Leisure Reading and Reading Comprehension: the Moderating Role of Executive Functions

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Abstract

Reading comprehension is an important contributor to school success. A positive direct relation between leisure reading and reading comprehension has often been found, however, most of this research has been conducted with English-reading students, and in the early years of primary school. Additionally, it is not clear why there are between-person differences in the strength of the relation. The influence of the executive functions working memory and inhibition on the relation has not been studied, even though a moderating relation seems probable. Therefore the current study mainly aims to examine if working memory and inhibition have a moderating role in the relation between leisure reading and reading comprehension. The Cito Reading Comprehension test, a Survey for Demographic Information and Leisure Reading, the Monkey game and an adoption of the Flanker task are used to gather data of a sample of 108 Dutch speaking Grade 5 and 6 students. Correlation analyses show significant direct relations from leisure reading, working memory and inhibition to reading comprehension. However, no moderating roles of the executive functions were found. The study indicates leisure reading to be equally beneficial for reading comprehension, for all Dutch Grade 5 and 6 students regardless their working memory and inhibition.

Key words: leisure reading, reading comprehension, executive functions, working memory, inhibition

The Relation between Leisure Reading, Executive Functions and Reading Comprehension

Reading comprehension can be defined as the process of constructing meaning from written text (Gilakjani & Sabouri, 2016). It does not intend to acquire the meaning from individual words or sentences, but to get an understanding of a text as a whole. Reading comprehension is essential in formal education settings, as students are as they get older to a constantly increasing extent expected to learn from print information (Bharuthram, 2012; Reschly, 2010). Because information from written sources needs to be comprehended before it can be stored and recalled, most school subjects are dependent on reading comprehension skills (Tarchi, 2017; Alexander & Jetton, 2000). Therefore, reading comprehension can be seen as an important contributor to school success (Alexander & Jetton, 2000).

Because of its importance, research has focused on creating a better understanding of the concept. According to the Simple View of Reading theory, decoding skills and language comprehension are the most essential components for reading comprehension (Gough & Tunmer, 1986). Decoding skills are necessary to translate print into language, and language comprehension is then necessary to interpret this language. However, reading comprehension is a much more complex process, and is influenced by various other components, as is described in different models (e.g. Perfetti & Stafura, 2014; van den Broek et al., 1996; van Dijk & Kintsch, 1983). Furthermore, various external and internal factors are found to influence reading comprehension, such as home literacy (e.g. Boerma, Mol & Jolles, 2017; De Jong & Leseman, 2001) and reading motivation (e.g. Takaloo & Ahmadi, 2017; Kuşdemir & Bulut, 2018).

Leisure reading is considered as one of these factors contributing to better reading comprehension as well (e.g. Cunningham & Stanovich, 1997; Torppa et al., 2020). This relationship has a practical relevance for students, as it indicates that increasing the amount of leisure reading one does is an effective intervention for students with weak reading comprehension. Recent research suggests that between-person variation exists in the strength of the association between leisure reading and reading comprehension (Stutz & Schiefele, 2016; Torppa et al., 2020). The current study aims to investigate whether the relation between the two variables is moderated by, and thus whether variation in strength of the relation is a result of, executive functions. If leisure reading is not equally effective in increasing reading comprehension for individuals who score high and low on executive functions, leisure reading might also not be an equally suitable intervention for everyone.

The current study specifically focusses on the relation among Dutch students in Grade 5 and Grade 6. Reading comprehension is particularly important for this age group, as they are preparing for secondary school, where independent acquisition of information from texts is expected (Evers-Vermeul et al., 2017). They are also mature enough to independently seek out leisure time activities fitting with personal interests and abilities, causing an increase in individual differences in leisure reading (Mol & Bus, 2011). Despite these relevant characteristics of the age group, a meta-analysis of Mol and Bus (2011) shows that the relation between leisure reading and reading comprehension has primarily focussed on students in the earlier grades of primary school.

The same meta-analysis shows that the majority of research on the relation is conducted among English-reading participants (Mol & Bus, 2011). Whether these results are generalizable to readers in other languages is questionable, because of the non-transparent orthography of the English language in terms of spelling-sound correspondence (Share, 2008). The language is harder to decode and takes up more cognitive resources than languages with a transparent orthography do, such as Dutch (Müller & Brady, 2001; Share, 2008). Therefore, the effect of leisure reading on reading comprehension might be different for Dutch readers, as there is a lower need for freeing up cognitive resources. By investigating the relation between leisure reading and reading comprehension among Dutch speaking students in Grade 5 and 6, the current study additionally aims to address both gaps in the literature.

Theoretical Framework

Leisure Reading and Reading Comprehension

Leisure reading, sometimes referred to as voluntary reading or recreational reading, can be defined as the reading an individual does independently and in their own time (National Reading Panel, 2000). It is related to an individual's motivation to engage in reading (Harlaar et al., 2011), reading frequency (Schüller et al., 2017) and print exposure (Erbeli et al., 2020). Various studies have shown a positive relation between the amount of leisure reading one does and their reading comprehension (e.g. Cunningham & Stanovich, 1997; Mol & Bus, 2011; Torppa et al., 2020).

Multiple mechanisms can explain this positive relation. Firstly, more leisure reading can increase the automation of reading processes, provide more opportunities to acquire new word meanings, and improve reading fluency (Becker, 2010; Harlaar et al., 2011). As less attention has to be directed toward the basic process of reading, more cognitive resources are available for processes important for the comprehension of text, such as coordinating multiple pieces of information or allocating attention to the most important passages (Becker, 2010;

Rapp et al., 2007). A second explanation could be the supporting role frequent leisure reading has in the self-concept and self-efficacy beliefs related to reading (Becker, 2010). The feeling of competence makes individuals more likely to select challenging texts and work diligently to master them, which is associated with higher text comprehension (Guthrie et al., 1999). Another possible explanation can be found in the enlargement of the prior knowledge base of the individual resulting from more leisure reading (Becker, 2010). Prior knowledge provides a framework that guides word-identification and comprehension on a text-based level (Priebe et al., 2012). But the relation could also be reciprocal; people with better reading comprehension may also choose to do more leisure reading (Torppa et al., 2020; Harlaar et al., 2011). Poor readers are more likely to experience reading as unrewarding, causing them to avoid it all together (Stanovich, 2009; Leppännen et al., 2005).

Executive Functions and Reading Comprehension

The direct relation between executive functions and reading comprehension have been a focus of recent research as well (e.g. Follmer, 2018; Spencer et al., 2020). *Executive functions* (EFs) is an umbrella term for cognitive higher order skills important in independent, goal-directed behaviour and in non-automized tasks (Diamond, 2013). EFs help individuals, among other things, to stay focused, process relevant information, and relate new information to prior knowledge, which has particular relevance in developing academic skills like reading (Cartwright, 2012).

Working memory and *inhibition* are two EFs that have been suggested to be the most integral processes of executive functioning, and are frequently associated with reading (Booth et al., 2014; Follmer, 2018; Kendeou et al., 2014). Working memory is the ability to simultaneously temporarily store and process input (Diamond, 2013; Segers et al., 2016). It for example reflects the abilities of an individual to incorporate new information into their thinking, to mentally relate information, and to consider alternatives (Diamond, 2013). The working memory provides an indication of an individuals' cognitive flexibility (Anderson, 2002). Inhibition on the other hand indicates an individuals' attentional control. It can be defined as the ability to suppress or inhibit dominant responses in favour of a sub-dominant responses (Follmer, 2018). It is one's ability to do what is appropriate by controlling attention, thoughts, emotions and behaviour to override external lures or internal predispositions (Diamond, 2013).

The relations between these two EFs and reading comprehension are mostly found to be positive (Follmer, 2018). Individuals with a better working memory have a greater capacity to memorize passages of a text and integrate information from different passages while

reading, which contributes to better reading comprehension (Kendeou et al., 2014; Van de Weijer-Bergsma et al., 2015). Furthermore, to comprehend a text, individuals have to only maintain an active memory of important information, while suppressing less important information (Kendeou et al., 2014). Therefore, high inhibition contributes to better reading comprehension as well.

Leisure Reading and Executive Functions

Earlier studies have examined factors that could lead to variation in strength of the relation between leisure reading and reading comprehension. For example, the effects of gender (Kavanagh, 2019; Stutz & Schiefele, 2016), socioeconomic status (Kavanagh, 2019), and difficulty or kind of texts read in leisure time (Carver & Leibert, 1995; Torppa et al., 2020) have been researched. However, no research has been conducted on the influence of executive functions on the relation.

One could expect these executive functions to moderate the relation between leisure reading and reading comprehension. As discussed, the positive relation can be the result of various mechanisms (e.g. Becker, 2010; Guthrie et al., 1999; Harlaar et al., 2011). Among other things, leisure reading leads to more available cognitive resources for processes relevant to reading comprehension (e.g. coordinating multiple pieces of information and allocating attention), and provides a larger prior knowledge base (Becker, 2010; Rapp et al., 2007). Individuals with high working memory and inhibition are already skilled at temporarily storing information and allocating attention (Diamond, 2013; Segers et al., 2016), possibly helping them to make more efficient use of the additional cognitive resources in favour of reading comprehension. High executive functioning could additionally help an individual to relate the additional prior knowledge to texts, and ignore it when irrelevant (Diamond, 2013), which could also increase reading comprehension. Therefore, it seems probable that the relation between leisure reading and reading comprehension is stronger for individuals who score high on the two EFs.
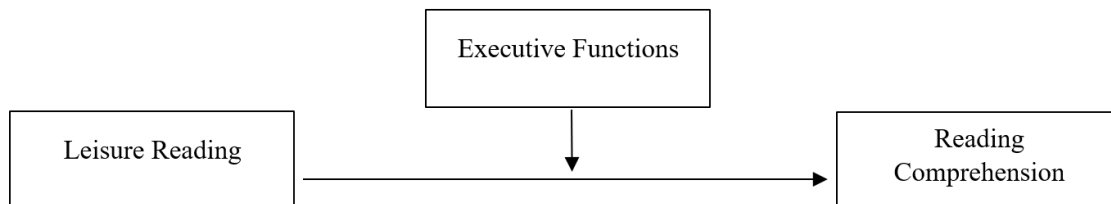
Current study

The main aim of the current study is to examine the relation between leisure reading, the EFs working memory and inhibition, and reading comprehension in one model. Because high executive functioning could lead to more effective use of cognitive space and better incorporation or suppression of prior knowledge (Becker, 2010; Rapp et al., 2007), a positive moderating role of the executive functions working memory and inhibition on the relation between leisure reading and reading comprehension is probable (see Figure 1). The current study tests this hypothesised model. The corresponding research question is: '*To what extent*

are the executive functions working memory and inhibition a moderator for the effect of leisure reading on reading comprehension, when looking at Dutch students in Grade 5 and 6?'.

A prerequisite to examine this moderation model is that there are direct relations between leisure reading and the two EFs with reading comprehension. Therefore a subquestion of the current study is: '*To what extent have (1) leisure reading, and (2) the executive functions working memory and inhibition, independently a direct effect on reading comprehension for Dutch students in Grade 5 and 6*?'. It is expected that the effects of leisure reading and EFs on reading comprehension exist and are positive, as various studies under younger English-reading participants showed a positive relation (e.g. Cunningham & Stanovich, 1997; Mol & Bus, 2011; Torppa et al., 2020; Follmer, 2018). However, because of the transparent orthography of the Dutch language, effects might be less prominent.

Figure 1

Visual Representation of the Hypothesised Moderating Role of the Executive Functions on the Relation between Leisure Reading and Reading Comprehension

Method

Participants

A total of 110 participants took part in the data-gathering of the current study. However, 2 participants were completely excluded from all analyses. One of these participants generally functions on a Grade 4 level according to their teacher, making them unrepresentative of the target population. The other participant was noticeably unfocussed and distracted during data-gathering, and therefore not included. Additionally, through boxplots both participants were identified as extreme outliers on the inhibition measure. Therefore, 108 participants served as the sample of this study.

The participants (36.1% Grade 5 and 63.9% Grade 6) had a mean age of 11.10 years ($SD = 0.70$, min = 10, max = 12). Of all participants, 57 identified as male (52.8%), 50 as

female (46.3%), and one participant did not want to disclose their gender (0.9%). Parents or caretakers of all participants were informed by letter and gave active informed consent for participation. As literature indicates that normally a power of $1 - \beta = .80$ is sufficient (Field, 2018), the aimed power of $1 - \beta = 0.90$ of the current research would be adequate to detect the aimed effects. A power analysis with the G*power 3 tool (Faul et al., 2007) showed the current study would need a minimum of 99 participants with an effect size of $f^2 = 0.15$ ($\alpha = 0.05$) to reach this power. Therefore, the current sample size is considered large enough to perform the intended analyses.

Instruments

Cito Reading Comprehension Test

As a measure for reading comprehension, the skill scores on the Cito Reading Comprehension test in February 2021 (M7 and M8) were used. The Cito Reading Comprehension test is a nationally standardized test, widely applied among Dutch primary schools to track the reading development of students (CITO; Centraal Instituut voor Toetsontwikkeling; Institute for Test Development Netherlands, 2016). The Dutch Expertgroup Testing for Primary Education has found the test to have a sufficient reliability and validity (Expertgroep Toetsen PO, 2018; Expertgroep Toetsen PO, 2019).

The Cito Reading Comprehension test consists of texts varying in length (e.g. one passage or multiple passages) and genre (e.g. fictional story or formal text). Texts are accompanied by multiple choice questions, separable in five categories: (1) fill in the blank, (2) prediction of content, (3) text content, (4) searching in sources, and (5) summarizing (CITO, 2016). Raw scores on this test are converted to standardized skill scores, which allow comparison between students of different grades (Hollenberg & Verbeek, 2014). A higher score on the test indicates a higher level of reading comprehension. Generally, it can be expected of students in Grade 5 to get a mean skill score of 191.10 and for students in Grade 6 to get a mean skill score of 205.67 (Tomesen et al., 2019) .

Survey for Demographic Information and Leisure Reading

The Survey for Demographic Information and Leisure Reading consists of a total of 8 items (see Attachment 1). Of these items, three focus on the demographic background of participants (namely age, gender, and grade). The other five items of the survey aim to measure leisure reading. These five items are based on the 'Reading for your own enjoyment' questions of the Reading Activity Inventory (RAI; Guthrie et al., 1994). The measure is found to have a substantial level of stability (Wigfield & Gurthie, 1997), indicating reliability. The items from the RAI that ask participants how often they generally read different kinds of

reading material were included in the survey of the current study (e.g. '*How often do you read a book outside of school, for fun or for your own interest?* '). The kinds of reading materials included in the survey are based on the research of Torppa et al. (2020): (1) books, (2) newspapers, (3) comics, (4) magazines, and (5) digital texts. These reading materials differ from the original RAI (Gurthrie, McGough & Wigfield, 1994), with the aim to ensure inclusion of more modern reading materials. All items are answered on a scale of 1 ('*almost never*') to 4 ('*almost every day*'). A high mean total score on the survey indicates a high amount of leisure reading.

Monkey Game

To measure working memory, the Monkey game was used, which is proven to be a reliable and valid instrument (Van de Weijer-Bergsma et al., 2015). The digital and online game consists of a verbal backward span task. Participants first hear a sequence of spoken words. The nine words that can be included in these sequences are the Dutch words for: (1) moon, (2) fish, (3) rose, (4) eye, (5) house, (6) ice, (7) fire, (8) cat, and (9) coat. The words are highly common, and are therefore assumed to be known by the participating students. After auditory exposure to the sequence, participants are asked to recall the words in reverse order. They use their mouse button to click on the correct words written in a 3x3 matrix. As the participants are required to temporarily remember words, and simultaneously process the information by reversing the order, the task is seen as an appropriate measure for working memory (Diamond, 2013; Van de Weijer-Bergsma et al, 2015).

Participants are first presented three practice sequences of two words. After these, the game consists of five levels participants go through. With each level, the number of words that need to be recalled backwards increases (i.e. two words in Level 1, three words in Level 2, etc.). Each level includes four random word sequences, after which the participant moves on to the next level. Participants can recall a maximum of 80 words correctly. The final score of participants on the Monkey game consists of the proportion of items they correctly recalled in reverse order (min = 0, max = 1). A high score on the Monkey games indicates a high score on working memory.

Flanker Task

To measure inhibition, the PsyToolkit (Stoet, 2010) of a simplified adaptation of the Flanker task (Eriksen & Eriksen, 1974) was used. In this task, participants are presented a sequence of five letters (for example XXBXX). The middle letter is the target item, to which participants should respond. For the letters X and C participants have to press the A key on their keyboard (i.e. the left key), and for the letters V and B participants have press the L key

on their keyboard (i.e. the right key). Participants are instructed to react as fast and accurate as possible.

The target item is surrounded by four other letters (i.e. flankers) that should be ignored. The flankers can be congruent (i.e. requiring a similar response as the target item) or incongruent (i.e. requiring a different response than the target item). Participants are exposed to 50 sequences of letters for a maximum of 2.000 ms each. After each sequence participants get feedback on whether their response was correct (i.e. they see a green plus sign), or either incorrect or too slow (i.e. they see a red plus sign). Per participant a range of 34-68% of sequences was congruent and a range of 32-66% of sequences was incongruent.

The Flanker task is commonly applied as a measure for inhibition, because participants have to supress surrounding flankers, exercising their inhibition (Eriksen & Eriksen, 1974; Eriksen, 1995). In the current study, an Inverse Efficiency Score is used as the score of participants on inhibition, to overcome any accuracy-speed trade-offs (Bruyer & Brysbaert, 2011; Chan et al., 2005). This score is calculated by dividing the mean reaction time of a participant through their proportion correct responses (Bruyer & Brysbaert, 2011). A high Inverse Efficiency Score indicates a low inhibition.

Procedure

The design of the current study was approved by the ethical commission of the Faculty Social Sciences of University Utrecht. Three Dutch primary schools were found willing to participate in the current study. Consent from parents or caretakers of the Grade 5 and 6 students at these schools was obtained through an informative letter and signed paper note. Each participant got assigned a student code, which was used to connect the scores of participants on the different measures. The key to these participant codes is only known to the researcher, and is kept separately from the gathered data.

Teachers conducted the Cito Reading Comprehension test in a classroom setting halfway the current school year, and provided the researcher with the skill scores of the participating students on this test. The remaining part of the research was conducted in a classroom setting during schooltime by one researcher, and took about 45 minutes. Participants were placed in front of a device, and went through the different tasks individually in a self-paced manner. First, the Flanker task was explained through a PowerPoint, and executed by participants. Next, the survey was filled in by participants in the online tool LimeSurvey. Thereafter, participants used a personal link to play the Monkey Game. During the data gathering, the researcher managed the classroom setting, and answered questions

about the procedure. No answers included specific information about the content of the tasks. All gathered data is stored on a safe server of Utrecht University.

Analysis

First, the power of the current study is calculated using the G*power 3 tool (Faul et al., 2007). For the analyses needed to answer the research question of the current study, the program IBM SPSS Statistics 26 is used. First descriptive statistics are interpreted. Next, the presence of outliers and the assumptions of normality, linearity, homoscedasticity and multicollinearity are checked. A Pearson correlation analysis is conducted with the variables leisure reading, inhibition, working memory, and reading comprehension to identify direct relationships between the variables. The results of this analysis help answering the subquestion of the current study. To answer the main research question, PROCCES v3.0 (Hayes, 2018) is used to conduct two moderation analyses: one with leisure reading as the independent variable, reading comprehension as the dependent variable and working memory as the moderator, and another one with the same dependent and independent variables, but with inhibition as the moderator. For all analyses, a statistical significance level of $p < .05$ was used to interpret results.

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Results

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With $N = 108$ participants, the achieved power ($1-\beta$) of the current study is 0.93 ($\alpha = 0.05$, $f^2 = 0.15$, $k = 3$). Table 1 shows the means and standard deviations of the raw scores of all variables. The descriptive statistics show that participants scored a mean score of 204.55 ($SD = 21.64$, min = 139, max = 269) on reading comprehension. Participants in Grade 5 scored a mean of 201.05 ($N = 39$, $SD = 21.15$, min = 139, max = 237) and participants in Grade 6 a mean of 206.52 ($N = 69$, $SD = 21.81$, min = 160, max = 269). Both are slightly higher than the score that can be expected of students in these grades (Tomesen et al., 2019). Participants showed a mean score of 2.56 on leisure reading ($SD = 0.62$, min = 1.20, max = 4.00). They mostly read digital texts ($M = 3.42$, $SD = 1.01$, min = 1, max = 4), and rarely read a newspaper ($M = 1.46$, $SD = 0.80$, min = 1, max = 4) in their leisure time. With a Cronbachs Alpha of $\alpha = .54$, the Survey for Leisure Reading has a low reliability (Gliem & Gliem, 2003). Item analyses showed only mediocre increases of the reliability when deleting items from the list. Therefore, and together with the theoretical strength of the survey and the loss of valuable information when deleting items, it was decided to not delete items. Low reliability of the instrument will be considered while interpreting the results.

In the dataset, 8 values were missing for the variable inhibition (7.3%) and 3 values were missing for the variable working memory (2.7%). As it is desired to exclude as little

valuable information as possible from the study, the nature of the missings was analysed. The Little's MCAR test was insignificant ($\chi^2 = 1.62$, $DF = 2$, $p = .44$), indicating that values were missing at random, and could be estimated. An Expectation Maximization analysis in SPSS was conducted to estimate the missing values. After estimation of missing values, the mean accuracy score on the working memory task Monkey Game was 0.57 ($SD = .11$, min = .26, max = .88).

For inhibition, a non-recursive procedure (Van Selst & Jolicoeur, 1994) was used to identify and exclude outliers in reaction time in the Flanker Task from analysis, separately for congruent and incongruent trials. A total of 135 out of 2551 congruent sequences (6.0%) and 126 out of 2549 incongruent sequences (4.9%) were excluded from analysis, as they deviated two or more standard deviations from the mean reaction time. The reaction times on excluded sequences were thus either so small that it is likely the participant did not give a serious reaction (i.e. they pressed a random button as quick as possible) or so large that it is likely participants were not focussed for that sequence. After exclusion, an average of 47.54 sequences were included for each participant in analysis ($SD = 2.46$, min = 38 , max = 50). A mean of 23.78 of these sequences were congruent ($SD = 3.40$, min = 16, max = 34) and a mean of 23.86 were incongruent ($SD = 3.52$, min = 14, max = 32). After exclusion of outliers the mean Inverse Efficiency Score of participants was 899.35 ($SD = 148.34$, min = 673.77, max = 1336.05).

Table 1

Descriptive Results Variables (N = 108)

Variables	M	SD	min	max
Reading comprehension	204.55	21.64	139	269
Leisure reading	2.56	.62	1.20	4.00
Working memory	0.57	.11	.26	.88
Inhibition	899.35	148.34	673.77	1336.05

Note. Scores on reading comprehension are skill scores on the CITO. Scores on leisure reading are scores on the Survey for Leisure Reading. Scores on working memory are a proportion of accuracy on the Monkey Game. Scores on inhibition are the Inverse Efficiency Scores on the Flanker Task. For Working Memory and Inhibition, missing values were estimated.

Correlation and Moderation analysis

Prior to conducting the analyses, data was checked for outliers and multiple assumptions were tested. As described in the method section, because of participant characteristics and extreme scores on the Flanker Task, two participants were identified as univariate outliers and excluded from all analyses. Of the 108 remaining participants, none exceeded the critical Mahalanobis distance of $\chi^2 (2)= 13.82$ at $\alpha = .001$ for both the combination of the independent variables inhibition and leisure reading, and working memory and leisure reading. This indicates multivariate outliers were no concern. Second, the assumption of normality was checked with Sharpio-Wilk statistics ($p > .05$ for a normal distribution) and the histograms of variables. The assumption was not met by the variables inhibition ($W = .956$, $p = .001$) and leisure reading ($W = .976$, $p = .046$). However, because of the power in the current study ($1-\beta = 0.93$), current analyses were assumed robust to this violation of the normality assumption. Inspection of the histogram and scatterplot showed that the assumptions of linearity and homoscedasticity were met.

A correlation analysis shows that there are significant relations between most variables included in the current study (see table 2). Of the significant relations, the relation is strongest for leisure reading and reading comprehension ($r = .370$), and weakest for inhibition and working memory ($r = -.206$), indicating that these sub-tasks of EF were indeed measuring independent subconstructs. Both leisure reading ($r = .370$) and working memory ($r = .262$) show a positive relation with reading comprehension. This indicates that students with a high score on working memory or leisure reading also score high on reading comprehension. Inhibition shows a negative correlation with reading comprehension ($r = -.211$), which indicates that participants with a high score on the Flanker Task show a low score on reading comprehension. As a low score on the Flanker Task indicates a high inhibition, the relation between inhibition and reading comprehension thus is positive as well.

Table 2

Pearson Correlations between Variables from Conceptual Model

	(1)	(2)	(3)	(4)
(1) Reading Comprehension	1			
(2) Leisure reading	.370*	1		
(3) Working memory	.262*	.218*	1	
(4) Inhibition	-.211*	-.010	-.206*	1

Note. $N = 108$. * indicates a significant correlation for $p < .05$

Because direct relations between the variables exist, further analyses can be performed. First, a moderation analysis is conducted for the model with working memory as moderating variable (see table 3). Because tolerance >.02 and the VIF > 5, z-scores were used to ensure the multicollinearity assumption would not be violated. The overall model with the dependent variable reading comprehension, the independent variable leisure reading and the moderating variable working memory is significant, F (3, 104) = 7.95, p < .05, R^2 = .19. This means 19% of the variance on reading comprehension is explained by the model. The interaction effect of leisure reading and working memory is not significant (p = .17), indicating working memory has no moderating effect on the relation between leisure reading and reading comprehension.

Table 3

Moderation Leisure Reading (X), Working Memory (M) and Reading Comprehension (Y)

	b	*SE B*	*t*	*p*	95% CI	
(Constant) Reading comprehension	204.56	1.94	105.18	.00*	200.19	207.88
Leisure reading	7.46	1.98	3.78	.00*	3.54	11.39
Working memory	4.20	1.96	2.14	.03*	.31	8.09
(Interaction) Leisure reading x Working memory	2.38	1.71	1.39	.17	-1.01	5.76

Note. For the model R^2 = .19. * indicates a significant relation (p <.05).

The second moderation analysis looked at the moderating role of inhibition on the relation between leisure reading and reading comprehension (see table 4). Again, as the tolerance and VIFs were too high, z-scores were used to meet the multicollinearity assumption. The overall model with the dependent variable reading comprehension, the independent variable leisure reading and the moderating variable inhibition is significant, F (3, 104) = 7.85 , p < .05, R^2 = .18. This indicates 18% of the variance on reading comprehension is explained by the model. The interaction effect of leisure reading and inhibition is not significant (p = .44), indicating inhibition has no moderating effect on the relation between leisure reading and reading comprehension.

Table 4

Moderation Leisure Reading (X), Inhibition (M) and Reading Comprehension (Y)

	b	SE B	t	P	95% CI	
(Constant) Reading comprehension	204.56	1.91	107.27	.00*	200.78	208.34
Leisure reading	8.10	1.92	4.21	.00*	4.29	11.92
Inhibition	-4.64	1.93	-2.41	.02*	-8.46	-0.82
(Interaction) Leisure reading x Inhibition	1.32	1.71	0.77	.44	-2.07	4.71

Note. For the model $R^2 = .18$. * indicates a significant relation ($p < .05$).

Discussion

Reading comprehension can be seen as an important contributor to school success (Alexander & Jetton, 2000), which makes it a relevant concept to gain more insight in. The current study set out to further examine the relation of leisure reading with reading comprehension, and focussed specifically on the moderating role of working memory and inhibition on this relation among Dutch students in Grade 5 and 6. First, the direct relationships between reading comprehension and (1) leisure reading, (2) working memory, and (3) inhibition were examined. The results of the current study show all these relations to be present and positive: students who spend more time leisure reading, have a better working memory, or have a better inhibition are also better at reading comprehension. This aligns with the hypothesis of the current study regarding the direct relations. Next, the moderating roles of working memory and inhibition on the relation between leisure reading and reading comprehension were examined, but not found. The results of the current study show that neither of the two executive functions did significantly strengthen or weaken the relation between leisure reading and reading comprehension. This does not align with the hypothesis of the current study. These findings, and the implications they have, will be discussed subsequently. Furthermore, the limitations of the current study and directions for future research will be addressed.

Direct Relations with Reading Comprehension

The positive direct relations of (1) leisure reading, (2) working memory, and (3) inhibition with reading comprehension found in the current study align with prior research. Meta-analyses that include a large variety of studies to these direct relations show that they are generally also found to be positive and of a similar size among other linguistic groups and age groups (Follmer, 2018; Mol & Bus, 2011). For the relation between working memory and leisure reading, the meta-analysis of Mol & Bus (2011) showed an average correlation of *r*

=.36 and the current study found a very close $r = .37$. The meta-analysis of Follmer (2018) shows an average correlation of $r = .38$ for the relation between reading comprehension and working memory. The current study found a $r = .26$ for this same relationship. In both studies, the strength of association can be classified as moderate (Rosenthal, 1996). Moreover, this recent meta-analysis of Follmer (2018) showed an average correlation of $r = .21$ for the relation between inhibition and reading comprehension, which is identical to the strength of correlation the current study found.

As all the examined direct relations align with earlier research among relatively diverse populations (Follmer, 2018; Mol & Bus, 2011), the specific characteristics of the population of the current study do not seem to alter the direct relations. Hence, the current study contributes to establishing generalizability of relations over various languages and age groups. Research to the relation between leisure reading and reading comprehension has been mainly studied among English speaking participants in the earlier grades of primary school (Mol & Bus, 2011). By conducting research among speakers of the transparent language Dutch, and children in the later years of primary school, the current research adds to the literature on the direct relations among a underrepresented group in research.

The results show overlap with the very limited amount of existing research on the topic among speakers of a transparent orthography and age group of students in Grade 5 and 6. A recent study of Dolean et al. (20121) studied the relations between the two EFs covered in the current study and reading comprehension among participants speaking Romanian, which is orthographically transparent. Like the current study, positive direct relations were found between working memory and inhibition with reading comprehension. The study of McBride-Chang et al. (1993) included the relation between reading comprehension and leisure reading among students in Grade 5 through Grade 8. They also identified a positive, moderately strong relation between the two variables. These results are thus also similar to the ones reported in the current study.

The found positive direct relations in the current study among a Dutch population can have practical implications for educational practices in the Netherlands. Awareness among teachers about factors directly influencing reading comprehension empowers them to identify students at risk for lower reading comprehension. Similarly to prior research (Follmer, 2018; Mol & Bus, 2011), the current study shows that Dutch students in Grade 5 or Grade 6 with a low working memory, low inhibition, or who do a low amount of leisure reading are also likely to score lower on reading comprehension. With this in mind, teachers can alter instructions based on their knowledge of the higher order thinking skills and reading habits of

their students. Differentiated instruction has been found to be an effective way of improving student achievement regarding reading comprehension (Baumgartner et al., 2003). Furthermore, teachers can encourage students to participate in leisure reading as a way to improve their reading comprehension.

Moderating Roles Working Memory and Inhibition

The proposed moderating roles of both working memory and inhibition on the relation between leisure reading and reading comprehension were not found in the current research; working memory and inhibition did not significantly strengthen or weaken the effect of the relation. This indicates that it does not matter whether a Dutch student in Grade 5 or 6 has a good or bad working memory or inhibition, reading in their free time equally contributes to better reading comprehension for all students. Based on these results, the hypothesised model of the current study should be rejected.

The absence of the expected moderating role of the EFs is interesting, as the rejected model was based on ideas derived from prior research. The current study combined literature about the relation between leisure reading and reading comprehension (e.g. Becker, 2010; Rapp et al., 2007; Torppa et al., 2020) and the executive functions working memory and inhibition (e.g. Diamond, 2013; Segers et al., 2016) to form and substantiate expectations of the moderating relations. The findings seem to contrast the idea that a high working memory and inhibition could lead to more effective use of additional cognitive space and better incorporation or suppression of prior knowledge gathered through leisure reading (Becker, 2010; Diamond, 2013; Rapp et al., 2007) and would therefore lead to higher benefits on reading comprehension. As the current study is to my knowledge the first to include both leisure reading and executive functions when looking at reading comprehension, it provides new insights and clarification on the relations between these different factors that are regularly associated with reading comprehension (Follmer, 2018; Mol & Bus, 2011). Future research with a focus on the same factors could further explicate the interrelations between these factors. Additionally, the current study indicates that the between-person variation in the strength of the effect of leisure reading on their reading comprehension (Stutz & Schiefele, 2016; Torppa et al., 2020) is not due to the EFs working memory or inhibition of individuals. More research is needed to examine what does cause this variation.

A reason for the expected moderating roles being absent could possibly be found in the complexity of the EFs studied. According to the model of Friedman and Miyake (2004) there are various types of inhibition. In the current study, with the Flanker Task (Eriksen & Eriksen, 1974), the type of inhibition concerning the *resistance to distractor interference* was

measured (Friedman & Miyake, 2004). This is the ability of a person to focus their attention on items relevant to a task, while ignoring any simultaneously-presented extraneous irrelevant items (Borella & De Ribaupierre, 2014; Friedman & Miyake, 2004). However, if the moderating role of inhibition on the relation between leisure reading and reading comprehension is linked to the suppression or inclusion of prior knowledge, another type of inhibition might be more relevant. In their model, Friedman and Miyake (2004) explicate *resistance to proactive interference* as another type of inhibition. This has to do with limiting the activation of irrelevant prior items and memory intrusions (Borella & De Ribaupierre, 2014; Friedman & Miyake, 2004). This type of inhibition may thus be more strongly related to the memory of an individual, and the prior knowledge they activate. Possibly, the focus of the current research was on the wrong type of inhibition, and the resistance to proactive interference type of inhibition would show a moderating function. Follow-up research is needed to further examine this suspicion.

Similarly, for working memory there can be made a distinction between two types: (1) verbal working memory, and (2) visuo-spatial working memory (Kane et al., 2004). In the current study, the Monkey Game was used, which measures verbal working memory (Van de Weijer-Bergsma et al., 2015). Verbal working memory is the ability to remember and process auditory-linguistic information (Kane et al., 2004). Research suggests that verbal working memory is more strongly related to reading comprehension than the visual-spatial working memory (Seigneuric et al., 2000). The current research did find a moderately strong relation between leisure reading and verbal working memory. Having said that, maybe the visual-spatial working memory is more important in moderating the relation between leisure reading and reading comprehension. The visual-spatial working memory concerns remembering and processing visual and spatial information (Kane et al., 2004). Again, more research is needed to examine whether this could be the case.

Limitations and Direction for Future Research

The current study knows a few limitations concerning the instruments utilized to measure the variables within the proposed models. To measure inhibition, the Flanker Task from PsyToolkit (Stoet, 2010) was used, which is a simplified version of the original Eriksen Flanker Task (Eriksen & Eriksen, 1974). In the software, letter sequences were randomized to ensure diversity in order of flankers. As the number of congruent and incongruent sequences were not balanced, differences exist regarding the proportion of congruent and incongruent sequences participants were exposed to. Research shows that when incongruent sequences are rarer, there will be more response conflict (Botvinick et al., 2004; Tillman & Wiens, 2011). It

thus can be questioned whether the scores on inhibition are fully comparable between participants when exposure to incongruent sequences was not equal.

Additionally the survey used to measure leisure reading, based on the questions of the Reading Activity Inventory (RAI; Guthrie et al., 1994), showed a low reliability with a Cronbach's Alpha of $\alpha = .54$ (Gliem & Gliem, 2003). This indicates that the data derived from the survey is vulnerable for inconsistency (Tavakol & Dennick, 2011), and could therefore be a slightly inaccurate measure of leisure reading. In relation to this, it should be pointed out that Cronbach's Alpha depends on the number of items of a survey (Field, 2018). As the Survey for Leisure Reading consisted of a small number of items, it is not surprising and maybe not that meaningful that the Cronbach's Alpha is fairly low. Another limitation of the survey is that it requires participants to self-report on their leisure reading. This way of measuring a variable is prone to a social desirability bias, where participants respond in a way that creates a favourable image of them (Van de Mortel, 2008). Because the survey was conducted in the school environment that centres the message that reading is important, it is possible participants scored themselves higher than is reality. The social desirability bias can affect the validity of the results from the survey (Van de Mortel, 2008).

Despite these limitations, it is not expected that the instruments and measurements used in the current study lead to majorly inaccurate representations of the variables. The results did uncover direct positive direct effects between the three independent variables (i.e. leisure reading, working memory and inhibition) and reading comprehension, which aligned with prior research, both in direction and in size (Torppa et al., 2021; Follmer, 2018). Therefore, it seems unlikely that the current research drastically misrepresents the variables and relations between these variables. Nevertheless, they are critical notes that future research to the same topic should attend to.

Additionally, with regard to future research it is relevant to underscore that the current study only examined a restricted number of executive functions. Executive functions is broad spectrum, consisting of many different higher order skills (Diamond, 2013). The current study does not rule out the possibility that other EFs do moderate the relation between leisure reading and reading comprehension, even though no moderating role was found for inhibition and working memory. For example, attentional control is recognized as an executive function as well (Anderson, 2002; Follmer, 2018). Attentional control can be defined as the ability to selectively attend to specific stimuli and retain attention for a prolonged period of time (Anderson, 2002). Possibly, an individual with high attentional control is better at focussing on relevant passages during leisure reading, which helps them build a stronger prior

knowledge base. As established before, prior knowledge guides word-identification and comprehension on a text-based level (Priebe et al., 2012), which enhances reading comprehension. Because such a moderating role can be hypothesised, it would be interesting for future research to use a similar research design as the current study did to investigate whether other EFs do influence the relation between leisure reading and reading comprehension.

Conclusion

In summation, the current research did not find a moderating role of (1) verbal working memory, and (2) resistance to distractor interference inhibition on the relation between leisure reading and reading comprehension. These executive functions thus do not explain the between-person variance in strength of the relation. However, the current study did unveil a significant positive effect of leisure reading on reading comprehension. This indicates that all Dutch Grade 5 and Grade 6 students, no matter how good their working memory or inhibition is, could benefit from more leisure reading. Therefore, leisure reading can be seen as a universal intervention to better students' reading comprehension, and increase their school success.

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Attachment 1

Survey for Demographic Information and Leisure Reading

Table 1

Items Survey for Demographic Information and Leisure Reading

Itemlable	Item
Age	Wat is je leeftijd?
Gender	Wat is je geslacht?
Grade	In welke groep zit je?
LeisureReading1	Hoe vaak lees je <u>buiten school</u> een boek voor je plezier, of uit eigen interesse?
LeisureReading2	Hoe vaak lees je <u>buiten school</u> een krant voor je plezier, of uit eigen interesse?
LeisureReading3	Hoe vaak lees je <u>buiten school</u> een stripverhaal voor je plezier, of uit eigen interesse?
Leisure Reading4	Hoe vaak lees je <u>buiten school</u> een magazine voor je plezier, of uit eigen interesse?
LeisureReading5	Hoe vaak lees je <u>buiten school</u> digitale tekst (bijvoorbeeld een blog, e-mail of berichtjes op social media) voor je plezier, of uit eigen interesse?

Note. The Leisure Reading items were answered with (1) Bijna nooit, (2) Ongeveer een keer in de maand, (3) Ongeveer een keer in de week, or (4) Bijna iedere dag.