management Journal*, 39(3), 607–634.
<https://doi.org/10.5465/256657>
- Paulus, P. B. (2000). Groups, Teams, and Creativity: The Creative Potential of Idea-generating Groups. *Applied Psychology*, 49(2), 237–262.
<https://doi.org/10.1111/1464-0597.00013>
- Paulus, P. B., & Yang, H. C. (2000). Idea Generation in Groups: A Basis for Creativity in Organizations. *Organizational Behavior and Human Decision Processes*, 82(1), 76–87. <https://doi.org/10.1006/obhd.2000.2888>
- Payne, R. (1987). Individual differences and performance amongst R and D personnel: Some implications for management development. *R & D Management*.
<https://doi.org/10.1111/j.1467-9310.1987.tb00049.x>

- Probst, T. M., Stewart, S. L., Gruys, M. L., & Tierney, B. W. (2007). Productivity, counterproductivity and creativity: The ups and downs of job insecurity. *Journal of Occupational and Organizational Psychology*, 80(3), 479–497.
<https://doi.org/10.1348/096317906x159103>
- Rietzschel, E. F., De Dreu, C. K. W., & Nijstad, B. A. (2007). Personal Need for Structure and Creative Performance: The Moderating Influence of Fear of Invalidity. *Personality and Social Psychology Bulletin*, 33(6), 855–866.
<https://doi.org/10.1177/0146167207301017>
- Saroghi, H., Libaers, D., & Burkemper, A. C. (2015). Examining the relationship between creativity and innovation: A meta-analysis of organizational, cultural, and environmental factors. *Journal of Business Venturing*, 30(5), 714–731.
<https://doi.org/10.1016/j.jbusvent.2014.12.003>
- Scott, S. G., & Bruce, R. A. (1994). Determinants of innovative behavior: A path model of individual innovation in the workplace. *Academy of Management Journal*, 37(3), 580–607. <https://doi.org/10.2307/256701>
- Shalley, C. E., Zhou, J., & Oldham, G. R. (2004). The Effects of Personal and Contextual Characteristics on Creativity: Where Should We Go from Here? *Journal of Management*, 30(6), 933–958. <https://doi.org/10.1016/j.jm.2004.06.007>
- Simonton, D.K. (1988). *Scientific genius: A psychology of science*. Cambridge, UK: Cambridge University Press.
- Stroebe, W., Nijstad, B. A., & Rietzschel, E. F. (2010). *Advances in Experimental Social Psychology*, 157–203. [https://doi.org/10.1016/s0065-2601\(10\)43004-x](https://doi.org/10.1016/s0065-2601(10)43004-x)
- Taylor, W. G. K. (1989a). The Kirton Adaption - Innovation Inventory: A re-examination of the factor structure. *Journal of Organizational Behavior*, 10(4), 297–307.
<https://doi.org/10.1002/job.4030100402>

- Taylor, W. R. (1989b). The Kirton adaption-innovation inventory: Should the sub-scales be orthogonal? *Personality and Individual Differences*. [https://doi.org/10.1016/0191-8869\(89\)90056-1](https://doi.org/10.1016/0191-8869(89)90056-1)
- Tierney, P., Farmer, S. M., & Graen, G. B. (1999). An examination of leadership and employee creativity: the relevance of traits and relationships. *Personnel Psychology*, 52(3), 591–620. <https://doi.org/10.1111/j.1744-6570.1999.tb00173.x>
- Torrance, E.P. (1974). *The Torrance tests of creative thinking: Norms-technical manual*. Princeton, NJ: Personal Press
- Townsend, D. W., & Hunt, R. H. (2019). Entrepreneurial action, creativity, & judgment in the age of artificial intelligence. *Journal of Business Venturing Insights*, 11, e00126. <https://doi.org/10.1016/j.jbvi.2019.e00126>
- Urban, K., Pešout, O., Kombrza, J., & Urban, M. W. (2021). Metacognitively aware university students exhibit higher creativity and motivation to learn. *Thinking Skills and Creativity*, 42, 100963. <https://doi.org/10.1016/j.tsc.2021.100963>
- Woodman, R. J., Sawyer, J. E., & Griffin, R. W. (1993). Toward a Theory of Organizational Creativity. *Academy of Management Review*, 18(2), 293–321. <https://doi.org/10.5465/amr.1993.3997517>
- Zhou, J. (2003). When the presence of creative coworkers is related to creativity: Role of supervisor close monitoring, developmental feedback, and creative personality. *Journal of Applied Psychology*, 88(3), 413–422. <https://doi.org/10.1037/0021-9010.88.3.413>
- Zhou, J., & George, J. M. (2001). When Job Dissatisfaction Leads to Creativity: Encouraging the Expression of Voice. *Academy of Management Journal*, 44(4), 682–696. <https://doi.org/10.5465/3069410>

Appendix A

Regression tables for control variables

Multiple regression analysis regarding creative performance in terms of originality controlled for age.

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Age	-.358	.721	-0.36				
Independent variables							
KAI	-.234	.816	-.033				
AI	3.728	.001	.368				
Interaction	-.250	.081	-.250				
Overall model				5.955	4, 81	.001	.189

Multiple regression analysis regarding creative performance in terms of originality controlled for gender.

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Gender	-.920	.360	-.094				
Independent variables							
KAI	-.207	.837	-.029				
AI	3.838	.001	.390				
Interaction	-1.716	.082	-.248				
Overall model				6.187	4, 81	.001	.196

Multiple regression analysis regarding creative performance in terms of originality controlled for occupation.

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Occupation	-.508	.613	-.051				
Independent variables							
KAI	-.235	.815	-.033				
AI	3.742	.001	.367				
Interaction	-1.728	.088	-.245				
Overall model				5.997	4, 81	.001	.190

Multiple regression analysis regarding creative performance in terms of originality controlled for previous experience in a similar creative task.

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Previous experience	1.378	.172	.137				
Independent variables							
KAI	-.511	.611	-.073				
AI	3.492	.001	.343				
Interaction	-1.614	.110	-.228				
Overall model				6.527	4, 81	.001	.206

Multiple regression analysis regarding creative performance in terms of originality controlled for location.

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Location	-.688	.493	-.067				
Independent variables							
KAI	-.294	.770	-.041				
AI	3.705	.001	.362				
Interaction	-1.786	.078	-.252				
Overall model				6.066	4, 81	.001	.193

Multiple regression analysis regarding creative performance in terms of originality controlled for attention.

	<i>t</i>	<i>p</i>	β	<i>F</i>	<i>df</i>	<i>p</i>	<i>adj. R</i> ²
Control variable							
Attention	-1.057	.294	-.107				
Independent variables							
KAI	-.280	.780	-.039				
AI	3.373	.001	.338				
Interaction	-1.696	.094	-.239				
Overall model				6.274	4, 81	.001	.199