MASTER'S THESIS

Using Growth Mindset and Competition to Support Motivation and Manage Cognitive Load in Academic Learning.

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Using Growth Mindset and Competition to Support Motivation and Manage Cognitive Load in Academic Learning

Het Gebruik van Groeimindset en Competitie om Motivatie te Ondersteunen en de Cognitieve Belasting te Managen bij Schools Leren

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Abstract

Students often experience a lack of motivation for academic learning. Earlier studies showed that a growth mindset, the belief that intelligence is malleable through effort and practice, improves learning performance, supports motivation (e.g. mastery goal orientation) and reduces perceived cognitive load. Competition too has shown to enhance learning performance and motivation (e.g. performance goal orientation). However, research also shows that competition may not always be beneficial for learning. In particular, it can increase perceived cognitive load by inducing unnecessary cognitive processing during learning.

In this randomized controlled study, it was investigated what the effect of growth mindset and competition was on learning performance, motivation (i.e., mastery and performance goal orientation) and cognitive load and if a growth mindset may counteract the negative effect of competition by helping the learner focus on the learning task and reduce the task extra processing. The joint effect of a growth mindset and competition was explored during a short vocabulary task in an experimental setting based on a two by two design: 1) promoting a growth mindset prior to learning and 2) using a competition manipulation in the learning task. A sample of 49 secondary vocational education students performed a foreign vocabulary learning task within a 45 minutes online experimental session. Part of the participants received a growth mindset manipulation, the other part, the control group, received a neutral reading and writing task. Next to the growth mindset manipulation, a competition manipulation was implemented. Part of the participants received a competition manipulation, the other part, the control group, did not.

The mindset manipulation was successful. A growth mindset had no significant effect on mastery avoidance goal orientation, but it did have a significant effect on mastery approach goal orientation. Contradictory to the expectation based on literature, a growth mindset reduced the mastery approach goal orientation. Also not expected, a growth mindset raised the perceived extraneous and intrinsic cognitive load significant, but had no significant effect on the germane perceived cognitive load. The participants in the competition condition showed a significant higher learning performance than participants in the competition control condition. A growth mindset combined with competition leads to a higher learning performance. Participants who were in the mindset condition and the competition condition showed a higher learning performance than participants who were in the mindset control condition and the competition condition.

Following the findings of this research it is not advisable for teachers to induce a growth mindset in their students, if they aim to decrease the perceived cognitive load, because it is found that a growth mindset did not decrease the perceived cognitive load and can even increase the perceived intrinsic and extraneous cognitive load. It was also found that a growth mindset can decrease the mastery approach goal orientation, which can have a negative effect on the learning process. Competition was found to have a positive effect on learning performance. This effect was even stronger when the participants had a high growth mindset. So, if teachers want to help their students to improve their learning performance by introducing a form of competition in the learning process, it is advisable to induce a growth mindset.

Keywords: growth mindset, competition, learning performance, motivation, cognitive load

Samenvatting

Studenten ervaren vaak een gebrek aan motivatie voor academisch leren. Eerdere studies toonden aan dat een groeimindset, de overtuiging dat intelligentie beïnvloedbaar is door inspanning en oefening, de leerprestaties verbetert, de motivatie ondersteunt (bijv. mastery-doelen) en de waargenomen cognitieve belasting vermindert. Ook is aangetoond dat competitie de (leer)prestaties en motivatie (bijvoorbeeld prestatiedoelen) verbetert. Sommige onderzoeken tonen echter aan dat competitie niet altijd gunstig is voor het leren. Competitie kan met name de cognitieve belasting verhogen door onnodige cognitieve verwerking tijdens het leren te induceren.

In deze gerandomiseerde gecontroleerde studie is onderzocht wat het effect van een groeimindset en competitie was op leerprestaties, motivatie (mastery- en prestatiedoelen) en cognitieve belasting was en of een groeimindset het negatieve effect van competitie kan tegengaan door de student te helpen zich te concentreren op de leertaak en zo de cognitieve belasting te beheersen. Het interactie-effect van een groeimindset en competitie werd onderzocht met behulp van een korte woordenschattaak in een experimentele setting op basis van een twee bij twee ontwerp: 1) het bevorderen van een groeimindset voorafgaand aan het leren en 2) het gebruik van een competitiemanipulatie in de leertaak. Een steekproef van 49 mbo-studenten voerde een leertaak voor het leren van vreemde woorden uit binnen een online experimentele sessie van 45 minuten. Een deel van de deelnemers kreeg een groeimindset-manipulatie, het andere deel, de controlegroep, kreeg een neutrale lees- en schrijftaak. Naast de groeimindset-manipulatie is er een competitiemanipulatie uitgevoerd. Een deel van de deelnemers kreeg een competitiemanipulatie, het andere deel, de controlegroep, niet.

De groeimindset-manipulatie was succesvol. Er is geen significant effect van de groeimindset op mastery avoidance doelen aangetoond. Er is wel een significant effect van de groeimindset op de mastery approach doelen aangetoond. In tegenstelling tot de verwachting op basis van de literatuur verminderde een groeimindset de mastery approach doelen. Ook anders dan verwacht, verhoogde een groeimindset de externe en intrinsieke cognitieve belasting, maar had geen significant effect op de germane cognitieve belasting. De deelnemers in de competitieconditie hadden een significant hogere leerprestatie dan de deelnemers in de competitiecontroleconditie. Een groeimindset in combinatie met competitie leidde tot hogere leerprestaties. Deelnemers in de groeimindsetconditie en de competitieconditie lieten hogere leerprestaties zien dan deelnemers die in de groeimindsetconditie zaten, maar niet in de competitieconditie.

De bevindingen van dit onderzoek geven aanleiding docenten af te raden om een groeimindset te induceren bij hun studenten, als ze de waargenomen cognitieve belasting willen verminderen, aangezien niet is gebleken dat een groeimindset de waargenomen cognitieve belasting vermindert en zelfs de waargenomen intrinsieke en externe cognitieve belasting kan verhogen. Ook bleek een groeimindset de mastery approach doel oriëntatie kan verminderen, wat een negatief effect kan hebben op het leerproces. Concurrentie bleek een positief effect te hebben op leerprestaties. Dit effect was nog sterker als de deelnemers een hoge groeimindset hadden. Als docenten een vorm van competitie willen toepassen met het doel de leerprestaties van hun studenten te verbeteren, is het dus aan te raden ook een groeimindset te induceren.

Keywords: growth mindset, competition, learning performance, motivation, cognitive load

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Using Growth Mindset and Competition to Support Motivation and Manage Cognitive Load in Academic Learning

1. Introduction

Research shows that students often experience a decline in motivation during formal education (Wigfield & Eccles, 2002). Manipulations that aim to direct the beliefs of students about effort and ability have shown to promote motivation and achievement (Blackwell, Trzesniewski, & Dweck, 2007; Rhew et al., 2018). Dweck (2000) formed the belief that human intelligence and abilities are the result of effort and not a fixed state as the growth mindset. Students with a growth mindset are likely to be more focused on improving knowledge and skills and persist through challenging tasks, which results in academic achievement (Dweck & Master, 2009). Research literature supports a positive association between a growth mindset and learning performance (Sisk et al, 2018). Furthermore, a growth mindset has been found to affect motivation (i.e., mastery goal orientation), namely it fosters mastery goal orientation (Xu et al 2020). When students have a high mastery goal orientation they want to develop competence by acquiring new knowledge and skills (Harackiewicz, 2008). Growth mindset also reduces perceived cognitive load (Xu et al 2020). Perceived cognitive load is the information processing load induced by learning tasks (Sweller, 1988; Sweller, Van Merrienboer & Paas, 1998).

It has also been observed that students with a fixed mindset, the idea that intelligence is a fixed trait that is unalterable, have a tendency to feel threatened by the success of their peers, while students with a growth mindset learn from the success of others (Saunders, 2013). Elliot (2020) proposed that competition is ubiquitous in various societal settings, including schools. Competition is an interpersonal competition in which an individual's success and failure are defined in terms of how one person's outcomes compare with those of another person or persons (Elliot 2020). Introducing competition in learning tasks increases in some cases learning performance (Czocher et al.,2020; Chen et al. 2020) and also performance goal orientation (Elliot et al, 2005). When students have a performance approach goal orientation they want to demonstrate competence relative to others and when they have a performance avoidance orientation they hope to avoid a demonstration of their incompetence (Haraciewicz 2008). However, competition can also introduce unwanted perceived cognitive load and deplete working memory (Crouzevialle & Butera, 2013). Unwanted perceived cognitive load might lead to detrimental effects on learning outcomes (Crouzevialle & Butera, 2017). In particular, influential theories on instructional design research, such as the perceived cognitive load theory, have stated that learning happens when new information is successfully transferred from our working memory into our long-term memory (Sweller, 1988), which requires memory resources. Thus competition might impose unnecessary perceived cognitive load on the working memory, which leads to suboptimal effect on information processing related to learning.

A growth mindset and competition manipulation may be helpful to increase the learning performance and motivating, which will help students finish their education. The effect of these manipulations on perceived cognitive load should be taken in account, because extra perceived cognitive load may counteract the positive effects of the manipulations and, in this way, have a negative effect on learning performance. To our knowledge, no research on the combined effect of growth mindset and competition on learning performance, motivation and cognitive load has been done. The present investigation proposed that a growth mindset may counteract the negative effect of competition on perceived cognitive load by helping the learner to focus on the learning task and reduce the task extra processing. This way, the perceived cognitive load, caused by inducing competition during learning, may decrease or even disappear completely. This study will investigate the effect of growth mindset and competition on increasing learning performance, fostering motivation and managing perceived cognitive load in a secondary vocational education in the Netherlands. The findings can be seen more broadly then just secondary vocational education, which will allow students and teachers of different levels and educations to benefit from the results.

1.1 Theoretical Framework

1.1.1 Growth Mindset

Dweck (1999) developed a theory of mindset, which contains a spectrum ranging from the fixed mindset to the growth mindset. This social-cognitive theoretical framework describes how mindset beliefs affect the way in which people ascribe attributions to success and failures. These beliefs mark out the plan to divergent motivational and behavioural consequences (Dweck, 2017; Dweck & Master, 2008). Learners with a fixed mindset deem intelligence as fixed and unalterable. Contrastingly, learners with a growth mindset believe that intelligence can be improved with practice and the help of others (Xu et al., 2020). They see intelligence as malleable (Dweck & Yeager, 2019) and they believe in the importance of effort. More broadly, people can also have different mindsets towards varying areas of their lives. For example, learners can have a fixed mindset towards their ability to complete academic tasks and a growth mindset towards their ability to play baseball (Dweck, 1999). In the context of education, manipulation strategies from the perspective of growth mindset theory directly target promoting learner motivation and the effort for school learning (Dweck & Yeager, 2019). Research literature supports a positive association between a growth mindset and learning performance. A recent meta-analysis of Sisk and colleagues based on 43 manipulation studies (2018) showed that many recent school-based manipulations which target cultivating a growth mindset belief have modest effect on learning performance. In another recent study, a growth mindset has been found to increase learning performance, foster mastery goal orientation and reduce perceived cognitive load (Xu et al 2020).

1.1.2 Competition

Competition is ubiquitous in daily life. For example, it is found in the classroom, at the workplace, on the ballfield and online. It is everywhere where standards of competence are relevant (Elliot, 2020). Competition leads people towards normative competence evaluation and active social comparison concerns and processes (Garcia, Tor, & Schiff, 2013; Mussweiler, 2003; Tesser, 1988). Adding competition in learning tasks has been shown to be effective in increasing performance, in particular in game based learning scenarios (Chen & Chang, 2020; Chen, Law & Huang, 2019).

1.1.3 The Combined Effect of Growth Mindset and Competition on Learning Performance

A growth mindset has been found to increase learning performance (Sisk, 2018; Xu et al 2020). Competition can also increase (learning) performance (Chen & Chang, 2020; Chen, Law & Huang, 2019). To our knowledge, no research has been done to the combined effect of a growth mindset and competition on learning performance. It is expected that both positive effect will enhance each other, resulting in an even higher learning performance.

1.1.4 Achievement Goals

Achievement goals are the reasons or purposes of task engagement. They direct the learners' responses to events which are associated with learning in achievement situations (Elliot, 2005; Elliot & Church, 1997). In early research, two types of goal orientations can be distinguished, namely mastery goals and performance goals (Dweck & Leggett, 1988). Mastery goal orientation is defined as the striving to develop competence and task mastery. Mastery avoidance goal orientation is defined as a striving to avoid absolute or intrapersonal incompetence (Elliot 1999). Performance approach goal orientation is seen as the striving to demonstrate competence relative to others and performance avoidance goal orientation as the striving to avoid a demonstration of their competence (Haraciewicz 2008). A positive relation has been found between a high mastery approach goal orientation and high academic performance (Huang, 2012; Korn, Elliot & Daumiller, 2019). Both high mastery approach goal orientation and high performance approach goal orientation were found to positively predict exam performance, but the effect of high performance approach goal orientation was far less positive than that of high mastery approach goal orientation. High performance avoidance goal orientation did not show a negative exam performance, but was a positive predictor of worry and a negative predictor to energy. High mastery avoidance goal orientation was linked to both positive and negative learning performance.

1.1.4.1 Mindset and Achievement Goals

It is assumed that mindset beliefs have an influence on achievement goal orientations in terms of mastery goals (Dweck, 2008; Blackwell et al, 2007; Xu et al., 2020). Learners with a growth mindset regard skill development as malleable. They see effort as a means to achieve skills, which would lead to higher mastery approach goal orientation and high mastery goal orientation has been found to be positively related with growth mindset, both in observational (Chen & Pajares, 2010; Diaconu-Gherasim et al., 2019) and experimental settings (Dinger & Dickhäuser, 2013; Lou & Noels, 2016; Song et al., 2020). Unclear is what the effect of a growth mindset is on mastery avoidance goal orientation.

1.1.4.2 Competition and Achievement Goals

Learners with a high performance approach goal orientation focus on competence relative to another person or persons, which plays an important role in competition (Elliot, 2020). In particular, competition is considered to underly performance goal orientation (Elliot, 2020). Competition energizes the individual regarding competence relative to others. Individuals act on this energization by adopting and pursing specific, concrete performance goals that help them direct their behaviour. This may lead an individual towards a higher performance goal orientation (both approach and avoidance), namely because the individual will try to do well relative to others (i.e., higher performance approach orientation), whereas on the other hand, it may lead an individual away from competition by adopting higher performance avoidance goal orientation, in which the individual will try to avoid doing poorly relative to others. Several empirical studies linked competition in games to positive consequences such as increased intrinsic motivation, greater attention and excitement, more collaborative work, and active participation (e.g., Burguillo, 2010; Cagiltay et al., 2015; Cheng et al., 2009; Wu et al., 2010). Cheng et al. (2020) found in a meta study that competition had a significant positive main effect on learning performance. So, competition has found to increase performance approach goal orientation, both approach and avoidance.

1.1.5 Perceived Cognitive Load

Many learning theories, including the cognitive load theory, state that novel information is processed in a limited-capacity working memory. Learning occurs when this information is stored in long-term memory. This last type of memory is considered to have an unlimited capacity (Van Merriënboer & Sweller, 2005). The cognitive load theory classifies three kinds of cognitive loads that arise from the interaction of the learner with the instructional design (Sweller et al., 1998; Sweller et al., 2019). These are the intrinsic load, the extraneous load and the germane load. The intrinsic load refers to the complexity of the information which is being processed. This depends on the number of interacting elements in a task. The extraneous load also depends on the number of interacting elements. This is the part of the cognitive load that is unnecessary and caused by the way the information is presented to the learner, or the procedure required to perform the task. The germane load is necessary for the construction and storage of schemata into the long term memory (Kirschner, 2002). It refers to the cognitive resources that are allocated to meaningful and effective learning of the information that was depicted by the intrinsic load. Learning thus requires shifting information to the germane load (Kirschner, 2002).

1.1.5.1 Mindset and Perceived Cognitive Load

In previous research growth mindset has been found to affect a learner’s perceived cognitive load. Learners with a growth mindset value effort more, because they see ability as malleable through effort. Furthermore, they might be more likely to focus on controllable factors such as effort rather the uncontrollable aspects that pertain to the intrinsic and extraneous perceived cognitive load aspects of the learning task (Xu et al., 2020). In a study, Xu and her colleagues (2020) found that learners with a growth mindset experienced a lower intrinsic and extraneous load. Based on the literature, it is expected that a growth mindset will lower the perceived intrinsic and extraneous cognitive load. To our knowledge, no prior research has been done on the effect of a growth mindset on germane cognitive load. The expectation is that a growth mindset will also lower the perceived germane cognitive load.

1.1.5.2. Competition and Perceived Cognitive Load

Perceived cognitive load is also affected by competition. Research shows that competition increases perceived cognitive load (Crouzevialle & Butera, 2017). Crouzevialle proposed a distraction hypothesis due to evaluative pressure (Crouzevialle & Butera, 2017). She argues that although competition can orient the learner to focus and sustain task engagement, competition (or the consequent performance goals) on other hand also impose evaluative pressure, which can become a distraction that can deplete working memory resources during task performance. Indeed, there are several experiments that appear to supported this hypothesis (Crouzevialle & Butera, 2013; Avery & Smilie, 2013). Nebel and his colleagues (2016) also found that competition increased the perceived intrinsic and extraneous cognitive load. Embedding competition in the experimental tasks depleted the working memory resources during the task performance. The cognitive load theory predicts that irrelevant load, such as the status of the competitors in comparison with the position of the student, increases the extraneous perceived cognitive load (Sweller et al., 1998). This may hinder effective transfer or detail learning. It is expected that competition will raise the perceived intrinsic and extraneous cognitive load. The effect of competition on perceived germane cognitive load is still unknown.

1.1.5.3 The Combined Effect of Growth Mindset and Competition on Cognitive Load

Research shows that competition increases perceived cognitive load (Crouzevialle & Butera, 2017) and a growth mindset lowers the perceived intrinsic and extraneous cognitive load (Xu et all., 2020). To our knowledge, no research has been done to the combined effect of a growth mindset and competition on perceived cognitive load (intrinsic, extraneous and germane). It is expected that the negative effect of competition on perceived cognitive load (intrinsic, extraneous and germane) will be (partly) counteracted by the positive effect of growth mindset on perceived cognitive load (intrinsic, extraneous and germane).

1.2 Current Study

In this study the main research questions focus on whether inducing a growth mindset and adding competition have an effect on learning performance, motivation and perceived cognitive load. The hypotheses are organised by the outcomes learning performance, motivation and perceived cognitive load.

Learning Performance

Hypothesis 1: Participants who receive the growth mindset manipulation will report higher learning performance than participants who do not receive the growth mindset manipulation.

Hypothesis 2: Participants who receive the competition manipulation will report higher learning performance than participants who do not receive the competition manipulation.

Hypothesis 3: Participants who receive the growth mindset manipulation and the competition manipulation will report higher learning performance then participants who do not receive the growth mindset manipulation but do receive competition manipulation.

Achievement Goals

Hypothesis 4: Participants who receive the growth mindset manipulation will report higher mastery approach goal orientation than participants who do not receive the growth mindset manipulation.

Hypothesis 5: Participants who receive the competition manipulation will report higher performance approach goal orientation than participants who do not receive the competition manipulation.

Cognitive Load

Hypothesis 6: Participants who receive the growth mindset manipulation will report lower perceived cognitive load (intrinsic, extraneous and germane) than participants who do not receive the growth mindset manipulation.

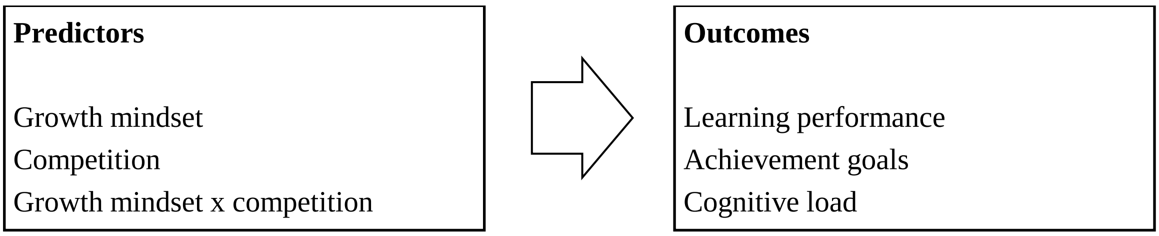
Hypothesis 7: Participants who receive the competition manipulation will report higher perceived cognitive load (intrinsic, extraneous and germane) than participants who do not receive the competition manipulation.

Hypothesis 8: Participants who receive the growth mindset manipulation and the competition manipulation will report lower perceived cognitive load (intrinsic, extraneous and germane) than participants who do not receive the growth mindset manipulation but do receive the competition manipulation.

These predictors and outcome variables are depicted in Figure 1.

Figure 1

Predictors and Outcomes in the Current Study



2. Method

2.1 Design

The experiment is a two by two between subjects randomized controlled experimental design. The two independent variables were growth mindset and competition, manipulated in two manipulations. The participants were randomly divided in four groups: the first group received a growth mindset and a competition manipulation, the second group received a growth mindset manipulation and no competition manipulation, the third group received no mindset manipulation and a competition manipulation and the fourth group received no manipulation at all. To induce a growth mindset factor, the half of the participants received a growth mindset manipulation. The other half performed a comparable control task. To induce competition, the participants (45%) performed a learning task with a competition manipulation and the other part (55%) performed the same task, without the competition manipulation. The outcome variables examined were learning performance on the learning task, motivation (mastery and performance (approach and avoidance) goal orientation) and perceived cognitive load (intrinsic, extraneous and germane). Learning performance was measured by a performance test. Motivation and perceived cognitive load were measured by subjective ratings by the participants on questionnaires.

2.2 Participants

The participants were recruited from students attending a regionaal opleidingscentrum (ROC) in the central-western Netherlands and who followed the first, second or third year of a level 4 secondary vocational education, which is the highest level of secondary vocational education in the Netherlands. In total the results of 49 participants were included in this research. The overall mean age was M = 17.59 (SD = 2.21). Of the participants, 75.5% was female and 24.5% was male.

Based on previous comparable research in an experimental setting on growth mindset a target sample size of at least 128 participants was determined (Xu et al., 2021). This sample size would provide a power of 80% for a medium effect size (Cohen's d = 0.5), basing on a type I error rate of 5%. Unfortunately, the COVID-19 pandemic made the data collection difficult, which resulted in a smaller sample size of 49. The circumstances and their results are specified in the Limitations and Future Directions section of the Discussion. This sample size provided a power of 82%, for a medium effect size (Cohen's d = .06) based on a type I error of 5%. The power calculation is presented in Appendix A.

The students took part in the study on a voluntary basis. They were randomly assigned to the experimental conditions or the control condition groups. The 'Rooms'-function in MS Teams was used for the random assignment based on the order in which the students participated.

2.3 Materials and Measures

2.3.1 Materials

Growth Mindset Manipulation. The participants performed a reading and a writing task (adapted from Yeager et al., 2016). The participants in the growth mindset read an article about the malleability of intelligence. After this they were asked to write a letter to an imagined fellow student who is struggling with learning. This strategy is based on 'saying-is-believing' (Aronson, 1999), which has been shown to be an effective strategy (e.g. Yeager et al., 2016). The template of reading and writing has proved to be effective in earlier research with 10th grade students recruited from public high schools (Xu et al., 2020). In the control group, participants read a neutral article of similar length about general brain functioning. In this article malleability of the brain is not mentioned. As a writing task the participants were asked to write a summary of the article. The materials are presented in Appendix B.

Competition Manipulation. The competition manipulation was embedded in the form of a short textual message displayed right before the learning task. This strategy was previously used in other research (Tauer & Harackiewicz, 1999; Murayama & Elliot, 2012) and is adapted for the present research as below:

'At the end of the experiment we will test you to see how many words you remembered. On this test, you will compete with the other participants in this experiment. Please, do your best in competing with the others. At the end of the experiment, you will receive information about your score and whether you have outperformed or underperformed against others who have completed the task.'

The students in the control group got the following message instead .

'At the end of the experiment there will be a test to see how many words you remembered. Please, do your best to remember as many words as possible. After completion of the task, you will receive information regarding your score.'

Learning Task. The students were instructed to study 20 new word combinations as new vocabulary of an unknown, fictional language. Each combination contained a Dutch word, the native language, paired with an invented translation of the word, a pseudoword. Pseudowords were used to rule out potential prior knowledge of the studied word combinations (De Groot & Keijzer, 2000). An overview of the word combinations is provided in Appendix C. The design of the word combinations was based on lexical principles as applied by De Groot and Keijzer (2000). The design of the learning task took factors that may influence word recall, such as abstractness/concreteness (Brysbaert, Stevens, De Deyne, Voorspoels & Storms, 2014), word length (e.g. Ellis & Beaton, 1993), and frequency (e.g. Keuleers, Brysbaerts & New, 2010) in account. To minimize the differences in difficulty of remembering the various words, since shorter words are better recalled (e.g. Ellis & Beaton, 1993), word length of all pseudowords were approximately equal at 6 to 8 letters, with each pseudoword consisting of two syllables. The goal was that the learner remembered as many words as possible on the learning performance test at the end of the experiment. The words were shown one by one on a computer screen, the Dutch translation on the left and the pseudowords on the right. The word combinations appeared on the screen for eight seconds and were shown twice in scrambled order. The duration and the presentation of the word combinations followed a similar protocol as in De Groot and Keijzer (2000). The order of the word combinations within each round was randomized according to a four by four reduced Latin square to account for any potential confounding effect related to the order of presentation. After eight seconds, the program jumped to the next word combination automatically. The third time the student got the possibility to quiz themselves, but entering an answer was not obligated. In the quiz, only the Dutch translations were shown and the student was encouraged to type the corresponding pseudowords in the eight second window in a text box. During the fourth presentation, the complete word combinations were shown again, similar to the first and second presentations.

2.3.2 Measures

Mindset Beliefs. Mindset beliefs were measured with the Implicit Theory of Intelligence Scale questionnaire (ITIS) (Dweck, 2000). This questionnaire contains four items on a growth mindset (e.g., “No matter who you are, you can significantly change your intelligence level.”) and four items on a fixed mindset (e.g., “You have a certain amount of intelligence, and you can’t really do much to change it.”). The statements have to be rated on a six-points Likert scale from (1) completely disagree to (6) completely agree. The fixed mindset items were reverse coded, because they are opposite to the items on a growth mindset (Blackwell, Trzesniewski, & Dweck, 2007). The fixed mindset items and the growth mindset items were combined into a single scale representing growth mindset. The highest possible score was 48. A high score indicated a strong orientation towards growth mindset. Earlier research showed a good internal consistency (α = .82 to .97) (De Castella and Byrne, 2015). The mindset beliefs were measured twice, once before the mindset manipulation and once after. From each measurement a subscale was created for growth mindset beliefs and a recoded one for fixed mindset beliefs. These subscales were combined into one measurement of mindset. This was measured twice: once before the mindset manipulation and once after the manipulation. The subscale from the measurement before had a low internal consistency (α = .57). To increase the consistency, one item of the growth mindset belief measurement was removed, which resulted in a good internal consistency (α = .92). To make comparison possible, this item was also removed from the subscale of the measurement after the manipulation, which resulted in a good internal consistency (α = .94). The mindset beliefs measurements were only used to check if the mindset manipulation was effective. Appendix D contains the mindset beliefs measurements.

Learning Performance. Learning performance was measured by immediate word recognition and the recall rates of the 20 presented word combinations during the learning phase. The native word was given as a prompt and the students were asked to type the corresponding pseudoword in a textbox. After this, the same native word was given as a prompt and the student was asked to choose between four pseudowords. The alternatives were pseudowords that corresponded to another Dutch word combination of the experiment. The sum score of correctly recalled and recognized words had a good internal consistency (α = .96). The total sum of correctly recalled and word recognized words was used as measure of learning performance in the current study.

Achievement Goal Orientation. Motivation was measured as achievement goal orientation with the Achievement Goal Questionnaire-Revised (AGQ-R) (adapted from Elliot & Murayama, 2008), a seven-point Likert scale for the responses, ranging from (1) strongly disagree to (5) strongly agree. The questionnaire contained twelve items, measuring mastery avoidance goal orientation (e.g., “My aim is to avoid learning less than I possibly could”), mastery approach goal orientation (e.g., “My aim is to completely master the word combinations”), performance approach goal orientation (e.g., “My goal is to perform better than other students") and performance avoidance goal orientation (e.g., "My aim is to avoid doing worse than others students"). The subscales mastery approach goal orientation, performance approach goal orientation and performance avoidance goal orientation report resp. Cronbach's α = .82, Cronbach's α = .97 and Cronbach's α = .95, indicating that they are highly reliable. The subscale mastery avoidance goal orientation reports a lower, but acceptable, reliability with Cronbach's α = .76. In Appendix F the achievement goal orientation measurement is included.

The performance approach orientation and performance avoidance goal orientation were measured twice, once before the competition manipulation and once after. Two subscales performance goal orientation were created from the performance approach orientation and the performance avoidance orientation scales from both measurements. Both had a good internal consistency with α = .93 for the subscale from the measurement before the manipulation and α = .95 for the subscale from the measurement after. The differences between these subscales were used to check whether the competition manipulation leads to an increased performance goal orientation.

The mastery goal orientation was also measured twice, once before the mindset manipulation and once after. A subscale was created from the mastery approach orientation and the mastery avoidance orientation from the measurement after the mindset belief manipulation, white a good internal consistency (α = .84), which was used to represent the mastery goal orientation. The differences between these subscales were used to check whether the mindset manipulation leads to an increased mastery orientation.

Cognitive Load. The perceived cognitive load on the entire learning task was measured by an adapted Cognitive Load Index (CLI) (Leppink et al., 2013) once, after the learning task. It contained three items to measure intrinsic cognitive load (ICL) (e.g., "I perceived the learning task as very complex") and three items on perceived extraneous cognitive load (ECL) (e.g., "The instructions and/or explanations were very unclear"). The original items on perceived germane cognitive load (GCL) were replaced by four items that better aligned the learning task that was used (e.g., "I could fully understand the concepts covered in the learning task"), since the original items did not reflect the current definition of germane load anymore (Sweller et al., 2019). Participants rated each statement on an ten-point Likert scale, ranging from "not at all the case" (1) to "completely the case" (10). The three aspects of perceived cognitive load: intrinsic, extraneous and germane, were analysed separately. The subscale intrinsic load had a good internal consistency (α = .83 and the subscale germane had an acceptable internal consistency (α = .76). The subscale extraneous had a questionable internal consistency (α = .67). Appendix E contains the perceived cognitive load measurements.

2.4 Procedure

The experiment was conducted online using LimeSurvey. The participants were able to take the experiment in their own pace without external guidance. The researcher was present online in case of any questions. Most of the participants performed the experiment during an compulsory online class. A few students performed the experiment in a later stadium, because they missed the class in which the experiment was conducted. All experimental materials were translated into Dutch. The students were invited to participate in the experiment through their e-mail address of the school and by an oral invitation of the mentor. To stimulate participation, a gift card of € 25, - was raffled among the students that finished the whole research. The participants were informed about the procedure of the experiment and those who agreed to participate gave their consent. At the start of the experiment, each participant was randomly assigned to one of the four groups.

The experiment contained four phases and took approximately 45 minutes to complete. In the first phase (10 min), all participants were reminded of the procedure and asked to fill out demographic data (i.e., gender and age). The demographic data were used to check if the randomization over the conditions (mindset manipulation and competition manipulation) was successful. After filling in the demographic data, the participants practiced with the procedure of the vocabulary learning task with four words. These words were excluded from the final test.

In the second phase (10 min), participants first started with filling out the Implicit Theory of Intelligence Scale as a baseline measurement of mindset belief. Then, the mindset manipulation was applied, in which the participants performed a reading and a writing task, different for the manipulation and control group. This was followed by a manipulation check of the mindset manipulation using again the Implicit Theory of Intelligence Scale again. Next, participants were asked to fill out the Achievement Goal Questionnaire-Revised for the baseline measure of motivation for the competition type manipulation. Afterwards, participants in the competition group read the following text:

At the end of the experiment there will be a test to see how many words you remembered. Please, do your best to remember as many words as possible. After completion of the task, you will receive information regarding your score.

Participants in the control group read:

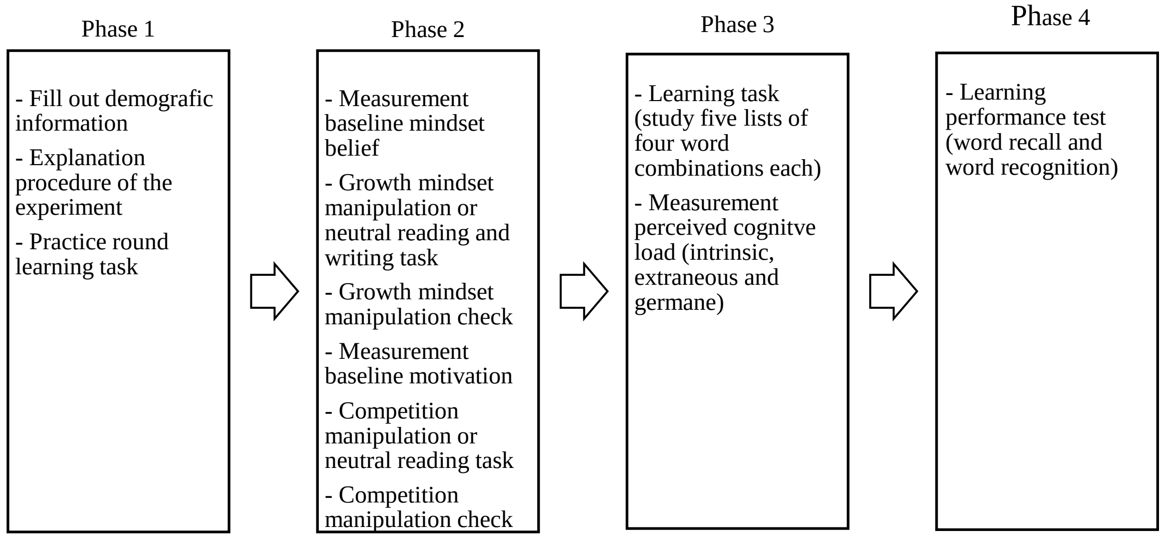
At the end of the experiment there will be a test to see how many words you remembered. Please, do your best to remember as many words as possible. After completion of the task, you will receive information regarding your score.

Hereafter, the participants were asked to fill out the Achievement Goal Questionnaire-Revised for the second time. The items about performance were used as a manipulation check.

In the third phase (20 min), all participants performed the learning task. They were asked to study five lists of four word combinations each. Each list was studied following the procedure as explained in figure 2. At the end of this learning phase, the participants filled out a questionnaire about the perceived cognitive load of the total learning experience. This was the short questionnaire of the CLI. Finally, in the fourth phase (5 min), the participants were tested on learning performance with the word recall and word recognition test.

Figure 2

Overview of the four phases



2.5 Data-analysis

The results were analysed with SPSS version 27. The data were cleaned: they were checked for missing values, unwanted outliers, and input errors. The sum scores of the measures were calculated.

Firstly, it was checked whether the randomisation of the participants over the type of manipulation (growth mindset vs control) and type of competition manipulation (competition vs no competition) was successful (i.e., age and sex). Independent t-tests were used to compare the mean ages between the manipulation and control groups of both the mindset and the competition manipulation. Crosstabs analysis with Pearson's chi squared were used to check whether gender was evenly divided over the manipulation and control groups of both the mindset and the competition manipulation.

Secondly, it was checked whether baseline mindset belief and motivation were randomly divided over resp. the mindset and the competition conditions. An independent t-test was used to compare the mindset belief before the mindset manipulation between the growth mindset condition group and the control group. An independent t-test was used to compare the performance goal orientation before the competition manipulation between the competition group and the control group.

Thirdly, manipulation checks (for competition: hypothesis 5) were performed for the growth mindset condition and the competition condition. The mindset belief manipulation was checked with a mixed ANOVA to compare the mindset belief before the manipulation with the mindset belief after the manipulation in the growth mindset condition and the growth mindset control condition. A mixed ANOVA was also used to compare the performance goal orientation before the manipulation with the performance goal orientation after the manipulation in both the competition condition and the competition control condition (i.e., hypothesis 5).

Fourthly, the hypotheses were tested. Hypothesis 1 (about the effect of the growth mindset manipulation on learning performance), hypothesis 2 (about the effect of the competition manipulation on learning performance), and hypothesis 3 (about the interaction effect between the growth mindset manipulation and the competition manipulation on learning performance) were analysed using a factorial ANOVA with learning performance as dependent variable and growth mindset condition (i.e., manipulation versus control condition) and competition condition (i.e., manipulation versus control condition) as independent variables. Hypothesis 4 (about the effect of the growth mindset manipulation on the mastery approach goal orientation). Hypothesis 6 (about the effect of growth mindset manipulation on perceived cognitive load (intrinsic, extraneous and germane), hypothesis 7 (about the effect of the competition manipulation on perceived cognitive load (intrinsic, extraneous and germane) and hypothesis 8 (about the interaction effect between the growth mindset manipulation and the competition manipulation on the perceived cognitive load (intrinsic, extraneous and germane), were analysed using a factorial ANOVA with perceived cognitive load (intrinsic, extraneous and germane) as dependent variable and growth mindset condition (i.e., manipulation versus control condition) and competition condition (i.e., manipulation versus control condition) as independent variables.

3. Results

The data were checked for unwanted outliers, which were not found. The data of participants who filled out only a small part of the research were deleted. Firstly, randomization was checked between the (growth mindset and competition) condition groups and the (growth mindset and competition) control group on age and gender. The t-test showed no significant difference between the growth mindset group and the growth mindset control group in age. Crosstabs analysis showed no significant difference between the two groups regarding gender, χ^2 (1) = 0.340, p = 0.560, with the growth mindset condition group consisting of 20,8 % males and 79,2 % females, and the growth mindset control group of 28,0 % males and 72,0 % females. The t-test showed no significant difference between competition group and the competition control group in age. Crosstabs analysis showed no significant difference between these two groups regarding gender, χ^2 (1) = 0.859, p = 0.354. with the competition condition group consisting of 18,2 % males and 81,8 % females, and the control group of 29,6 % males and 70,4 % females.

Secondly, the baseline mindset belief and motivation were checked. The t-test showed no significant difference between the growth mindset group and the growth mindset control group in growth mindset belief before the mindset manipulation. The t-test showed no significant difference between the competition and the competition control groups in performance approach goal orientation before the competition manipulation. The descriptive statistics regarding age, growth mindset baseline and competition baseline being equally distributed across the condition groups and control groups show a successful randomization of the groups. The descriptive data of all variables and the main analysis results are shown in Table 1.

Table 1

Descriptive Statistics of all Variables as well as ANOVA and T-test Results of Group Comparison

	Growth mindset		Control mindset		Competition		Control Competition	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Mindset before manipulation	9.75	2.71	10.48	2.73	10.90	2.88	9.48	2.44
Mindset after manipulation	15.05	3.74	14.09	3.42	15.60	3.44	13.72	3.52
Performance goal orientation before manipulation								
- approach					14.20	4.76	14.00	4.28
- avoidance					10.85	5.65	11.48	5.36
Performance goal orientation after manipulation								
- approach					14.00	4.89	13.56	4.23
- avoidance					10.80	6.04	12.52	5.31
Perceived ccognitive load								
– intrinsic	18.68	6.31	13.67	5.16	17.39	6.04	15.16	6.39
– extraneous	21.00	5.98	16.67	7.35	19.22	7.17	18.58	6.90
– germane	24.79	6.75	21.67	7.68	23.11	6.41	23.42	8.22
Learning performance	15.95	10.63	15.83	10.82	19.44	10.66	12.52	9.58
Mastery goal orientation								
- approach	12.27	4.28	15.17	4.30				
- avoidance	13.18	4.37	12.78	4.69				
Age	17.04	1.63	18.12	2.67	17.55	2.70	17.63	1.76

3.1 Growth Mindset and Competition Manipulations

The growth mindset manipulation was meant to induce a growth mindset. The mixed ANOVA showed a significant interaction effect between time and the mindset manipulation, $F(1,43) = 5.38$, $p = .025$. This shows that the effect of time was different for participants that received the growth mindset manipulation than for participants that were in the growth mindset control condition. In the growth mindset control condition the growth mindset belief rose with 3.61 from $M = 10.48$, $SD = 2.06$ to $M = 14.09$, $SD = 3.42$. In the growth mindset condition the growth mindset belief rose with 5.55 from $M = 9.50$, $SD = 2.69$ to $M = 15.05$, $SD = 3.74$. This means that the growth mindset belief rose with 1.94 more in the growth mindset belief than in the mindset growth control condition.

Also a significant difference in mean was found in growth mindset belief in the growth mindset condition after the mindset manipulation compared to the growth mindset belief before the growth mindset manipulation, main effect of time $F(1,43) = 120.25$, $p < .001$. The mindset belief before the manipulation was $M = 10.00$, $SD = 2.41$ and after the manipulation $M = 14.56$, $SD = 3.57$.

The competition manipulation was meant to induce the performance approach goal orientation. The mixed ANOVA showed no significant difference in the mean performance approach goal orientation in competition condition after the competition manipulation compared to the control group. Therefore the competition manipulation seems to be unsuccessful.

3.2 Learning Performance

Hypothesis 1 states that participants who receive the growth mindset manipulation will report a higher learning performance than participants who do not receive the growth mindset manipulation. The factorial ANOVA showed no significant difference between participants in the growth mindset and participants in the control condition.

Hypothesis 2 states that participants who receive the competition manipulation will report a higher learning performance than participants who do not receive the competition manipulation. The factorial ANOVA showed a significant difference in learning performance between participants in the competition condition and participants in the control condition, $F(1, 33) = 5.378$, $p = .027$. Participants in the competition condition scored higher than participants in the competition control condition.

Hypothesis 3 states that participants who receive the growth mindset manipulation and the competition manipulation will report higher learning performance than participants who do not receive the growth mindset manipulation but do receive the competition manipulation. The factorial ANOVA showed a statistically significant interaction between the effect of growth mindset condition and competition condition on learning performance, $F(1, 33) = 7.237$, $p = .011$. The t-test following the factorial ANOVA showed no significant difference in learning performance between participants who were in the competition control condition and the growth mindset condition on one hand and participant who were in the competition control condition and in the growth mindset control condition on the other. The t-test following the factorial ANOVA did show a significant difference for participants who were in the competition condition. Participants in the mindset and competition condition scored higher ($M = 68.20$ with a $SD = 11.54$ (t (10) = 3.67, $p = .002$) than participants who were in the growth mindset control condition and the competition condition ($M = 49.13$ with a SD = 10.16 (t (8) = 3.67, $p = .002$).

3.2 Achievement Goals

Hypothesis 4 states that participants who receive a growth mindset manipulation will report higher mastery approach goal orientation and lower mastery avoidance orientation than participants who do not receive the growth mindset manipulation. The mastery avoidance and the mastery approach goal orientation were analysed separately. The independent t-test showed no significant difference in mastery avoidance goal orientation in participants in the growth mindset condition compared to participants in the growth mindset control condition (t (43) = .46; $p = .769$). The difference in mastery approach goal orientation however was significant (t (43) = -2.27; $p = .028$). The participants in the growth mindset condition reported a lower mean ($M = 12.27$, $SD = 4.28$) than participants in the growth mindset control condition ($M = 15.17$, $SD = 4.30$).

Hypothesis 5 states that participants who receive the competition manipulation will report higher performance approach goal orientation than participants who do not receive the competition manipulation. The independent t-test showed no significant difference in performance approach goal orientation between participants who received the competition manipulation and participants who did not receive the competition manipulation.

3.3 Perceived Cognitive Load

Hypothesis 6 states that participants who receive the mindset manipulation will report lower perceived cognitive load (intrinsic, extraneous and germane) than participants who do not receive the growth mindset manipulation. The factorial ANOVA showed a significant difference in perceived extraneous cognitive load between participants in the growth mindset condition and participants in the control condition. Participants in the mindset condition scored higher than participants in the mindset control condition. The factorial ANOVA also showed a significant difference in perceived intrinsic cognitive load between participants in the growth mindset condition and participants in the control condition. Participants in the mindset condition scored higher than participants in the mindset control condition. The factorial ANOVA showed no significant difference in perceived germane cognitive load between participants in the growth mindset condition and participants in the control condition.

Hypothesis 7 states that participants who receive the competition manipulation will report higher perceived cognitive load (intrinsic, extraneous and germane) than participants who do not receive the competition manipulation. The factorial ANOVA showed no significant difference in perceived intrinsic, extraneous or germane cognitive load between participants in the competition condition and participants in the control condition.

Hypothesis 8 states that participants who receive the growth mindset manipulation and the competition manipulation will report lower perceived cognitive load (intrinsic, extraneous and germane) than participants who do not receive the growth mindset manipulation but do receive the competition manipulation. The factorial ANOVA showed no significant interaction effect for perceived intrinsic and germane cognitive load. However, a significant interaction effect was found for perceived extraneous cognitive load, $F(1, 33) = 5.506$, $p = .025$. The following independent t-test showed that participants who did receive the growth mindset manipulation and the competition manipulation had a higher mean ($M = 23.40$, $SD = 5.06$) than participants who did not receive the growth mindset manipulation but did receive the competition manipulation ($M = 14.00$, $SD = 6.00$). This difference was very significant (t (16) = 3.609, $p = .003$).

4. Discussion and Conclusions

Very often, students struggle with a lack of motivation for academic learning. A decline in motivation during formal education is common among students (Wigfield & Eccles, 2002). Manipulations that are targeted to change the beliefs of students about effort and ability have proven effective to increase motivation and achievement (Blackwell, Trzesniewski, & Dweck, 2007; Rhew et al., 2018). This research looked into the effects of growth mindset and competition to support learning performance and motivation. Further, the effect of growth mindset and competition on perceived cognitive load was investigated.

4.1 Growth Mindset and Competition Manipulations

The growth mindset manipulation was expected to increase the growth mindset beliefs. Participants who received the growth mindset manipulation reported a significant higher growth mindset belief after the growth mindset manipulation than participants in the control group. The effect of the competition manipulation was measured by the difference in performance approach goal orientation. When students have a performance approach goal orientation they want to demonstrate their competence in relation to others. Expected was that participants who received the competition manipulation would report higher performance approach orientation. Performance approach goal orientation, in its turn, is expected to facilitate performance (Murayama & Elliot, 2012). However, the participants who received the competition manipulation did not report a significant higher performance goal orientation than participants in the control group. This may indicate that the competition manipulation failed. But competition can be conceptualized in three different ways: as a characteristic of the person (trait competitiveness), as a characteristic of the perceived situation (perceived environmental competitiveness) and as a characteristic of the actual situation (structural competition). Perceived environmental competitiveness is an individual's cognitive construal of the competitive nature of the achievement setting (Murayama & Elliot, 2012). This form has been considered particularly important in educational settings (Maehr & Midgley, 1996). However, most of the studies in the education setting have focused on perceived environmental competitiveness as a group level variable (i.e., classroom or school), rather than an individual level variable (i.e., student;

e.g., Fraser & Fisher, 1982; Moos, 1979; Walberg & Anderson, 1972). With this type of design group level effects of competition (“Do competitive groups do better than non-competitive groups?”) has been investigated, but it does not answer the focal question “Do individual’s perceptions of the competitiveness of the environment influence their individual outcomes?”(Robinson, 1950). A systematic empirical review of the link between perceived environmental competitiveness and performance has not been conducted. Meta-analytic results show that the effect of perceived competitiveness on performance is extremely small (Murayama & Elliot, 2012). It is very possible that even if the competition manipulation was successful, this would not lead to a better learning performance. Performance approach goal orientation is a link between competition and learning performance. If learning performance is not affected by the competition manipulation it is likely that performance approach goal orientation is also not affected. So, the performance approach goal orientation might not be affected by the competition manipulation, because the competition manipulation increased the perceived environmental competitiveness, which in its turn, has a very small effect on learning performance and performance approach goal.

4.2 The effects of the Growth Mindset Manipulation on Learning Performance, Motivation and Perceived Cognitive Load

Positive effects of growth mindset on learning performance, motivation and/or perceived cognitive load have been demonstrated in previous research (e.g. Burnette et al., 2019; Yeager et al., 2019; Sisk et al., 2018; Xu et al., 2021). In the current study, no significant effect of growth mindset was found on learning performance. The theory that a growth mindset improves learning performance was not confirmed. Based on this research it is not advisable for teachers to implement a growth mindset in students to improve their learning performance. Even though participants who received the growth mindset manipulation did report higher growth mindset beliefs than participants who did not receive the growth mindset manipulation, the idea of a growth mindset may not have been sufficient integrated in the cognitive system of the participants. It might have been just an idea of which the participants took notice. A more extensive manipulation may be necessary to really make the growth mindset a part of the participants’ cognitive system. A enhanced learning performance may not been found because the participant did not sufficiently adopt a growth mindset belief.

A significant effect of growth mindset was found on perceived intrinsic and extraneous cognitive load. The perceived intrinsic cognitive load refers to the fundamental difficulty of the learning material. When a task is easy, it has a low perceived intrinsic cognitive load and when a task is difficult is has a high perceived intrinsic cognitive load. The perceived extraneous cognitive load refers to the representation of the information. When the information is presented in a clear way it has a low perceived extraneous cognitive load. When the information is presented alongside with irrelevant or unimportant information the perceived extraneous cognitive load is high. Participants in the mindset condition experienced a higher perceived intrinsic and extraneous cognitive load. These findings contradict the position that a growth mindset reduces perceived intrinsic and extraneous cognitive load (Xu et al., 2020). The raise of the perceived intrinsic and extraneous cognitive load may be caused by the participants still thinking about the possibilities of a growth mindset. This cognitive process might have seized a part of their brain that was available for the learning process, causing them to experience a higher perceived intrinsic and extraneous cognitive load. Based on these findings, teachers cannot help their students to reduce perceived cognitive load by inducing a growth mindset. In fact, inducing a growth mindset might increase the perceived intrinsic and extraneous cognitive load, which makes it more difficult for students to process the learning materials. The germane load was not affected by the growth mindset manipulation. Germane load refers to the cognitive resources that are allocated to meaningful and effective learning of the information that was depicted by the intrinsic load. Learning thus requires shifting information to the germane load (Kirschner, 2002). Van Merriënboer, Kester and Paas (2006) suggest that methods that reduce the perceived intrinsic and extraneous cognitive load, such as low variability and explicit guidance and feedback, may hinder the transfer of learning. Related to this theory, Bjork & Bjork (2011) argue that things that make learning 'easy' during instruction do not always lead to long-term learning and that by creating conditions which are difficult and appear to impede immediate performance lead to greater long-term retention and better transfer. This leads to the conclusion that it is likely that conditions that affect perceived intrinsic and extraneous load in one way, will affect the germane load in a different way. In this light it is not surprising that a growth mindset affects the intrinsic and extraneous cognitive load in a different way than the perceived germane cognitive load.

No significant effect of growth mindset on mastery avoidance goal orientation was found. When students have a mastery avoidance goal orientation, they want to avoid doing worse than they have done before or avoid failing to learn as much as possible. When students have a mastery approach orientation they strive to master or know the task they are performing. They want to learn to improve their knowledge and/or abilities. A significant effect of growth mindset on mastery approach goal orientation was found. Contradicting the findings of the literature however, a lower mastery approach goal orientation was found in the participants in the growth mindset condition than in participants in the mindset control condition. This may be caused by an insufficient adoption of the growth mindset belief, as mentioned in the beginning of the paragraph. Because a positive relation has been found between mastery goal orientation and academic performance (Huang, 2012), teachers should not induce a growth mindset in students to stimulate mastery approach goals to improve the academic performance of students, based on the findings of this research. In fact, inducing a growth mindset might lower the mastery approach goal orientation of students, which in its turn might negatively affect the learning performance.

4.3 The effect of Competition on Learning Performance, Motivation and Perceived Cognitive Load

Previous research showed that competition enhanced (learning) performance (Chen & Chang, 2020; Chen, Law & Huang, 2019; Cheng et al., 2020) and motivation (Burguillo, 2010; Cagiltay et al., 2015; Cheng et al., 2009; Wu et al., 2010) and raised the perceived cognitive load (Crouzevialle & Butera, 2017; Crouzevialle & Butera, 2013; Avery & Smilie, 2013; Nebel et al., 2016; Sweller et al., 1998). As mentioned in 4.1, the effect of the competition manipulation was measured by the difference in performance approach goal orientation (Murayama & Elliot, 2012). When students have a high performance approach goal orientation they want to demonstrate competence relative to others. Contrary to the findings in the literature, no significant difference in performance goal orientation between the competition group and the competition control group was found. This makes it questionable to test effects of competition on learning performance (hypothesis 2 and 3) and perceived cognitive load (hypothesis 6 and 8). Nonetheless, a significant effect of competition on learning performance was found. In line with the findings in the literature (Chen & Chang, 2020; Chen, Law &

Huang, 2019; Cheng et al., 2020), the participants in the competition condition scored better than the participants in the competition control condition. This result supports the finding that competition enhances learning performance. However, Murayama & Elliot, 2012 (2012) state that the effect of competition on learning performance needs the aid of a raised performance approach goal orientation. As mentioned, a significant raised performance approach goal orientation was not found. This suggests that competition might not only enhance learning performance indirectly, through performance goal orientation, but also directly. This makes competition a suitable learning tool to boost learning performance. Teachers can use a form of competition to help their students to score better.

Contrary to the findings in the literature, no significant effect of competition on motivation (Burguillo, 2010; Cagiltay et al., 2015; Cheng et al., 2009; Wu et al., 2010) and perceived cognitive load (Crouzevialle & Butera, 2017; Crouzevialle & Butera, 2013; Avery & Smilie, 2013; Nebel et al., 2016; Sweller et al., 1998) was found. Possibly, competition does not affect motivation and perceived cognitive load directly, but only indirectly, through a raised performance approach orientation. In that case, the fact that no raised performance approach goal orientation was found explains why no effect of competition on motivation and perceived cognitive load was found.

This leads to the conclusion that competition might work in a different way on learning performance (directly) on one hand and motivation and cognitive load on the other (indirectly through a raised performance approach goal orientation). Because no raised performance goal orientation has been demonstrated, the indirect influence of competition (on motivation and cognitive load) may not have been present. Because a raised performance goal orientation is not necessary for the direct effect of competition (on learning performance), a raised learning performance was demonstrated.

4.4 The Effect of the Interaction between Growth Mindset and Competition on Learning Performance, Motivation and Perceived Cognitive Load.

To our knowledge, no previous research about the interaction between mindset belief and competition in relation to learning performance, motivation and perceived cognitive load has been done. It was expected that the effect of growth mindset and competition on learning performance would enhance each other, which would result in a higher learning performance of participants who received the growth mindset manipulation and the competition manipulation than the learning performance of participants that did not receive the growth mindset manipulation but did receive the competition manipulation. A significant interaction effect of growth mindset and competition on learning performance was found. Participants in the mindset and competition condition showed a higher learning performance than participants in the growth mindset control condition and the competition condition. This result confirms hypothesis 3 and indicates that a growth mindset and competition enhance each other, resulting in a better learning performance when they are combined. This suggests that if teachers want to use competition to enhance the learning performance of their students, it is advisable to induce a growth mindset before they apply the competition element.

Is was expected that the negative effects of competition on perceived cognitive load would be counteracted by the positive effects of growth mindset belief (hypothesis 8). Only a significant interaction effect between a growth mindset and competition was found for perceived extraneous cognitive load, indicating that participants who did receive the growth mindset manipulation and the competition manipulation had a higher perceived extraneous cognitive load than participant who did not receive the growth mindset manipulation but did receive the competition manipulation. This is contradictory to the expectation and suggests that a growth mindset does not counteract the negative effect of competition on perceived extraneous cognitive load. However, maybe the participants that received both manipulations were overwhelmed by the information about a growth mindset and competition, which might have occupied a specific part of the brain. This, in its turn, might have made these participant more sensitive for perceived extraneous cognitive load. No significant interaction effect between a growth mindset and competition on perceived intrinsic and germane cognitive load was found. Perceived intrinsic and germane cognitive load might be less influenced by a occupied brain. Different parts of the brain may be involved in the different forms of cognitive load. It is possible that the part that is involved in extrinsic load is more sensitive to the load created by the manipulations than the parts involved in the germane and intrinsic load. This may have caused the perceived cognitive load to increase, while the perceived germane and intrinsic cognitive load were not affected.

This leads to the conclusion that an interaction effect between a growth mindset and competition does, as expected, enhance learning performance, unexpectedly did not counteract the negative effect of competition on perceived extraneous cognitive load, and had no significant effect on perceived intrinsic and germane cognitive load.

Following the above, it appears that it is not advisable for teachers to induce a growth mindset in their students, if the aim is to decrease the perceived cognitive load. It was not found that a growth mindset decreased the perceived cognitive load. It was even found that a growth mindset can increase the perceived intrinsic and extraneous cognitive load, which can complicate the processing of the learning material. It was shown that a growth mindset can also decrease the mastery approach goal orientation, which can have a negative effect on the learning process. However, a growth mindset can also have a positive effect on the learning performance. It was found that competition had a positive effect on the learning performance and that this effect was even stronger when the participants had a high growth mindset. So, if teachers want to help their students to improve their learning performance by introducing a form of competition in the learning process, it is advisable that they also induce a growth mindset.

4.5 Limitations and Future Directions

This research has some limitations. One of the limitations concerns the data collection, which took place during the Corona pandemic. Both the teachers and the students reported low student motivation for academic learning and school. It was difficult to get the students motivated to come to (online)classes and do their homework. The grades of the students were lower than usually. Both the teachers and the students reported more emotional problems in the students than usually, such as depressed mood, lower motivation and lack of interest. The research was conducted in six classes with in total 138 students. From these 138 students, 73 students attended the compulsory (online)class in which the research was conducted. Of these, 61 students chose to participate in the research. The other 11 chose to do a replacement assignment. From the 61 students that chose to participate in the research 12 students dropped out in such an early stadium that their data was unusable. Thus, from the 138 students, only 49 actually participated in the research. The effects of the Corona pandemic may be the cause for these low participant rates.

In addition, the learning task may not be suitable for secondary vocational education students. The students in the test run indicated that they found the learning task and questionnaires boring. They also indicated that the task in total was too long. From the 12 students that participated in the test run no one finished the tasks completely. One did not even start the task, one got through half and the others stopped before this. As a result of this feedback, the task has been shortened substantially. This shortened version was used for the current research. The effects of the Corona pandemic might also have been noticeable. They might have influenced the perseverance of the students in a negative way.

The competition manipulation turned out to be unsuccessful. A competition manipulation similar to the one that was used proved to be successful in other target groups (Tauer & Harackiewicz, 1999; Murayama & Elliot, 2012). Both manipulations were administered in a written form. These form of written manipulation might not be an effective way to carry out a manipulation in secondary vocational education students specifically. In follow-up research, the way to carry out manipulations needs attention. Namely, A different way to induce competition might be more successful, for example in the form of a computer game (Cheng et al., 2009). For the mindset manipulation, it might be more effective to provide the information in the form of a video or spoken explanation. It is also possible that the reading task to induce a growth mindset was too short. It may take a longer time to really induce a growth mindset. To accomplish this, multiple lessons may be necessary to really change the view of students on the possibility of the brains to adapt and ‘get smarter’ by practicing.

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Appendixes

Appendix A: Power calculation

1] **F tests -** ANOVA: Repeated measures, within-between interaction

Analysis:	A priori: Compute required sample size		
Input:	Effect size f	=	0.2526456
	α err prob	=	0.05
	Power (1-β err prob)	=	0.80
	Number of groups	=	4
	Number of measurements	=	2
	Corr among rep measures	=	0.5
	Nonsphericity correction ε	=	1
Output:	Noncentrality parameter λ	=	12.2553214
	Critical F	=	2.8164658
	Numerator df	=	3.0000000
	Denominator df	=	44.0000000
	Total sample size	=	48
	Actual power	=	0.8120209

2] **F tests -** ANOVA: Repeated measures, within-between interaction

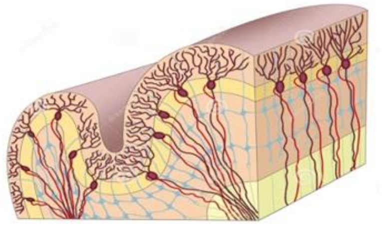
Analysis:	Post hoc: Compute achieved power		
Input:	Effect size f	=	0.2526456
	α err prob	=	0.05
	Total sample size	=	49
	Number of groups	=	4
	Number of measurements	=	2
	Corr among rep measures	=	0.5
	Nonsphericity correction ε	=	1
Output:	Noncentrality parameter λ	=	12.5106406
	Critical F	=	2.8115435
	Numerator df	=	3.0000000
	Denominator df	=	45.0000000
	Power (1-β err prob)	=	0.8215761

Appendix B : Materials for the growth mindset manipulation

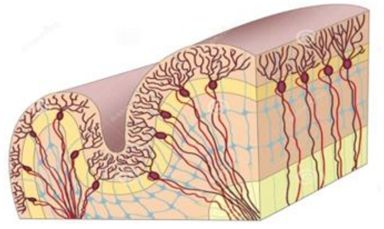
Table B1

Experimental condition: English and Dutch version of the growth mindset manipulation (adapted from Yeager et al., 2016)

English version	Dutch version
You can grow your intelligence	**Je kunt je intelligentie laten groeien**
New research shows that the brain can develop as a muscle	**Nieuw onderzoek laat zien dat de hersenen kunnen ontwikkelen als een spier**
Many people think that the human brain is a mystery. They do not know much about intelligence and how it works. With the word intelligence, many people think that this means that you are born either smart, average or stupid and that this remains the same throughout your life.	Veel mensen denken dat het menselijk brein (ook wel hersenen genoemd) een mysterie is. Ze weten niet veel over intelligentie en hoe het werkt. Bij het woord intelligentie denken veel mensen dat dit betekent dat je slim, middelmatig of dom geboren bent en dat dit je hele verdere leven hetzelfde blijft.
However, new research shows that the human brain works more like a muscle that changes and becomes stronger when you use it. Scientists have succeeded in showing how your brain grows and becomes stronger as you learn.	Echter, nieuw onderzoek laat zien dat het menselijk brein meer als een spier werkt die verandert en sterker wordt wanneer je het gebruikt. Het is wetenschappers gelukt om te kunnen laten zien hoe je hersenen groeien en sterker worden als je leert.
 *De hersenen*	 *De hersenen*
When you exercise and learn new things, such as with studying a new language, parts of the brain change and become bigger, just like muscles change and become bigger when you exercise.	Wanneer je namelijk oefent en nieuwe dingen leert, zoals tijdens het studeren van nieuwe taal, veranderen er gedeeltes van de hersenen en worden ze groter, net zoals spieren veranderen en groter worden wanneer je sport.



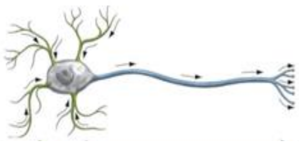
Een gedeelte van de hersenschors



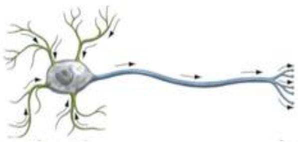
Een gedeelte van de hersenschors

Inside the cerebral cortex there are billions of tiny nerve cells called neurons. These nerve cells have branches with which they connect to other cells in a complex network. The communication between these brain cells makes it possible for us to think and solve problems.

Binnenin de hersenschors zijn er biljoenen kleine zenuwcellen die neuronen genoemd worden. Deze zenuwcellen hebben vertakkingen waarmee ze verbinding maken met andere cellen in een ingewikkeld netwerk. De communicatie tussen deze hersencellen maakt het mogelijk voor ons om te denken en problemen op te lossen.



Zenuwcel of neuron



Zenuwcel of neuron

When you learn new things, these small connections in the brain multiply and become stronger. The more you challenge your brain to learn, the more your brain cells grow. Subsequently, the things you first thought were very difficult or even impossible, such as studying vocabularies of a new language, seem to be easier. The result is a stronger, smarter brain.

Wanneer je nieuwe dingen leert, vermenigvuldigen deze kleine verbindingen in de hersenen zich en worden ze sterker. Hoe meer je je hersenen uitdaagt om te leren, hoe meer je hersencellen groeien. Vervolgens lijken de dingen waarvan je eerst vond dat ze heel erg moeilijk of zelfs onmogelijk waren, zoals bijvoorbeeld woordenschat van een nieuwe taal instuderen, makkelijker te worden. Het resultaat is een sterker, slimmer brein.

How do we know that the brain can grow stronger?

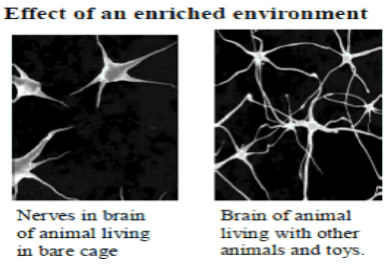
Scientists began to think that the human brain could develop and change when they started to examine the brains of animals. They discovered that animals that lived in a challenging environment in which they could train their brains by playing with toys or other animals, were much more active than animals that lived only in bare pens.

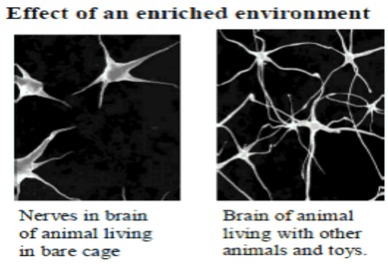
Hoe weten we dat de hersenen sterker kunnen groeien?

Wetenschappers begonnen te denken dat het menselijk brein kon ontwikkelen en veranderen toen ze de hersenen van dieren gingen onderzoeken. Ze ontdekten namelijk dat dieren die in een uitdagende omgeving leefden waarin ze hun hersenen konden trainen door met speelgoed of met andere dieren te spelen, veel actiever waren dan dieren die

These active animals had more larger and stronger connections between their nerve cells in their brains. Their brains were about 10% heavier than the brains of the animals that lived only in bare pens. The active animals were also 'smarter', they were better at solving problems and learning new things.

alleen in kale hokken leefden. Deze actieve dieren hadden meer grotere en sterkere verbindingen tussen hun zenuwcellen in hun hersenen. Hun hersenen waren ongeveer 10% zwaarder dan de hersenen van de dieren die alleen in kale hokken leefden. De actieve dieren waren ook ‘slimmer’, ze waren beter in het oplossen van problemen en het leren van nieuwe dingen.





Children’s brain growth

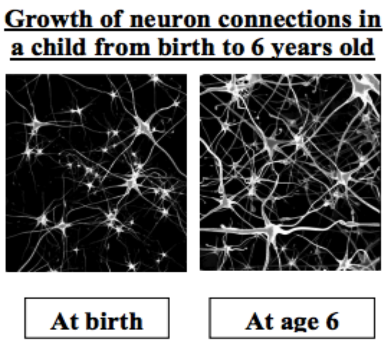
Another reason why scientists began to think that brain could grow was: babies. What makes it possible for them to learn to speak the language of their parents in the first few years of their lives? In a sense, babies train their brains by first listening very carefully and then starting to practice talking.

De groei van hersenen bij kinderen

Nog een andere reden waarom wetenschappers begonnen te denken dat hersenen kunnen groeien was: baby’s. Wat maakt het mogelijk dat zij de taal van hun ouders leren spreken in de eerste paar jaren van hun leven? In zekere zin trainen baby’s hun hersenen door eerst heel goed te luisteren en vervolgens zelf te gaan oefenen met praten.

Once children have learned a language, they will not forget them, because learning makes a lasting change in the brain. The brain cells have become larger and new connections have developed between the nerve cells, making the children's brain actually stronger and smarter.

Als kinderen eenmaal een taal hebben geleerd, zullen ze deze niet meer vergeten, omdat leren een blijvende verandering aanbrengt in de hersenen. De hersencellen zijn groter geworden en er zijn nieuwe verbindingen gegroeid tussen de zenuwcellen waardoor het kinderbrein feitelijk sterker en slimmer is geworden.



The truth about 'smart' and 'stupid'

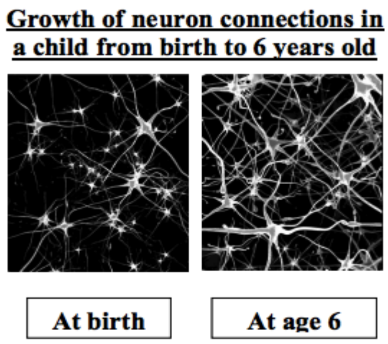
No one thinks that babies are stupid because they can’t talk. They have not yet learned how to do this. But some people will call others stupid because they cannot solve math’s, spell a word, or aren’t good at learning a new language - even though all these things can be learned by practicing. The more you learn, the easier it becomes to learn new things.

The key to growing the brain: practice!

Pupils whom everyone thinks they are 'the smartest' can simply be born without being different from others. But perhaps these 'smart' students have already started practicing reading, for example, before they went to school, so that they could already build their 'read muscles'. Other pupils might learn to do as well with practice.

What can you do to become smarter?

Just like an athlete you will have to train and practice. As you practice, you make your brain stronger. You will also learn skills that allow you to use your brain in a smarter way.



De waarheid over ‘slim’ en ‘dom’

Niemand denkt dat baby’s dom zijn omdat ze niet kunnen praten. Ze hebben alleen nog niet geleerd hoe ze dit moeten doen. Toch zijn er mensen die anderen dom noemen omdat ze geen wiskundesom op kunnen lossen, een woord niet goed kunnen spellen, of niet goed zijn in een nieuwe taal leren - ook al zijn al deze dingen te leren door te oefenen. Hoe meer je leert, hoe makkelijker het wordt om nieuwe dingen te leren.

De sleutel tot het laten groeien van de hersenen: oefenen!

Leerlingen van wie iedereen denkt ze ‘de slimste’ zijn, kunnen gewoon geboren zijn zonder te verschillen van anderen. Maar misschien zijn deze ‘slimme’ leerlingen al begonnen met oefenen van bijvoorbeeld lezen voordat ze naar school gingen, waardoor ze hun ‘lees spieren’ al op konden bouwen. Andere leerlingen zouden wellicht net zo goed kunnen lezen als zij ook zoveel zouden oefenen.

Wat kun je doen om slimmer te worden?

Net als een sporter zul je moeten trainen en oefenen. Als je oefent maak je je hersenen sterker. Je zult ook vaardigheden leren waardoor je je hersenen op een slimmere manier kunt gebruiken.

Only many people miss the opportunity to make their brains grow stronger because they think they cannot, or because it is too difficult. It takes effort, but if you feel that you are getting stronger and better, it is worth it!	Alleen lopen veel mensen de kans mis om hun hersenen sterker te laten groeien, omdat ze denken dat ze het niet kunnen, of omdat het te moeilijk is. Het kost moeite, maar als je voelt dat je sterker en beter wordt, is het het waard!
You can now make the reflection assignment below. Perhaps you have experienced at times that you found a subject, such as studying new vocabulary as you did a moment ago, very difficult to learn, but that you succeeded after hard practice and effort. What would you like to say to another student who is really struggling with a subject like this? What would you say to help and motivate him or her? Do this in about 5 sentences below. *Dear …, What I'd like to say to you to help you is:*	*Je mag nu hieronder de reflectie-opdracht maken.* Misschien heb je weleens meegemaakt dat je een onderwerp, zoals het instuderen van nieuwe woordenschat zoals je zonet gedaan hebt, erg lastig vond om te leren, maar dat het je na hard werken en oefenen toch lukte. Wat zou je aan een medestudent willen zeggen die echt worstelt met een onderwerp als dit? Wat zou je zeggen om hem of haar te helpen en te motiveren? Doe dit in ongeveer 5 zinnen: *Beste ….., Wat ik je graag wil meegeven om je te helpen is:*

Table B2

Control condition: English and Dutch version of the control task.

English version	Dutch version
The Neuron, Building Block of the Brain	**Het neuron, bouwsteen van de hersenen**
Your brain looks like an oversized walnut, not much bigger than two clenched fists against each other. What the brain does, it is too much to list: they regulate countless activities in your body, process stimuli and make you think, laugh, remember and much more. How does a soft mass of just over 1 kilogram achieve this? The cell is the smallest unit from which everything that lives, including man, is built up. There are different types of cells, each with a distinctive form and function. One of those species is the nerve cell or the neuron: a cell that specializes in receiving and transmitting signals.	Je brein ziet eruit als een uit de kluiten gewassen walnoot, niet veel groter dan twee gebalde vuisten tegen elkaar. Wat de hersenen doen, het is teveel om op te sommen: ze reguleren talloze activiteiten in je lichaam, verwerken prikkels en zorgen ervoor dat je kunt denken, lachen, onthouden en nog veel meer. Hoe krijgt een weke massa van iets meer dan 1 kilogram dit voor elkaar? De cel is de kleinste eenheid waaruit alles wat leeft, dus ook de mens, is opgebouwd. Er zijn verschillende soorten cellen met elk een kenmerkende vorm en functie. Een van die soorten is

de zenuwcel ofwel het neuron: een cel die gespecialiseerd is in het ontvangen en doorgeven van signalen.

Communication

Neurons are found in large numbers in your brain and spinal cord, but they also run like wires, the peripheral nerves, throughout the body.

Communicatie

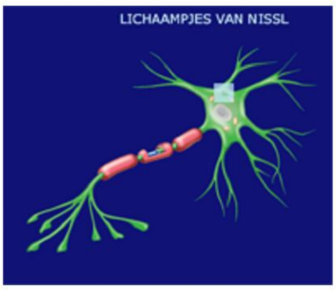
Neuronen vind je in grote aantallen in je hersenen en ruggenmerg maar ze lopen ook als draden, de perifere zenuwen, door het hele lichaam.

De hersenen

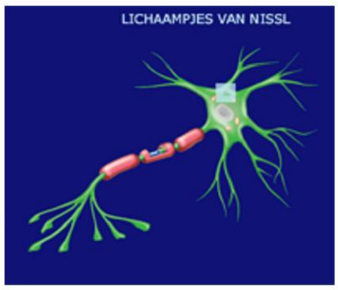
De hersenen

Everything that happens in the brain is all about communication between the neurons. Billions of electrical and chemical signals are constantly being circulated. Also over longer distances, all the way to the tip of your toes. The human brain is made up of about 100 billion neurons. These are all present at birth.

Bij alles wat er in de hersenen gebeurt draait het om de communicatie tussen de neuronen onderling. Er worden voortdurend miljarden elektrische en chemische signalen rondgestuurd. Ook over grotere afstanden, helemaal tot in het puntje van je tenen.
De hersenen van de mens zijn opgebouwd uit ongeveer 100 miljard neuronen. Deze zijn allemaal al bij de geboorte aanwezig.



Bouw van het neuron



Bouw van het neuron

Support cells

The billions of neurons that make up the nervous system have their own support cells: the neuroglia or glial cells.

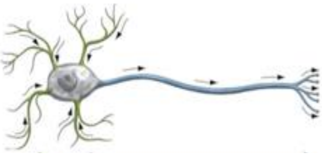
Steuncellen

De miljarden neuronen waaruit het zenuwstelsel bestaat hebben eigen steuncellen: de neuroglia of gliacellen. Ze

The can be compared with the connective tissue in other organs.

Unlike the neurons, these cells do not transmit electrical signals. Their job is to protect and support the neurons. For example, some support cells destroy microbes, others provide the circulation of the brain and spinal fluid. Yet other support cells form a protective layer that ensures that signals can not jump from one neuron to another.

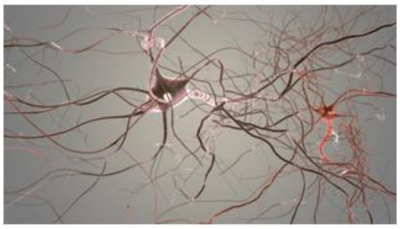
The nervous system contains more support cells than neurons.



Zenuwcel of neuron

Complex networks

Already during the pregnancy, a start is made with the embryo on establishing connections between the neurons. These are suitable for performing a number of basic functions that are required just after birth.



Verbinding tussen neuronen

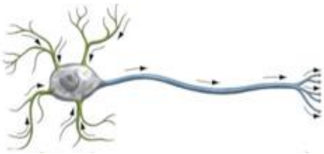
In order to perform all tasks well, large groups of neurons work closely together. As a result, there are specialized areas in the brain, such as for perception (hearing, seeing or smelling) or motor functions (walking or cycling).

The network does not stand still, but always changes.

zijn te vergelijken met het bindweefsel in andere organen.

In tegenstelling tot de neuronen geven deze cellen geen elektrische signalen door. Hun taak is de neuronen te beschermen en te ondersteunen. Sommige steuncellen vernietigen bijvoorbeeld microben, andere zorgen voor de circulatie van het hersen- en ruggenmergvocht. Weer andere steuncellen vormen een beschermlaagje dat ervoor zorgt dat signalen niet van het ene neuron op het andere over kunnen springen.

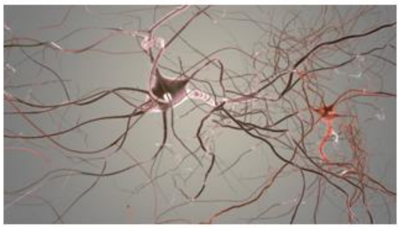
Het zenuwstelsel bevat meer steuncellen dan neuronen.



Zenuwcel of neuron

Complexe netwerken

Al tijdens de zwangerschap wordt er bij het embryo een begin gemaakt met het leggen van verbindingen tussen de neuronen onderling. Deze zijn geschikt voor het uitvoeren van een aantal basisfuncties die vlak na de geboorte nodig zijn.



Verbinding tussen neuronen

Om alle taken goed uit te kunnen voeren werken grote groepen neuronen nauw samen. Daardoor zijn er gespecialiseerde gebieden in de hersenen aanwezig, zoals bijvoorbeeld voor waarneming (horen, zien of ruiken) of motorische functies (lopen of fietsen).

Het netwerk staat niet stil, maar verandert altijd.

Plasticity

The possibility of changes is called plasticity, or adaptability. Neurons do not divide after birth and therefore do not form new cells as happens in other cells. Neurons are able to always make new interconnections: the plasticity.

The plasticity is greatest immediately after birth. Our brains are rapidly adapted to our environment.

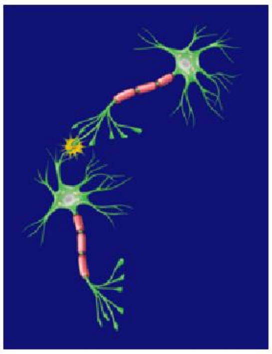
Thanks to this adaptability, there is also a chance to recover from a limited brain injury. The complexity of the network – there are many more connections than necessary – makes it possible to build detours if the 'direct route' to certain areas of the brain is closed. In other words, when an area in the brain is damaged, so that a function no longer can be performed, other (unused) areas in the brain can take over this function. This is called: reorganization.

Plasticiteit

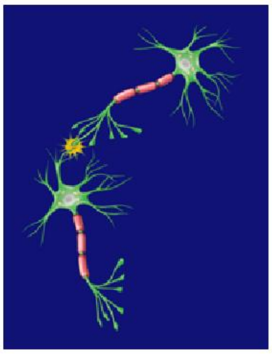
De mogelijkheid tot veranderingen noemen we plasticiteit, ofwel aanpassingsvermogen. Neuronen delen zich na de geboorte niet meer en vormen dus geen nieuwe cellen zoals dat bij andere cellen gebeurt. Neuronen zijn in staat om steeds nieuwe onderlinge verbindingen te maken: de plasticiteit.

Vlak na de geboorte is de plasticiteit het grootst. Onze hersenen worden razendsnel aangepast aan onze leefomgeving.

Dankzij dit aanpassingsvermogen is er ook een kans te herstellen van een beperkt hersenletsel. De complexiteit van het netwerk -er zijn veel meer verbindingen dan nodig zijn- maakt het mogelijk 'omwegen' aan te leggen als de 'rechtstreekse route' naar bepaalde hersengebieden afgesloten is. Met andere woorden: wanneer een gebied in de hersenen beschadigd is waardoor een functie niet meer uitgevoerd kan worden, kunnen andere (onbenutte) gebieden in de hersenen, deze functie overnemen. Dit heet: reorganisatie.



Doorgeven van signalen in het neuron



Doorgeven van signalen in het neuron

Construction of the neuron

Like other cells, neurons have a cell body with a nucleus. All parts that also provide cell management for other cells

Bouw van het neuron

Net als andere cellen hebben neuronen een cellichaam met een kern. Alle onderdelen die ook bij andere cellen zorgen

are present. The main difference is the form: the cell body of the neuron has a number of offshoots: the neurites. The number of neurites can differ per neuron. Nor can the cell body divide and multiply. If the cell body is damaged, there is a risk that the entire neuron dies.	voor de celhuishouding zijn aanwezig. Het voornaamste verschil is de vorm: het cellichaam van het neuron heeft een aantal uitlopers: de neurieten. Het aantal neurieten kan per neuron verschillen. Ook kan het cellichaam zich niet delen en vermenigvuldigen. Als het cellichaam beschadigd wordt bestaat het risico dat het hele neuron afsterft.
Core At the core is the genetic code, or the DNA stored, that determined how the cell develops and works. The DNA contains the instructions for everything that happens in the cell, resulting in thousands of chemical reactions. Without these reactions, cells would not be able to perform their tasks.	**Kern** In de kern is de genetische code, ofwel het DNA opgeslagen, die bepaalt hoe de cel zich ontwikkelt en werkt. Het DNA bevat de instructies voor alles wat er in de cel gebeurt met als gevolg duizenden chemische reacties. Zonder deze reacties zouden cellen hun taken niet kunnen uitvoeren.
You may now make the reflection assignments below.	*Je mag nu hieronder de reflectie-opdracht maken.*
Please write down a short summary about the text ‘The Neuron, Building Block of the Brain’. Do this in about 5 sentences below.	Schrijf een korte samenvatting van ‘Het neuron, bouwsteen van de hersenen’. Doe dit in ongeveer 5 zinnen hieronder.

Appendix C : Word Pairs

Table C1

The 20 Word Pairs in Dutch

lijst 1	**lijst 2**	**lijst 3**	**lijst 4**	**lijst 5**
1 vlinder - bumqit	5 telefoon - kodeiss	9 haar - morees	13 krant - kodiel	17 kikker - schomik
2 liefde -breefje	6 grammatica - wotsuit	10 vijand - plarker	14 zwaartekracht - pardaan	18 gunst -aaluuk
3 peer - miftee	7 paraplu - nufrijg	11 moeder - zappel	15 auto -soeluup	19 citroen - geschak
4 wraak - ellaan	8 vermenigvuldiging - klaspert	12 gevaar - bekaar	16 geschiedenis - strokit	20 haat -bijnjert

Table C2

The 20 Word Pairs in English

list 1	**list 2**	**list 3**	**list 4**	**list 5**
1 butterfly - bumqit	5 telephone - kodeiss	9 hair - morees	13 newspaper - kodiel	17 frog - schomik
2 love -breefje	6 grammar - wotsuit	10 enemy - plarker	14 gravity - pardaan	18 favor -aaluuk
3 pear - miftee	7 umbrella - nufrijg	11 mother - zappel	15 car -soeluup	19 lemon - geschak
4 revenge - ellaan	8 multiplication - klaspert	12 danger - bekaar	16 history - strokit	20 hate -bijnjert

Appendix D: Questionnaire mindset beliefs

English version	Dutch version
You have a certain amount of intelligence, and you can’t really do much to change it.	Je hebt een bepaalde hoeveelheid intelligentie en je kan niet echt veel doen om dit te veranderen.
Your intelligence is something about you that you can’t change very much.	Je intelligentie is een onderdeel van jezelf waaraan je niet erg veel kunt veranderen.
No matter who you are, you can significantly change your intelligence level.	Wie je ook bent, je kan je intelligentieniveau aanzienlijk veranderen.
To be honest, you can’t really change how intelligent you are.	Eerlijk gezegd, je kan niet echt veranderen hoe intelligent je bent.
You can always substantially change how intelligent you are.	Je kan je mate van je intelligentie altijd behoorlijk veranderen.
You can learn new things, but you can’t really change your basic intelligence.	Je kan nieuwe dingen leren, maar je kan niet echt je basisintelligentie veranderen.
No matter how much intelligence you have, you can always change it quite a bit.	Het maakt niet uit hoeveel intelligentie je hebt, je kan het altijd behoorlijk veranderen.
You can change even your basic intelligence level considerably.	Je kunt zelfs je basis intelligentieniveau aanzienlijk veranderen.

Appendix E: Questionnaires cognitive load

Table E

Questionnaire perceived intrinsic, extraneous and germane cognitive load after the total learning task

English version	Dutch version
Intrinsic CL	
The topic of the learning task was very complex	Het onderwerp van de leertaak was heel complex
I perceived the learning task as very complex	Ik ervaarde de leertaak als heel complex
The activity covered concepts that I perceived as very complex	De activiteit bevatte concepten die ik heel complex vond
Extraneous CL	
The instructions and/or explanations were very unclear	De instructies en/of uitleg waren erg onduidelijk.
The instructions and/or explanations were, in terms of learning, very ineffective	De instructies en/of uitleg waren, voor het leren, erg ineffectief.
The instructions and/or explanations were full of unclear language	De instructies en/of uitleg stonden vol onduidelijke taal
Germane CL	
I could fully understand the concepts covered in the learning task	Ik kon de concepten die in de leertaak behandeld werden volledig begrijpen
I could make sense of most of the words presented in the learning task	Ik snapte de meeste woorden uit de leertaak
I could see how all words are interconnected	Ik kon zien hoe de woorden met elkaar verbonden zijn
I could connect the new information I learnt in this learning task to what I already knew	Ik kon de nieuwe informatie die ik in deze taak leerde, koppelen aan wat ik al wist

Appendix F: Questionnaire Achievement Goal Orientation

English version	Dutch version
Mastery Approach Goal Orientation	
My aim is to completely master the words presented in this experiment	Mijn doel is om de woorden in dit experiment volledig te beheersen
I am striving to memorise the words of this experiment as thoroughly as possible	Ik streef ernaar om de woorden in dit experiment zo grondig mogelijk uit mijn hoofd te leren
My goal is to learn as much as possible	Mijn doel is om zo veel mogelijk te leren
Mastery Avoidance Goal Orientation	
My aim is to avoid learning less than I possibly could	Mijn doel is om te voorkomen dat ik minder leer dan ik kan
I am striving to avoid an incomplete memorisation of the words in the experiment	Ik streef ernaar om te voorkomen dat ik de woorden in dit experiment onvolledig uit mijn hoofd leer
My goal is to avoid learning less than it is possible to learn	Mijn doel is om te vermijden dat ik minder leer dan ik kan
Performance Approach Goal Orientation	
My goal is to outperform other students on the test in this experiment	Mijn doel is om beter te presteren dan andere studenten bij dit onderzoek
My goal is to do well compared to others in this experiment on the test	Mijn doel is om goed te presteren vergeleken met anderen bij dit onderzoek
My goal is to do better than my classmates on the test in this experiment	Mijn doel is om beter te presteren dan mijn klasgenoten bij dit onderzoek
Performance Avoidance Goal Orientation	
My goal is to avoid doing worse than other students on the test in this experiment	Mijn doel is om te voorkomen dat ik slechter presteer dan andere studenten bij dit onderzoek

My goal is to avoid doing poorly in comparison to others on the test in this experiment	Mijn doel is om te voorkomen dat ik slecht presteer vergeleken met anderen bij dit onderzoek
My goal is to avoid performing poorly relative to my fellow students on the test in this experiment	Mijn doel is om te voorkomen dat ik slechter presteer dan mijn medestudenten