

**Investigating the Relationship between a Growth Mindset and Intrinsic Motivation in a
Cognitive Task**

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Bachelor Thesis

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Abstract

Aiming to increase an individual's level of intrinsic motivation has long been a challenge for psychologists. Recently, the connection between a growth mindset and intrinsic motivation has started to become a topic of interest in the literature. It has been suggested that fostering a growth mindset may increase a person's intrinsic motivation, and there have already been studies showing a correlational connection between the two. However, there have been little attempts to investigate whether there is also a possible causal relationship present. This experiment aimed to investigate the possibility of a causal relationship between a growth mindset and intrinsic motivation, particularly regarding a cognitive task. Additionally, perceived competence was investigated as a possible mediator, based on theoretical insights from Self-Determination Theory (SDT). Participants took part in a 2 x 2 mixed design study, with mindset (growth versus fixed) as the between-subjects variable and perceived competence (high versus low) as the within-subjects variable. The results showed no significant causal (or correlational) relationship between a growth mindset and intrinsic motivation in this experiment. However, the results did show support for a positive correlation between intrinsic motivation and achievement, and between perceived competence and intrinsic motivation, as would be expected theoretically. There is an attempt to explain the results, and limitations as well as future directions for research are outlined.

Key words: growth mindset, intrinsic motivation, perceived competence

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Introduction

Motivation is the primary determinant which decides why and to what extent people put effort into something in all areas of their lives (Reeve et al., 2008). Therefore, it is no surprise that the concept of motivation is one of the most studied topics in psychology, and that it originated almost as soon as psychology became its own recognized scientific discipline at the end of the 19th century, with the first attempts at studying motivation being based on instincts and the evolutionary approach (James, 1890). One conceptualization of motivation that has been particularly much investigated is the distinction between intrinsic and extrinsic motivation. Intrinsic motivation occurs when people are inherently driven to perform an activity for the sake of the activity itself. This kind of motivation has a high level of autonomy (Ryan & Deci, 2000). Some examples of intrinsic motivation are when someone does an activity out of curiosity or because they want to challenge themselves (Csikszentmihalyi, 1997). Extrinsic motivation, on the other hand, is when people are motivated by aspects that are extrinsic to the activity itself, so for example receiving some type of reward like getting a good grade on a test, or avoiding a punishment (Ryan & Deci, 2000).

Intrinsic versus extrinsic motivation

Both intrinsic and extrinsic motivation can have a significant impact on people's behavior. Nonetheless, different research supports the claim that intrinsic motivation is overall the preferable type of motivation to have. For one, intrinsic motivation positively contributes to mental health and well-being (Deci & Ryan, 2012) and is associated with greater persistence (Cerasoli et al., 2014; Grant, 2008). It also correlates with higher effort (Kuvaas & Dysvik, 2009), employee satisfaction (Cho & Perry, 2011), and creativity (Amabile et al., 1976). In contrast, extrinsic motivation is linked to perfectionism, negativity, procrastination (Harpine et al., 2015), and higher depression levels (Lu, 1999). Moreover, extrinsic rewards and the resulting extrinsic motivation can in fact diminish intrinsic motivation over time, known as the overjustification effect (Deci et al., 1999).

Despite all of this research supporting the advantage that being intrinsically motivated has over extrinsic motivation, in many settings, including school-based, healthcare and workplace settings, extrinsic motivation is still being used more than intrinsic motivation (Pinder, 2011). This mismatch between the research supporting the utility of intrinsic motivation and its actual use in real-life is understandable when considering the nature of the two types of motivation. It is extremely easy to come up with lots of different types of

extrinsic motivators as long as one has the resources. However, intrinsic motivation, because of it originating from within a person, is much more difficult to foster in other people. Investigating which factors can increase people's intrinsic motivation is therefore of great importance. One concept that has been the subject of much research in recent years which has been suggested to influence intrinsic motivation is one's mindset, and specifically having a growth mindset as opposed to a fixed mindset.

Growth mindset

People with a growth mindset believe in the malleability of their skills and intelligence, and that it is possible for people to develop in all kinds of different areas where certain abilities are required. People with a fixed mindset, on the other hand, believe that people lack the ability to change in fundamental ways regarding these aspects, and that one's intelligence and abilities are largely fixed (Yeager & Dweck, 2012). Overall, having a growth mindset has been shown to have many benefits. Zhang et al. (2017) provide an extensive review of the research relating growth mindsets and academic achievement and show that, overall, there seem to be significant positive influences. For instance, praising 5th graders for their effort as opposed to their intelligence, thereby instilling a growth mindset, resulted in better performance (Mueller and Dweck, 1998) and Blackwell et al. (2007) found that teaching 7th graders about growth mindsets can protect them from a decline in their grades. As can be seen, both growth mindsets and motivation are factors which significantly influence people's behaviour and achievement, which is why investigating the connection between the concepts is a relevant topic of consideration (Zhao et al., 2018).

Previous research on the connection between a growth mindset and intrinsic motivation

Although both intrinsic motivation and growth mindsets have been investigated extensively on their own and in relationship to other variables such as achievement (e.g. Zhang et al., 2017; Haw & King, 2022), research into the connection between intrinsic motivation and a growth mindset is not as well-developed. The main research that has been conducted in this regard is correlational, and there is a lack of causal evidence connecting the two concepts. For instance, Zhao et al. (2018) conducted a cross-sectional study which found that intrinsic motivation acted as a mediator between growth mindset and grit, and that there was a positive correlation between a growth mindset and intrinsic motivation. Next, Dong et al (2023) investigated the relationship between growth mindsets and academic mathematics achievement, and found that it is mediated by intrinsic motivation, thereby also showing a

positive correlation between growth mindsets and intrinsic motivation. Even so, this was also only a questionnaire study which was not able to establish any causal relationship between the two concepts. Another study investigated gender differences in the relationship between some academic variables and intrinsic motivation, growth mindset, and some other factors. The results of this study demonstrated that intrinsic motivation and growth mindset also had a significant positive correlation in this case, however, due to the lack of an experimental manipulation on the mindset of participants, this was also not able to establish a causal relationship (Guo et al., 2023). Tan & Levesque-Bristol (2023), who investigated the opinions of preservice teachers' intentions to enact autonomy support in their teaching, including constructs like a growth mindset and intrinsic motivation also found a significant positive correlation between the two variables, with a moderate effect size. This was also a survey study not using experimental manipulation and therefore also a correlational study (Tan & Levesque-Bristol, 2023). Moreover, Komarraju & Nadler (2013) looked at growth mindsets as well as motivation, but more in regards to self-efficacy rather than intrinsic motivation. In their research, they also mention the lack of causality as a limitation of their work and that “Future researchers can also extend our work by conducting experimental or longitudinal studies that would permit causal inferences between motivational orientations, cognitive and metacognitive strategies, self-beliefs and performance”.

One of the few studies attempting to investigate a growth mindset and intrinsic motivation in terms of a causal relationship was Blackwell et al. (2007), who conducted a growth mindset intervention in middle schoolers, and in which the teachers reported higher levels of intrinsic motivation in students that had undergone the growth mindset intervention in comparison to those who had not. However, the study itself mentions that “This is a very preliminary result and future research should include more detailed assessment of [intrinsic motivation]”. Additionally, some research investigating growth mindsets and motivation together in a causal manner is not quite applicable because it investigated other types of motivation rather than intrinsic motivation. For instance, Rhew et al. (2018) investigated the effects of a growth mindset intervention on students, and found a significant positive difference in motivation scores in the experimental group according to the Motivation for Reading Questionnaire (MRQ). However, the MRQ does not directly measure intrinsic motivation. Nonetheless, this does indicate that there is a good chance for there to also be a positive relationship between a growth mindset and intrinsic motivation, providing another reason for why this is a worthy topic of investigation.

From this review of previous research in the field, a few main observations can be made which demonstrate a current research gap. First, a large part of the research investigating the concepts of a growth mindset and intrinsic motivation together, cannot establish a causal relationship, due to the correlational nature of the studies. Next, studies which do try to establish a causal relationship, despite there being few of these to start with, also not always directly measure intrinsic motivation and rather other types of motivation. This is why the current study will try to fill this research gap by attempting to conduct an experiment to investigate the possibility of a causal relationship between a growth mindset and intrinsic motivation when completing a cognitive task.

Perceived competence

Another interesting point that can be noticed when looking at the current research investigating the concepts of a growth mindset and intrinsic motivation together is that although a significant positive correlation between the two variables can often be found, the strength of this correlation varies considerably. For instance, some studies only found a weak significant correlation between the variables (Tempelaar et al., 2014; Renaud-Dube et al., 2015), while others found at least a moderate correlation between the two (Zhao et al., 2018). This raises the question of where this difference in the strength of these correlations stem from. In order to determine this, looking at the Self-Determination Theory (SDT) could be helpful, since this theory is directly aimed at explaining the factors which influence intrinsic motivation. SDT proposes that there are three main psychological needs which influence the amount of intrinsic motivation which people have. These are autonomy, competence and relatedness (Ryan & Deci, 2000). Since these concepts have been empirically supported to influence intrinsic motivation, it might be expected that one of them could be a moderator variable between the possible relationship of a growth mindset and intrinsic motivation. One study that supports this hypothesis as it not only makes the already-established connection between these factors of SDT and intrinsic motivation but also between a growth mindset and SDT is Dutt et al. (2023). Here, semi-structured interviews were conducted with ophthalmology students to assess their motivation in regards to SDT. It looked at which factors impacted the three basic psychological needs, and found that one of the factors impacting all of the three basic psychological needs of autonomy, relatedness and competence is a growth mindset. Furthermore, a growth mindset seems most closely connected to perceived competence out of the three basic psychological needs, since one way to describe a growth mindset would be by saying it is the belief that individuals have in their ability to

improve their competence in a given area. Additionally, in one study, the causal role of mindset in achievement was realised through perceived competence (Leondari & Gialamas, 2002). Due to this, out of the three basic psychological needs from SDT, perceived competence will be investigated as a possible mediator between the relationship of a growth mindset and intrinsic motivation.

The current study: research questions and hypotheses

Based on the previously reviewed literature on the topic of growth mindsets and intrinsic motivation that has been reviewed so far, this study will investigate the following research questions: What effect does a growth mindset manipulation have on the amount of intrinsic motivation while performing a cognitive task? Does perceived competence have a moderating effect on the relationship between a growth mindset and intrinsic motivation? In regards to the first question, it is hypothesised that there is a significant positive relationship between a growth mindset and the amount of intrinsic motivation displayed by participants during a cognitive task. In other words, the first hypothesis states that participants in the growth mindset condition will have a significantly higher amount of intrinsic motivation compared to the people in the fixed mindset condition. Regarding the second question, it is hypothesised that participants in the high perceived competence condition will have a significantly higher amount of intrinsic motivation than participants in the low perceived competence condition. Finally, it is hypothesised that perceived competence has some kind of interacting effect on the relationship between a growth mindset and intrinsic motivation.

Methods

Participants

After data screening, the final dataset of 83 participants out of the 93 participants that had completed the full survey had been determined. The data screening procedure is explained in the section below. Of these, 56 participants identified as female, 26 as male and 1 as non-binary. The mean age of participants was 21.99 years old. Participants were recruited through the use of a convenience sample, where they were either directly approached by the researcher or could sign up through the online research management system SONA systems. The majority of the participants were either Dutch (52%) or German (25%) with the remaining 19 participants coming from mostly other European countries. Participants who signed up through SONA systems were all Communication Science or

Psychology students from the University of Twente. The rest of the participants also mainly consisted of university students. In total, 91% of participants were university students. Participants recruited through SONA received 0.25 SONA credits for their participation in this study. All participants had the opportunity to opt into a lottery for their participation in the study, where one participant was randomly drawn after the conclusion of the study to receive a 25€ prize. The only criteria for participation in this study was for participants to be 18 years or older, have sufficient English language proficiency and be able to provide informed consent.

Data Screening

A total of 93 participants completed the entire survey. After data collection was concluded, the data of all participants was screened to assess whether all participants seemed to have paid attention thoroughly and given serious answers during the entire study. To judge this, a number of aspects were inspected. Firstly, the time that participants spent on the mindset condition manipulation page was observed. During the questionnaire design, it was built into the questionnaire that it was only possible to continue to the next page after a minimum of two minutes, meaning it was impossible for anyone to spend less than two minutes on the page. This was done because the researchers deemed it impossible to have attentively read the entire article and answered the questions adequately below this amount of time. In the fixed mindset condition, participants spent an average of 9.07 minutes on the mindset manipulation page, and in the growth mindset condition, participants spent an average of 15.5 minutes on the page. It is reasonable that participants in the fixed mindset condition spent a considerable amount of time less on the page on average, since the amount of text in the fixed mindset condition was shorter and there was only one question at the end of the article, as opposed to the two questions which participants in the growth mindset condition had to answer. The amount of time participants spent on the mindset condition page was used as a criterion for whether their answers were further inspected. The 23 participants who spent less than 6 minutes on the mindset condition page were further inspected. For these participants, it was inspected how long their answers to the open question(s) in the mindset manipulation were, as well as what their growth mindset score was. Based on inspecting these three aspects, it was attempted to determine whether participants seemed to have spent enough time on the page for the mindset manipulation to work. This procedure resulted in the removal of 10 participants.

Study design

This experiment was conducted via a survey designed with the online survey platform Qualtrics and had a 2x2 mixed design. The two independent variables that were investigated were mindset (which was either a fixed mindset or a growth mindset), and the perceived competence (which was either high competence or low competence). The participants' mindset was treated as a between-subjects variable, so roughly half of the participants completed the fixed mindset condition while the other half completed the growth mindset condition. Participants were randomly assigned to one of the two mindset conditions using the 'Randomizer' function in Qualtrics. Next, the perceived competence was treated as a within-subjects design. Therefore, all participants, regardless of their mindset condition, completed both the high competence and the low competence conditions after one another. The order in which the high competence and low competence conditions were presented was counterbalanced using the 'Evenly present elements' function within the 'Randomizer' on Qualtrics. The dependent variable of intrinsic motivation was measured after each of the two competence conditions for every participant, meaning it was measured twice per participant.

Procedure

Since the study only consisted of the online survey, participants could participate in the experiment whenever and wherever they wanted, as long as they had access to the internet on a technological device. It was recommended for participants to complete the survey on a laptop or desktop rather than a smartphone, as this provided a better usability in terms of the formatting. The study was meant to take between 20 to 30 minutes to fill in overall. In reality, the median time participants spent on the survey was 25 minutes.

First, participants were provided with a quick description of the experiment, after which they were asked to provide their consent. After some basic demographic questions (which could also be skipped if participants did not want to answer them), participants were randomly assigned to either the growth mindset or the fixed mindset condition. The design of these is further explained below. After completing one of the two mindset conditions, participants filled in the Growth Mindset Scale as a manipulation check (Dweck, 1995).

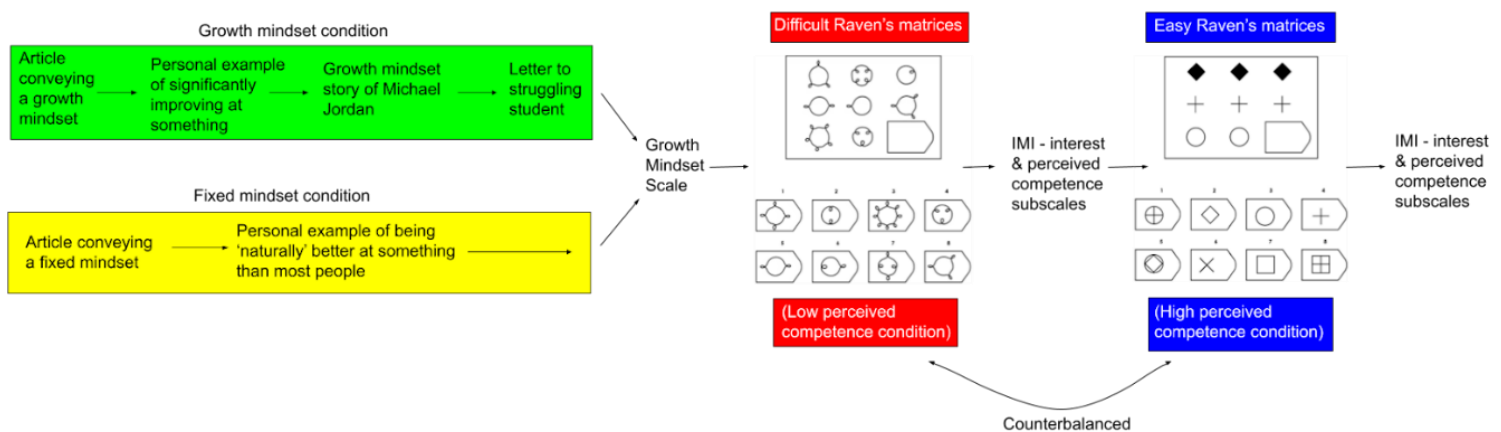
Next, participants completed a first round of the Raven's matrices cognitive task. Here they had to choose the right option on 20 matrices, with a time limit of 10 seconds per item. Participants were randomly assigned to either the high perceived competence or low perceived competence condition. In the high competence condition, the matrices were meant

to be very easy, and participants were expected to get (nearly) all of them correct, which was meant to make them feel competent about their abilities to solve the matrices. In the low competence condition, particularly difficult matrices were chosen on purpose so that participants would not get a lot of them correct, and consequently feel incompetent about their abilities to solve the matrices¹.

After completing the first set of the Raven's matrices, participants answered some questionnaire questions as a manipulation check for the perceived competence and to measure their intrinsic motivation for the task. Consequently, participants did a second round of the Raven's matrices, this time with the competence condition they had not previously completed, and answered the same questions as before one more time, only now regarding the second round of the task instead of the first. After both rounds of the cognitive task and the questionnaire had been completed, participants were debriefed about the true nature of the study and asked to reaffirm their consent. This study was approved by the Ethics Committee of the Behavioural, Management and Social Sciences (BMS) department at the University of Twente.

Figure 1

Survey flow



Note. The consent and demographics sections were completed by all participants before the mindset condition, and the debriefing was also completed by all participants after the second round of answering the IMI. These have been omitted from the figure above for conciseness.

¹ A small pilot study was conducted with three participants to check whether the difficulty of each of the sets of matrices seemed appropriate and whether participants indeed felt a significant difference in perceived competence between the two different sets of matrices. The results showed that 10 seconds seemed like an appropriate amount of time for most of the easy matrices to be filled in correctly and result in a high perceived competence, while at the same time causing a low perceived competence for the difficult set of matrices.

Growth mindset manipulation

The growth mindset manipulation in this study was based on a number of previous growth mindset intervention studies. Mirroring one of the most basic elements of many growth mindset interventions, participants first read an article which explained the concept of a growth mindset and why it is useful (Blackwell et al., 2007). This article was adjusted from those used in Paunesku et al. (2015) and Yeager et al. (2016). However, some additional information was included and the wording was changed to more accurately match the target population of university students and adults as opposed to middle school students, which was the case in both of the previously mentioned studies. Writing the article, care was taken to address recommendations made by Yeager et al. (2016) as a result of their redesign of a previous growth mindset intervention. One of the recommendations mentioned by Yeager et al. (2016), was to “Emphasise strategies not just hard work” in order to remove the stigma associated with needing to ask for help or switching one’s approach. This was addressed in the fifth paragraph of the growth mindset article. Additionally, it has been found that growth mindset interventions specifically addressing neuroplasticity are particularly effective (Sarrasin et al., 2018). This is why descriptions of the traditional neuroplasticity studies by Maguire et al. (2000) and Draganski et al. (2004) were included in the article. After reading the growth mindset article (which can be found in Appendix A), participants were asked to give their own example of a situation where they had gotten better at a skill they were initially struggling with as a self-persuasion exercise. This is based on the saying-is-believing principle, which is also a common part of many growth mindset interventions (Heaman et al., 2023) and was recommended in Burnette et al.’s (2022) paper on growth mindset intervention implementation strategies. Next, participants read a small text about the famous basketball player Micheal Jordan. This is based on Yeager et al.’s (2016) findings that growth mindset interventions are more successful if they include celebrity examples and can also be found in Heaman et al. (2023). Lastly, participants in the growth mindset condition completed another exercise based on the saying-is-believing principle. Here, they were asked to use the information which they had previously learned to write a short encouraging letter to a student struggling in one of their courses. This exercise was based on Miu & Yeager (2015) and also used in the Paunesku et al. (2015) study.

Fixed mindset manipulation

No previous studies have been found by the researcher that also aimed to implement a similar fixed mindset manipulation. This is probably because the overwhelming majority of past studies are intervention studies which compare their growth mindset condition to a

control condition with either no treatment or only a type of ‘placebo’ treatment that is not meant to influence the participants’ growth or fixed mindset views. Therefore, the fixed mindset manipulation was primarily designed to be the opposite of the growth mindset manipulation. Those aspects of the manipulation where no fitting fixed mindset counterpart seemed plausible were left out. In the fixed mindset condition, participants were first provided with an article which they were meant to read that conveyed a fixed mindset view, and can be seen in Appendix B. This article highlighted the ‘stability of cognitive abilities’, and in order to make it sound positive, framed it in a way that said that accepting the stability of our intellectual capacities can help us in finding clarity and purpose in life. The text was intentionally designed in such a way that it would avoid mentioning the concept of a fixed mindset directly, so that people who had heard about the growth and fixed mindset concepts in the past would not start thinking of this and as a result question the article. After reading this text, the saying-is-believing strategy was implemented again, only instead of naming an example of where they had improved their abilities (as was the case in the growth mindset condition) participants were asked to name an example of an area where they had “always been naturally better than the average person”, and asked to explain how they use this skill/ability in their current everyday life. Writing a letter to a struggling student and the celebrity example were not deemed to be reasonably adaptable to support a fixed mindset, which is why these aspects were not included in the fixed mindset manipulation.

Materials

Raven’s progressive matrices

The Raven’s progressive matrices were used as the cognitive task that participants had to complete and based on which they were meant to report their intrinsic motivation and perceived competence. The matrices were first published by J.C. Raven in 1938, and quickly became popular due to the easily comprehensible and non-verbal nature of the task, making it possible to easily compare results between people of different language backgrounds. The first version of the matrices included five levels of 12 matrices each, with increasing difficulty (Raven, 1941). For this experiment, 20 of the matrices were chosen for each of the two conditions, with one set being intentionally significantly more difficult than the other. None of the matrices was chosen for more than one of the conditions.

Measures

Growth Mindset Scale

The Growth Mindset Scale by Dweck was used as a manipulation check to see whether the mindset manipulation was successful (Dweck et al., 1995). This is a 3-item measure which uses a 6 point Likert scale ranging from 1 (*strongly agree*) to 6 (*strongly disagree*). The items consist of statements like “You have a certain amount of intelligence, and you can’t really do much to change it”. The scores on each item of the scale are summed so that a higher score indicates a higher growth mindset orientation. It is a widely used scale to assess general growth mindset opinions. Rammstedt et al. (2022) provides a comprehensive assessment of the scale, which psychometrically validates the reliability, comparability and validity of this scale in adolescents as well as adults.

Intrinsic Motivation Inventory (IMI)

The IMI is a multidimensional scale commonly used in experiments related to intrinsic motivation and self-regulation (Ryan, 1982). It has been applied and validated broadly, including in the context of puzzle completion, which the Raven’s matrices can be counted towards (Ostrow & Heffernan, 2018;)There are several versions of this scale, however, this study refers to the standard 22-item version with four subscales. Two of the subscales were used in this experiment, namely the interest/enjoyment subscale and the perceived competence subscale.

Interest/enjoyment subscale. Although the entire scale is called Intrinsic Motivation Inventory, only the interest/enjoyment subscale is considered to assess intrinsic motivation per se, which is why this subscale was used to measure the participants’ intrinsic motivation for each round of the Raven’s matrices. The interest/enjoyment subscale includes 7 items, measured on a 7-point Likert scale ranging from 1 (*not at all true*) to 7 (*very true*). Two of the items are reverse coded, and the scores on each item of the scale are summed so that a higher total score on the scale indicates a higher amount of intrinsic motivation. Two example items from the scale are “I enjoyed doing this activity very much” and “This activity was fun to do”. This subscale is expected to take roughly a minute to answer. (Ryan, 1982).

Perceived competence subscale. The perceived competence subscale of the 22-item IMI includes 6 items and was used as a manipulation check after both rounds of the Raven’s matrices. The purpose of the scale was to assess the perceived competence of participants for the Ravens’ matrices and verify whether the competence manipulation was successful or not. Like the rest of the IMI, it is also measured on a 7-point Likert scale ranging from 1 (*not at all true*) to 7 (*very true*). Here again, a higher score indicates a higher amount of perceived competence, with one item having to be reverse coded. Two example items from the perceived competence scale are “I think I am pretty good at this activity” and “After working

at this activity for a while, I felt pretty competent”. Similarly to the interest/enjoyment subscale, this subscale is also expected to take roughly a minute to answer (Ryan, 1982).

Data Analysis

The data analysis for this study was conducted using the statistical programming software ‘R’, specifically, R version 4.3.0. The data analysis consisted of five main stages. In the first stage, the data was screened according to how it is described in the ‘Data screening’ section above. After arriving at the final dataset through this, the second stage consisted of validity and reliability assessments of the measurement tools used. Specifically, Cronbach’s alpha was calculated for the Growth Mindset scale, and Interest/Enjoyment and Perceived Competence subscales of the IMI. The third stage consisted of a general exploration of the data, which included descriptively analysing the results on each of the main measured variables, as well as the participants’ scores when completing the matrices. Additionally, this stage included manipulation checks of both independent variables. Specifically, an independent samples t-test was conducted for the two different mindset conditions, and a paired-samples t-test for the perceived competence. The fourth step of the data analysis consisted of doing statistical tests to answer the main research questions and test the hypotheses that were made in the beginning through ANOVAs and linear regression analyses. Here tests of the assumptions of linearity, equal variance and normal distribution of residuals were also conducted. Finally, in the fifth step, further exploratory statistical tests were conducted to test for correlations between some of the variables that were not initially included in the hypotheses.

Results

Planned Analyses

Manipulation check

After screening the data and deciding on the final sample of 83 participants to be included in the dataset, manipulation checks were performed to test the success of the experimental manipulations of the growth mindset manipulation and the perceived competence manipulations. The manipulation check for the growth mindset manipulation was based on the scores of the Growth Mindset Scale. A two-sided independent samples t-test was used to test the difference between the Growth Mindset Scale scores for participants in the

growth mindset condition ($M = 12.77$, $SD = 2.62$) as compared to participants in the fixed mindset condition ($M = 9.31$, $SD = 2.94$). This revealed a significant difference between the two groups, $t(81) = 5.64$, $p < 0.001$. Next, a two-sided repeated measures t-test was performed to test for the difference in perceived competence scores from the Perceived Competence subscale of the IMI in the high competence condition ($M = 4.60$, $SD = 7.06$) as opposed to the low competence condition ($M = 1.89$, $SD = 5.21$). This analysis also resulted in a significant difference between the two conditions, $t(81) = 19.6$, $p < 0.001$. Therefore, it can be concluded that both the mindset manipulation as well as the perceived competence manipulation were successful.

Reliability analysis

To test the reliability of the scales used for the growth mindset, intrinsic motivation and perceived competence scales in this experiment, Cronbach's alpha was calculated for each of these measures. For the Growth Mindset Scale, Cronbach's alpha was calculated as 0.883, which is a satisfactorily high value. Cronbach's alpha for the Perceived Competence subscale was also more than satisfactorily high, with a value of .96. Lastly, the Interest/enjoyment subscale of the IMI which was used to measure intrinsic motivation had a Cronbach's alpha of .84.

Descriptive statistics

Following the successful manipulation checks and reliability analyses, some general descriptive statistics of the relevant collected data were calculated to get a first overview of the results. The table below shows some general descriptive statistics of the growth mindset scores, perceived competence scores, intrinsic motivation, and achievement scores divided up into the high competence and low competence conditions in the growth mindset condition.

Table 1

Descriptive statistics of main questionnaire results and performance on matrices

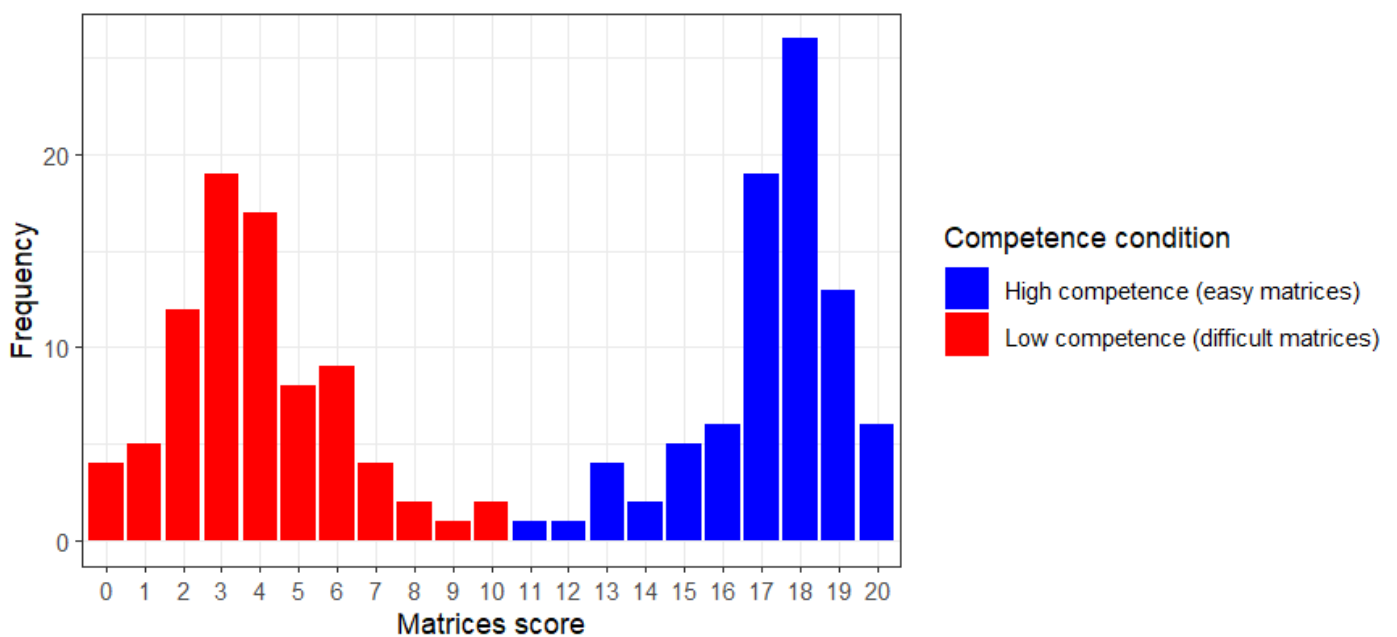
Variable	Average total score	Median	Minimum	Maximum	Standard deviation
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Growth mindset score (possible range: 3-18)	11.1	12	4	17	3.3
Intrinsic motivation score (possible range: 7-49)	29.5	29	11	49	8.1
Perceived competence score (possible range: 6-42)	19.5	18	6	42	10.2
Amount of easy matrices correct (possible range: 0-20)	17.3	18	11	20	1.9
Amount of difficult matrices correct (possible range: 0-20)	3.9	4	0	10	2.2

The graph below summarizes the performance of participants on the Raven's matrices in both conditions:

Figure 2

Frequency of matrix scores correct per competence condition

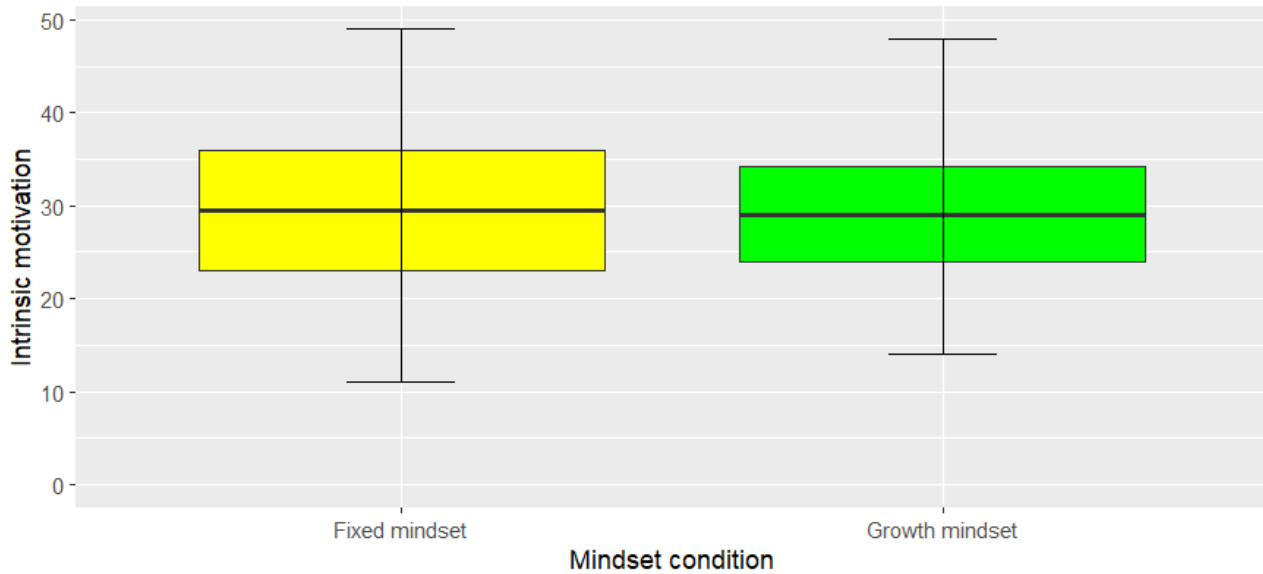


Primary hypotheses testing

Next, in order to answer the main research question of whether there is a relationship between one's mindset and intrinsic motivation and whether perceived competence has some kind of interacting effect on this, a linear mixed model was used. Checks of the assumptions of linearity, equal variance and normal distribution of residuals were conducted. All of these assumptions were met, as can be seen in Appendix C. In the model, mindset condition and perceived competence condition were both entered as fixed categorical effects, and random effects for participant. An ANOVA showed that the null hypothesis could not be rejected for the effect of the growth mindset condition $F(1, 82) = 0.03, p = .85$. For the perceived competence condition, the null hypothesis could however be rejected, $F(1, 165) = 36.83, p < .001$. In order to double check these results, some linear regression analyses were performed to test for the effect of growth mindset on intrinsic motivation, within both the high perceived competence and low perceived competence conditions separately, but these revealed similarly insignificant results for the growth mindset condition. Next, another linear mixed model and ANOVA were conducted in the same manner as before, only this time using the growth mindset score rather than simply the dichotomous growth mindset condition as well as the perceived competence score instead of only the perceived competence condition as predictor variables, with random effects for participant again. As expected, the results of this were overall more significant than before, however, there was still no evidence to reject the null hypothesis for the effect of the growth mindset on intrinsic motivation $F(1, 82) = 0.44, p = 0.51$. Again, however, the null hypothesis for the effect of perceived competence on intrinsic motivation could be rejected, $F(1, 165) = 72.75, p < 0.001$. Thus, unlike what was hypothesised, there was no statistically significant relationship between the participants' mindset (either when considering the mindset condition or the growth mindset score) and their intrinsic motivation. The boxplot below illustrates the lack of difference between the intrinsic motivation scores of participants in the fixed and growth mindset condition.

Figure 3

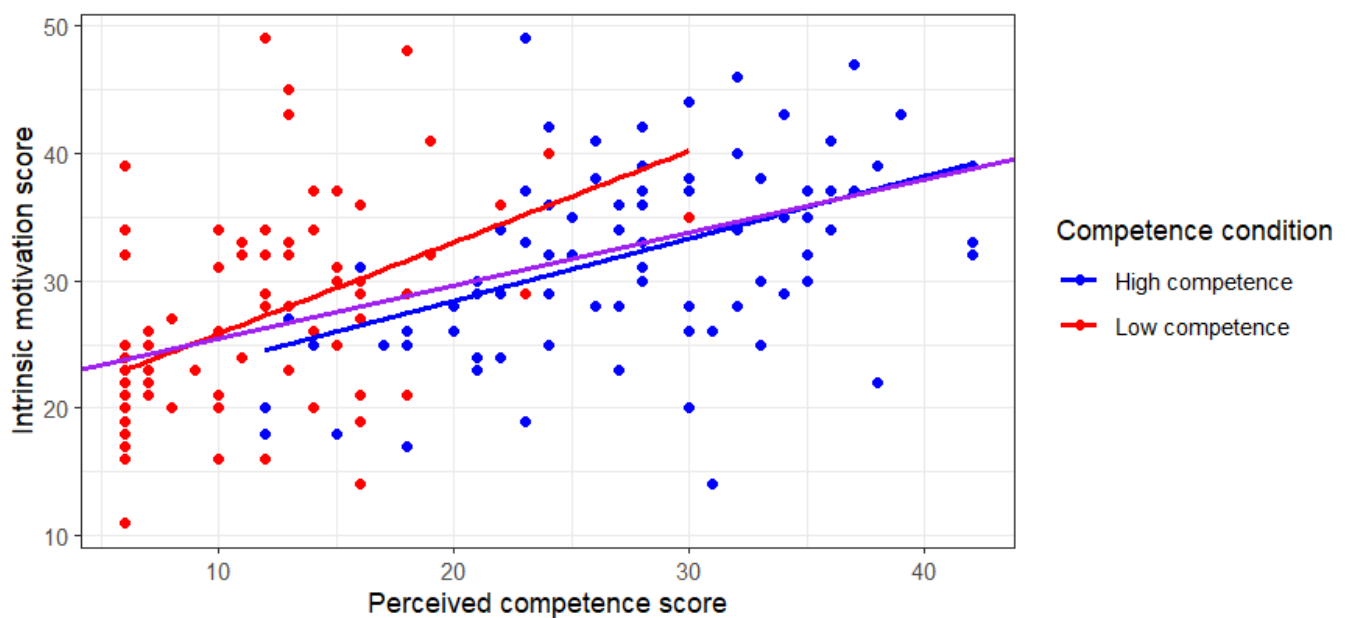
Boxplots of intrinsic motivation scores for each mindset condition



On the other hand, in line with the hypothesis regarding the perceived competence, there was a positive relationship between higher levels of perceived competence and intrinsic motivation, within both perceived competence conditions, as illustrated in the figure below.

Figure 4

Relationship between perceived competence and intrinsic motivation



Note. The purple line shows the combined linear regression line for the relationship between perceived competence and intrinsic motivation, regardless of the competence condition.

Exploratory Analyses

After investigating the research questions and hypotheses, some exploratory analyses were conducted to gain some further insight into the data. First, going beyond the hypothesized relationship between perceived competence and intrinsic motivation, an exploratory investigation was conducted to see if the performance on the Raven's matrices had some type of effect on the relationship between the variables. For this, a median split was conducted to sort participants into the higher and lower half of performers on the Raven's matrices. Furthermore, this relationship was analyzed within the high competence and low competence conditions. Therefore, four different linear regression models were used to test for the effect of perceived competence and intrinsic motivation, within the high and low performers and within the high and low perceived competence conditions respectively. The results of these have been reported in the table below.

Table 2

Output of regression analyses between high/low performers in each competence condition to test for the effect of perceived competence on intrinsic motivation

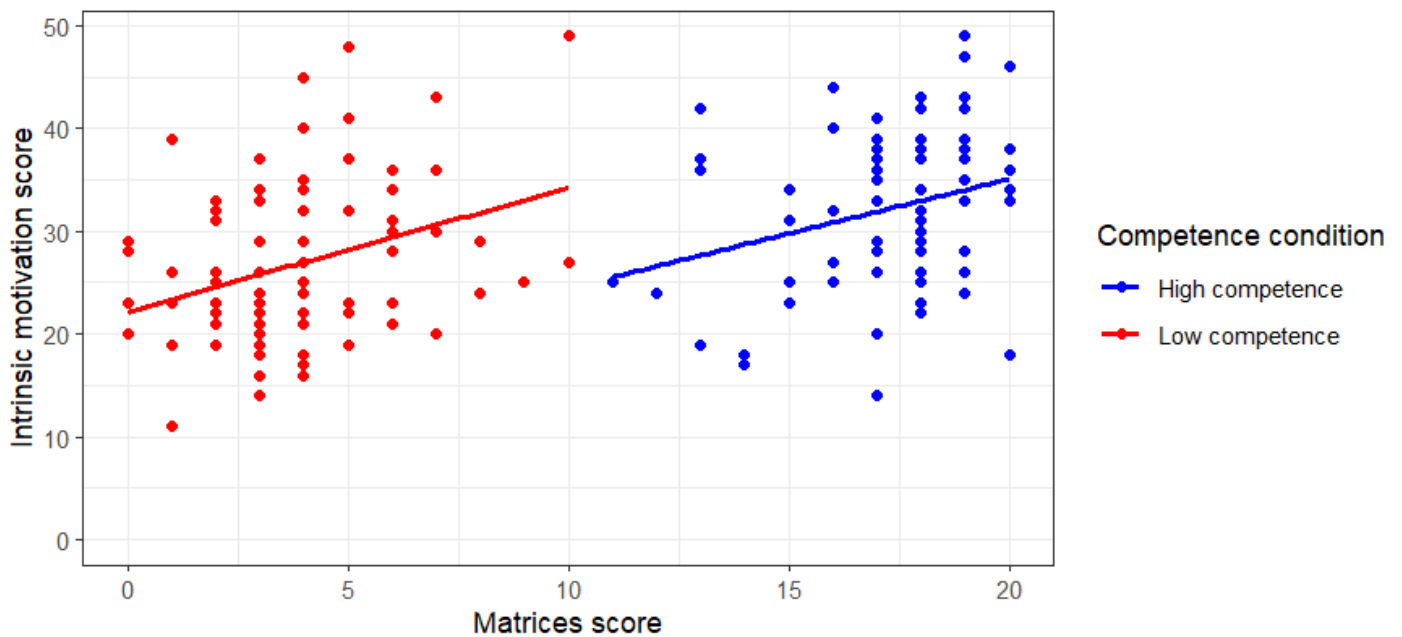
	β	t	p-value	R ²
High performers, low competence condition	0.689	5.37	<0.001	.25
High performers, high competence condition	0.360	3.09	0.003	.10
Low performers, low competence condition	0.385	2.06	0.043	.05
Low performers, high competence condition	0.591	6.13	<0.001	.33

Next, the results were used to conduct some additional tests and see if there were any other relevant relationships between the main variables of growth mindset, perceived competence, intrinsic motivation and achievement score on the matrices. One variable that would be expected to have a significant positive effect on the achievement score on the Raven's matrices is the intrinsic motivation of participants. Therefore, a linear regression model was used to test for a correlation between the intrinsic motivation score and matrices

achievement score, while adding the perceived competence condition as another independent variable to control for this in the model. This did indeed result in a statistically significant relationship between the variables. The intrinsic motivation score had a significant effect on the achievement score on the matrices $\beta = 0.08$, $t = 4.08$, $p < 0.001$, $R^2 = .92$, as did the competence condition, $\beta = 12.95$, $t = 40.48$, $p < 0.001$, $R^2 = .92$. Below is a plot showing the relationship between the interest score and achievement score for both perceived competence conditions:

Figure 5

Correlation between matrices score and intrinsic motivation per competence condition



Again, an exploratory analysis was conducted to see whether the results differed for participants in the top half of performers on the Raven's matrices and the bottom half. While both correlations were significant, the linear regression analysis between the intrinsic motivation and matrices scores for the top half of performers on the matrices showed a noticeably less strong correlation between the two ($\beta = 0.07$, $t = 2.52$, $p = 0.014$, $R^2 = .07$) as compared to the same linear regression analysis for the lower half of performers on the matrices ($\beta = 0.48$, $t = 4.97$, $p < 0.001$, $R^2 = .24$).

Apart from this, relationships were investigated between the growth mindset and perceived competence within each competence condition and growth mindset as well as achievement scores on the matrices. None of the relationships that were otherwise investigated yielded significant results.

Discussion

Summary of results

The primary intention of this study was to investigate if there could be a causal relationship established between a growth mindset and intrinsic motivation. It was hypothesised that people in the growth mindset condition would have a higher amount of intrinsic motivation as compared to participants in the fixed mindset condition. As the results have demonstrated, this was not the case in this experiment, and next to that, there was also no significant correlation between a growth mindset and intrinsic motivation in general. Since there was no relationship between a growth mindset and intrinsic motivation, it was also not possible for perceived competence to act as a mediating third variable, therefore, the second hypothesis about perceived competence having some type of effect on the relationship between a growth mindset and intrinsic motivation, was also not supported. Next to this, a positive relationship was found between the perceived competence and intrinsic motivation of participants, which supported the third hypothesis. Exploratory analyses revealed that for the higher scoring half of participants in the Raven's matrices, the correlation between perceived competence and intrinsic motivation was stronger in the low competence condition as compared to the high competence condition. For the lower half of participants, this trend was turned around, so here the correlation between perceived competence and intrinsic motivation was stronger in the high competence condition. Finally, there was a positive correlation between intrinsic motivation and performance on the Raven's matrices, and this correlation was appreciably stronger for the lower half of performers within the Raven's matrices. Some of these results are quite different from what was hypothesized, while others are in line with what was expected. This raises interesting questions about how these results can be explained and what they mean, which will be attempted to be explained in the following sections.

Lack of effect of growth mindset condition on intrinsic motivation

As demonstrated in the introduction, a considerable number of studies have found positive correlations between a growth mindset and intrinsic motivation. However, the effect sizes for these correlations differ quite a bit. Additionally, there are also some studies that have not found a correlation between a growth mindset and intrinsic motivation. For instance, Orosz et al. (2017) conducted a study to test the effects of a growth mindset intervention in

Hungarian school students. This found no effect of the mindset on the intrinsic motivation of the students, and the authors predicted that this may be due to the culture where the study was conducted, as in Hungarian culture effort is not generally seen in a positive light, as well as because this study was conducted with a sample of relatively high scoring students. In the past, growth mindset interventions have seemed to be particularly effective with low performing students and they have not been as effective in increasing motivation and performance in already high scoring students (Blackwell et al., 2007; Paunesku et al., 2015). In the present study, although grades were not assessed, the majority of participants were university students in their second year or later at a Dutch university. This means most of the participants are not only university students, but have also passed the Binding Study Advice (BSA) requirement that is present in Dutch universities in the Netherlands. This in itself puts the participants of this study in an extremely high percentile of achievers academically speaking, as compared to the overall population, and might partly contribute to why there was no effect found of the growth mindset on the intrinsic motivation of participants. Dommett et al. (2013) also found no effect of their growth mindset intervention on the motivation of participants from the start compared to the end of their study.

Relationship between perceived competence and intrinsic motivation

Unlike the first two hypotheses, the hypothesis that there was a relationship between the perceived competence of participants and their level of intrinsic motivation was supported by the results of this experiment. Just like what would be expected according to SDT, being in the high competence condition and having higher levels of perceived competence in general is correlated with higher levels of intrinsic motivation (Ryan & Deci, 2000). This is also in line with previous research regarding SDT which shows that higher levels of perceived competence lead to high levels of intrinsic motivation (Kaiser et al., 2020; Ryan & Deci, 2017; Eckes et al., 2018; Li et al., 2005). Furthermore, a median split was done to sort people into high and low achievers on the Raven's matrices. Examining the correlation between perceived competence and intrinsic motivation within participants in the higher and lower half of achievers on the Raven's matrices is also in line with what would be expected from a theoretical point of view.

In particular, when looking at the top performing half of participants in terms of the amount of Raven's matrices they answered correctly, the correlation between perceived competence and intrinsic motivation is significantly higher in the low competence condition compared to the high competence condition. This is to be expected, since for the high

performing people, there is probably a ceiling effect present for their scores on the easy set of matrices. Additionally, they are most likely not adequately challenged by the level of difficulty of the matrices in the easy matrices (high competence) condition. This makes it reasonable to expect the correlation between perceived competence and intrinsic motivation to be lower for them for this condition, because their level of perceived competence is so high that they are bored by the task and therefore not anymore as intrinsically motivated by it. The difficult matrices on the other hand are still quite challenging for them due to the short time limit, so their perceived competence and intrinsic motivation are more correlated here.

Moreover, for participants scoring in the lower half of Raven's matrices, the correlations are turned around, which is also in line with what would be expected theoretically. For the lower half of performers on the Raven's matrices, the correlation between perceived competence and intrinsic motivation is much higher in the easy matrices (high competence) condition compared to the difficult matrices. Unlike the high performers, the lower half of performers are more adequately challenged by the easy matrices. This results in the correlation between perceived competence and intrinsic motivation being higher for this group of people. Additionally, for the difficult set of matrices, the lower half of performers are simply overwhelmed with the difficulty of them, and get barely any correct. Therefore, they have very low levels of perceived competence in general, and the correlation of this with intrinsic motivation is quite low because people do not tend to be intrinsically motivated for tasks when their perceived competence is extremely low.

Correlation between intrinsic motivation and achievement

Finally, even though this was not originally a separate hypothesis, the positive correlation that was found between intrinsic motivation and achievement score on the Raven's matrices was also to be expected and is in line with the literature. As already showcased by the literature review in the introduction, higher levels of intrinsic motivation are associated with lots of positive achievement outcomes, including performance on various tasks (Taylor et al., 2014; Cerasoli et al., 2014).

Furthermore, apart from this general correlation that is in line with theoretical expectations, splitting people up into those that scored a high and low amount of the matrices correctly gives some more interesting insights. In this case, the correlation between intrinsic motivation and achievement on the matrices is stronger for people within the lower half of Raven's matrices scores. This also seems logical, because people who are generally a little less capable at a task would be more reliant on other factors (like their motivation) to ensure

that they score high. For people that are already comparatively good at the matrices, it is less important for them to be significantly intrinsically motivated, because they perform well either way. Therefore, the high performing half of people has a lower correlation between their intrinsic motivation scores and their achievement scores on the Raven's matrices. This supports the statement that having high levels of intrinsic motivation is more important when one's actual performance levels at a task are not as high.

Practical implications

Based on the discussion of the results, some practical implications can be drawn for educators working with growth mindset interventions. As has been discussed, who the target group of a growth mindset intervention is seems to have a significant effect on whether the intervention has any effect on motivational and achievement outcomes. Therefore, it is important to not view growth mindset interventions as a one-size-fits-all solution for increasing the intrinsic motivation and/or performance of learners. Instead, before implementing such interventions, the target group should be carefully studied in order to determine whether there are high chances of a significant effect of the intervention. The results and literature discussed in the last few paragraphs seem to indicate that the highest chances of success for growth mindset interventions seem to exist within groups that are not yet as well performing or as highly educated as the average within their demographic.

Similarly, as the varying strengths of the correlations between perceived competence and intrinsic motivation based on participants' performance have shown, it is similarly important to consider the baseline level of performance of participants before aiming to increase perceived competence and intrinsic motivation. Although the literature generally strongly supports the use of encouraging higher levels of perceived competence, and as a consequence intrinsic motivation, increasing intrinsic motivation can have quite different effects based on people's starting performance. Therefore, to allocate resources in the most useful manner, interventions aiming to improve the intrinsic motivation of participants as a first step to try to increase performance should specifically be aimed at students with lower levels of achievement, as these will most likely benefit the most from these efforts. In general, this research supports the importance of carefully considering the target group when wanting to make practical decisions about the implementation of growth mindset interventions.

Limitations of the study

In order to understand the results of this study better and why some of the expected relationships were not found, next to looking at possible explanations within the literature and theory, it is important to consider the limitations of the study and consider how these may have impacted the results. First of all, this study includes two basic limitations that are regularly present in lots of psychological studies. These are the sample size and the biased sample population. Even though the sample size was aimed to be close to 100 to reflect previous similar studies in the field (Toeroek et al., 2022; Niiya et al., 2009), this is overall still a relatively small sample size, which unfortunately increases the likelihood of unreliable results and decreases its generalizability. Next, as a result of the sampling context and method the sample population is quite homogenous. As the sample was collected through a convenience sample within a university context and consisted of a huge majority of students, the participants have the typical “WEIRD” characteristics of this type of demographic, which decreases the generalizability and possibly validity of the results (Henrich et al., 2010, Nielsen et al., 2017).

One additional limitation of the study design was that the growth mindset beliefs of participants were only tested once (after conducting the mindset manipulation). Even though there are statistically significant differences in the growth mindset scores that people displayed for the different mindset conditions, this does not conclusively tell us to what extent the growth mindset manipulation worked. In order to completely accurately assess whether the growth mindset manipulation worked and especially to what extent, it would have been necessary to also assess their growth mindset before the start of the experiment. From this, it would be possible to evaluate their baseline level of growth mindset, and see how the intervention changed it. Setting the study up like this was considered during the experiment design, however, it was intentionally decided against this.

If participants were to complete the Growth Mindset Scale a second time, there would be two main reasonable options of implementing this in the context of the current experiment. First of all, it would have been possible to simply build the Growth Mindset Scale into the beginning part of the experiment, and have participants complete the scale both before and after the growth mindset manipulation. This was not considered to be a good choice, since there would only be around 10-15 minutes in between the first and second round of completing the questionnaire, possibly leading to two unintentional negative consequences. Firstly, people will remember that they had just completed the questionnaire a couple minutes

ago, which will most likely lead to them remembering their questions from before and therefore giving similar answers as in the first round. Second, repeating the questions might lead to people guessing the intention behind the study which might cause unintentional demand characteristics.

To avoid at least the first of these consequences, a second way of implementing the Growth Mindset Scale a second time would have been by conducting a two-part study design, where the first part is simply the Growth Mindset Scale, and the second part would be everything else, with a time delay of a certain amount of days in between. This would make it less likely that participants would answer the second round of the Growth Mindset Scale based on their answer to the first round of it. However, this was also not deemed as a good option, since this would most likely lead to a lower number of participants overall as it increases the participant burden. Due to this, it was an intentional choice to not include the Growth Mindset Scale in the study twice, however, it is still a significant limitation of the study as no comparisons can be made to the baseline level of growth mindset beliefs of the participants.

Another possible limitation of the study is the placement of the Growth Mindset Scale directly after the growth mindset manipulation. It is quite obvious that the topic of the text in the mindset manipulation (both for the growth and for the fixed mindset condition) and the questions in the Growth Mindset Scale are related. Therefore, instead of seeing the questionnaire as asking for their opinions on the items in the Growth Mindset Scale, participants might have seen it as a test of how much attention they paid to the text and how well they understood it, this might have skewed the results by making it seem like participants had opinions that confirmed to the mindset condition they were in more than they actually did.

The duration of the mindset manipulation is another limitation of the study. Compared to past studies in which there have been growth mindset interventions or manipulations, most of them consist of several sessions over an extended period of time and last way longer. Even when only looking at single-session growth mindset interventions, the average amount of only around 15 minutes that participants spent on the growth mindset manipulation page, is significantly shorter than the overwhelming majority of past studies (Burnette et al., 2022). The short duration of the mindset manipulation most likely lessened the effectiveness of it, and therefore induced the beliefs regarding the mindset condition less than a longer duration would have. Therefore, a longer growth mindset manipulation would most likely have led to larger differences in Growth Mindset Scale scores in between the two conditions.

Furthermore, the time limit within the Raven's matrices might have been another limitation, since it could possibly have affected the results within the perceived competence ratings. In the comments that participants could make at the end of the study, several comments referenced that they had trouble with the extremely short time limit within the low competence condition of the matrices. This was of course intentional, since the time limit was (apart from the actual difficulty of the matrices) the other factor that aimed to ensure that people would have significantly different perceived competence ratings for the two conditions. However, even though this generally seems to have worked from looking at the perceived competence ratings, some people could have judged their competence at the matrices not only based on how they did with the time limit, but also how they would have done had the time limit not been there. One participant commented that "For me a big difficulty with the task was the time limit rather than the substance of the task". This seems to imply that this participant believes they would have done well at the difficult matrices (in other words, they had a considerable amount of perceived competence) had the time limit not been there. Therefore, it could have happened that this person and other people with similar trains of thought judged their perceived competence in the difficult matrices higher, because they might have disregarded the time limit and only considered the actual difficulty of the matrices. It could have been more clearly specified in the description that participants were meant to judge their actual performance at the matrices under the time constrained conditions, regardless of whether they would have felt like they could have done better at it with more time.

Directions for future research

Based on what has been discussed so far, a few directions for future research can be suggested, which would be helpful in discovering more about the concepts investigated in this study. First of all, coming up with a study design which includes a pre and post mindset manipulation assessment of the participants' growth mindset would be extremely helpful. This could reveal to exactly what extent the growth mindset manipulation was successful. If an actual causal relationship would be established in this study, this would also make it possible to see how much of it is actually due to the mindset manipulation and how much of it is due to the previous mindset of the participants. It should be carefully considered how to introduce this so that it does not become too obvious to the participants what exactly is being investigated.

As has been demonstrated through the results, the current study was not able to establish either a relationship or a correlation between growth mindset and intrinsic motivation, even though this often appears in other studies. Therefore, it would be interesting to replicate the concept of the study (regarding the aim of establishing a causal relationship between a growth mindset and intrinsic motivation) with a longer growth mindset manipulation, to see if this might have been the issue. Having a longer (and possibly multi-session) growth mindset intervention would have a much higher chance of actually changing the mindset of the participants involved, which would also make it more likely that there would be an observed effect of the growth mindset on intrinsic motivation or another variable. One other possible reason discussed above for the lack of a relationship that was found between a growth mindset and intrinsic motivation, is the sample of the population. If it is indeed true that the sample in this experiment was already of a too highly educated and well performing level, it would be interesting to test out what would happen when investigating this relationship with participants that have different educational backgrounds and abilities. Considering culture as a possible factor would be interesting as well (Orosz et al., 2017).

Another interesting avenue for future research would be to include some other variables that might affect the intrinsic motivation of participants. The results of this study have for instance confirmed predictions made by SDT regarding the influence of perceived competence on intrinsic motivation. Even though this was not found to be a moderator between growth mindset and intrinsic motivation, investigating some other concepts related to SDT might be an interesting extension of the present research. For example, including autonomy as another variable to investigate would be quite interesting, especially to see if this would influence intrinsic motivation to the same extent that perceived competence does, or to a greater or lesser extent.

Conclusion

In conclusion, although the objective of establishing a causal relationship between a growth mindset and intrinsic motivation was not successful, in the process of the investigation some possible theoretical explanations for this were discovered regarding the importance of considering the target population of growth mindset interventions. Consequently, some interesting practical implications could be drawn for educators. In the future, it would be interesting to assess the exact effect of different target populations more in detail, as well as build on some of the concepts related to SDT that were introduced in this

study, to possibly discover other interesting findings about the interactions between growth mindset and other motivational factors. Growth mindset research remains an interesting topic with lots of potential for future studies to be conducted on the topic.

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Appendix A

Growth mindset condition article

In a world where success often seems reserved for the select few with innate talent, a groundbreaking concept is reshaping the way we view our abilities and potential. It's called the growth mindset, and its implications extend far beyond mere optimism—it's a fundamental shift in perspective that can unlock hidden talents and propel individuals to new heights of achievement.

But what exactly is a growth mindset, and why is it so powerful? Simply put, it's the belief that our abilities are not fixed, but rather can be developed through dedication, effort, and strategic approaches. This idea, championed by psychologist Carol Dweck, has been gaining traction in educational and professional settings alike, with compelling research supporting its transformative effects.

Recent studies in neuroscience have shed light on the biological underpinnings of the growth mindset, revealing the remarkable plasticity of the human brain. One particularly compelling study conducted by Eleanor Maguire and her colleagues in 2000 examined the brains of London taxi drivers, renowned for their intricate knowledge of the city's streets. Through sophisticated neuroimaging techniques, the researchers found that these experienced drivers had enlarged hippocampi—the brain regions associated with spatial navigation and memory—compared to non-taxi drivers. Notably, the correlation between the size of the hippocampi and the duration of taxi driving experience was found to be proportional, suggesting a direct relationship between navigational expertise and brain structure adaptation. This fascinating discovery provides concrete evidence of the brain's ability to adapt and change in response to environmental demands, highlighting the potential for growth and development throughout our lives.

Furthermore, studies such as the research conducted by Draganski et al. (2004) have provided further evidence for the brain's remarkable capacity for growth and adaptation. In their investigation into the effects of juggling on brain structure, Draganski and his team found that participants who learned to juggle experienced measurable changes in the volume of gray matter in regions associated with visual and motor processing. These findings highlight the brain's ability to reorganize and expand its neural networks in response to learning and practice, underscoring the dynamic nature of cognitive development. By demonstrating how even a relatively short period of training can lead to structural changes in the brain, this study offers compelling support for the idea that abilities are not fixed but can be cultivated through effort and dedication—a core tenet of the growth mindset perspective.

But it's not just about working hard—it's also about working smart. Research by Yeager et al. (2016) emphasizes the importance of not only perseverance but also strategic thinking. Just exerting effort without effective strategies may not yield the desired results. As

Yeager and colleagues note, sometimes individuals may encounter challenges and try hard, but they get stuck. In such instances, it's essential to recognize the need for new strategies—new approaches to problem-solving that can facilitate learning and growth. This underscores the importance of seeking guidance, exploring alternative methods, and being open to adapting one's approach in pursuit of mastery.

From students tackling challenging subjects to professionals striving for mastery in their fields, individuals who embrace the belief that their abilities can be cultivated show greater resilience, motivation, and ultimately, achievement. By reframing failure as an opportunity for learning and viewing setbacks as temporary obstacles rather than insurmountable barriers, they unleash their full potential and chart a course for success.

The benefits of a growth mindset extend beyond individual achievement to encompass broader societal implications. In classrooms and workplaces where a culture of growth is fostered, collaboration flourishes, innovation thrives, and diversity of thought is celebrated. By nurturing a collective belief in the power of effort and perseverance, we create a world where everyone has the opportunity to excel and contribute their unique talents to the greater good.

Appendix B

Fixed mindset condition article

In a world where intelligence often seems predetermined and immutable, a groundbreaking concept is reshaping the way we perceive our cognitive abilities. It's a perspective that acknowledges the inherent stability of our intelligence and its implications extend far beyond mere acceptance—it's a fundamental understanding of the unchanging nature of our cognitive capacities.

But what exactly is this perspective, and why is it so compelling? Simply put, it's the belief that our intelligence is largely stable and resistant to change. This idea, supported by decades of research, challenges the notion that individuals can significantly alter their intellectual capacities through effort or practice. Instead, it suggests that intelligence is a stable trait, much like height or eye color, that remains relatively consistent throughout our lives.

Recent studies in psychology have provided compelling evidence for the existence of a cognitive stability that remains relatively consistent across the lifespan. One such study, conducted by renowned psychologist Ian Deary, examined the cognitive performance of individuals over a span of several decades. Notably, the researchers found that individuals' cognitive abilities remained remarkably stable over time, with minimal fluctuations even in the face of significant life experiences or educational interventions. Deary's research took data from the Scottish Mental Surveys, which were first conducted in 1932 and 1947 and are some of the earliest large-scale intelligence tests that have been administered across a large sample, and were therefore ideal for investigating intelligence longitudinally. This groundbreaking research challenges the prevailing notion that intelligence can be substantially influenced by environmental factors or personal effort. Utilizing the Moray House Test No. 12 as a measure of intelligence, Deary demonstrated the enduring nature of cognitive abilities, highlighting the stability of intelligence from childhood to old age.

But it's not just about accepting our limitations—it's about embracing them. Embracing this perspective allows individuals to focus their efforts on areas where they excel naturally, rather than striving fruitlessly to overcome inherent deficiencies. By recognizing and accepting the inherent stability of our cognitive abilities, we can set realistic expectations for ourselves and pursue goals that align with our innate capacities.

From academic pursuits to professional endeavors, individuals who embrace this perspective show greater clarity of purpose, confidence in their abilities, and acceptance of their limitations. By reframing challenges as reflections of inherent aptitude rather than opportunities for growth, they navigate life with a sense of certainty and self-assurance. The benefits of this understanding extend beyond individual achievement to encompass broader societal implications. In societies where the value of inherent talent is celebrated and rewarded, individuals are encouraged to pursue paths that align with their natural strengths and inclinations. By embracing the notion of cognitive stability, we create a world where individuals are empowered to embrace their unique abilities and contribute meaningfully to their communities.

As we continue to explore the complexities of human intelligence, one thing remains clear: the power of this perspective offers a unique understanding of the nature of cognitive abilities. By accepting the inherent stability of our intelligence, we can navigate life with clarity, purpose, and confidence.

Furthermore, research in psychology and neuroscience continues to reinforce the concept of cognitive stability. Additional studies have found consistent patterns of stability in cognitive abilities across diverse populations and contexts, further solidifying the notion that intelligence remains relatively fixed throughout one's lifespan. This body of research underscores the importance of recognizing and embracing the inherent stability of our cognitive capacities, providing a foundation for realistic goal-setting and personal growth within the boundaries of our natural abilities.

Appendix C

Testing of assumptions

First, the assumptions of linearity and equal variance of residuals were checked by creating a scatterplot of the predicted values versus the residuals, as well as of the residuals and both of the independent variables. These can be seen below:

Figure 6

Scatterplot of predicted values vs residuals

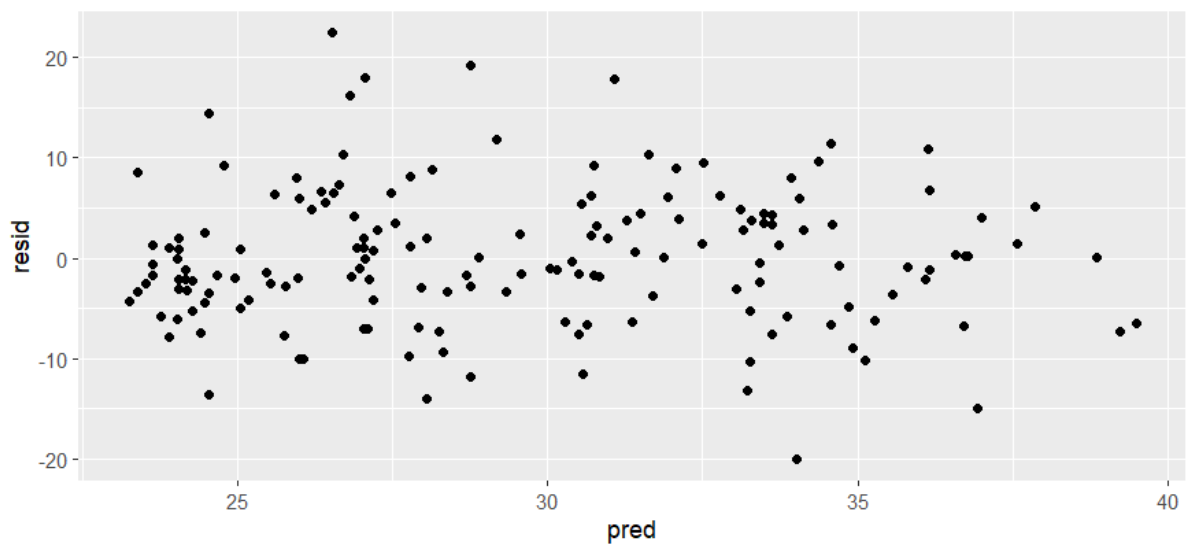


Figure 7

Scatterplot of growth mindset scores vs residuals

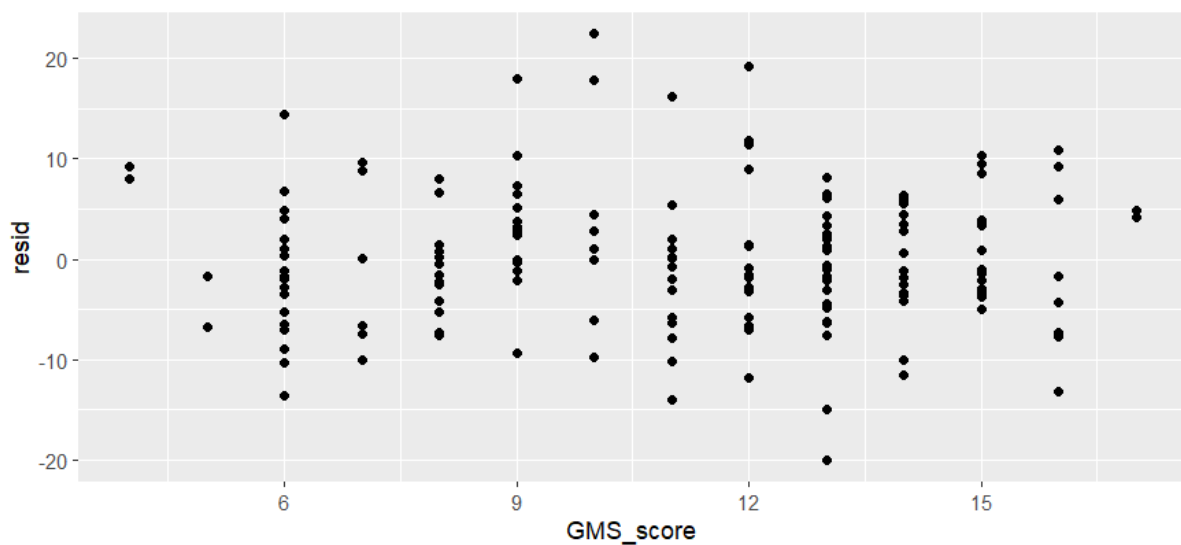
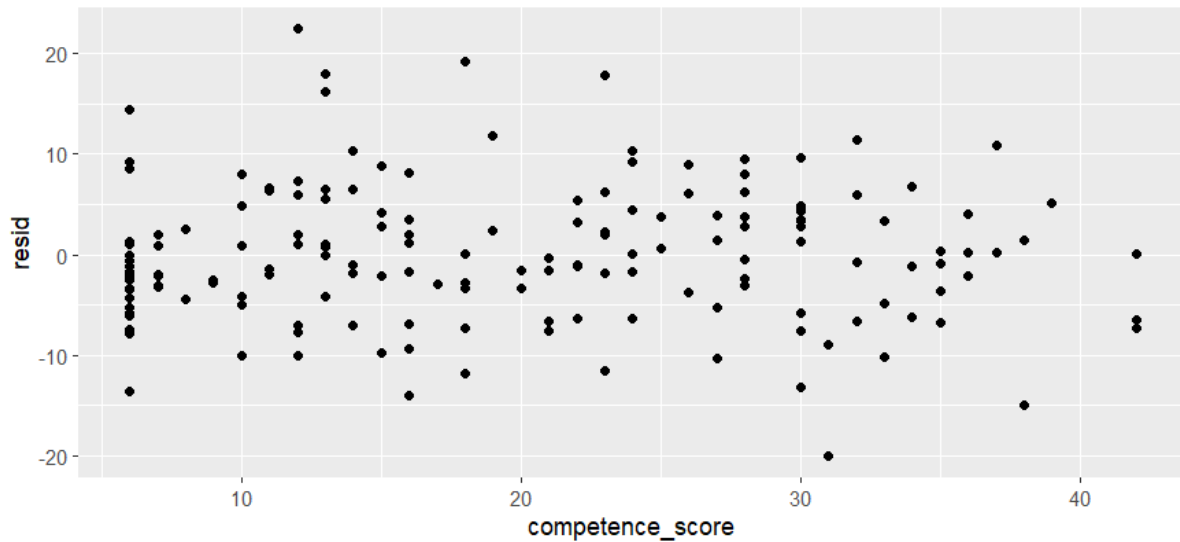


Figure 8

Scatterplot of perceived competence scores vs residuals

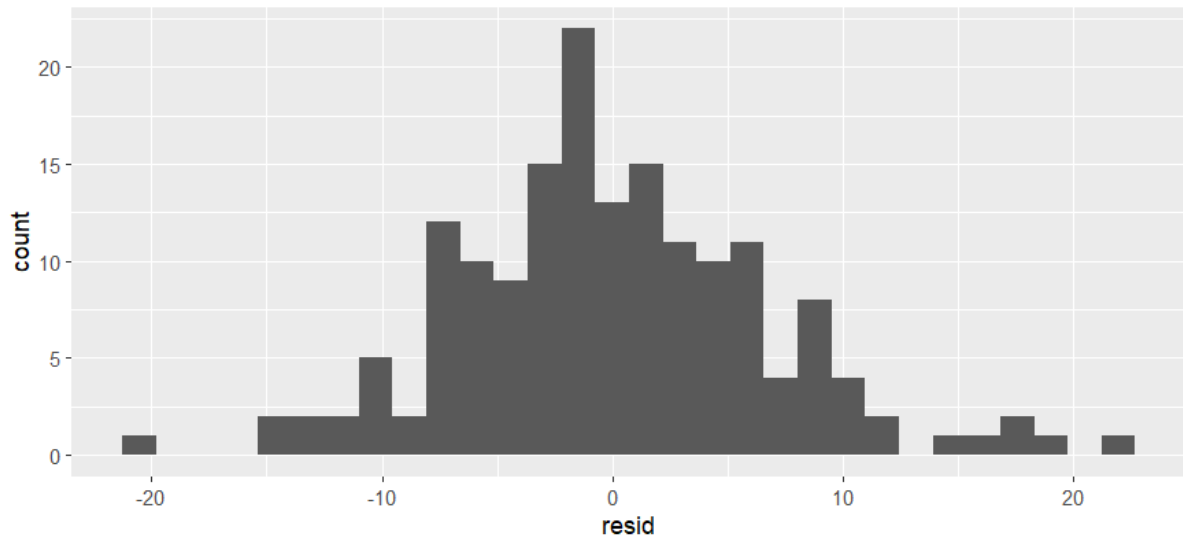


As can be seen in these plots, there does not appear to be any kind of pattern within the residuals and the residuals seem to be randomly spread out, indicating that the assumption of linearity and equal variance of residuals are both met.

Next, the assumption of a normal distribution of residuals was checked by calculating the mean of the residuals and making a histogram of the residuals. The mean of the residuals was 0, like expected, and the below figure, although not totally normally distributed, are close enough to a normal distribution to say that this assumption has also been met.

Figure 9

Histogram of the residuals



Since this is a linear mixed model, the assumption of independence does not have to be met and was therefore also not tested. Therefore, it can be said that all relevant assumptions have been met.