What distinguishes underachievers from highly achieving gifted children?

The relationship between underachievement in gifted and typically developing children and the role of working memory and learning style in this relation.

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Preface

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In this master thesis, the relationship between underachieving and highly achieving gifted children has been studied in children from grades 3 and 4. I have been working on this study with great pleasure. It has been an incredibly fun and educational project, in which I not only studied theoretically but also worked in practice by collecting the data from the children. The variation between theory and practice was very interesting and pleasant.

I would like to thank all the schools, teachers, parents and especially the children for participating in this study. Without them, this study was not conceivable. Besides them, I want to thank everyone who made this study possible, from the people with whom I was data collecting with, till the people who critically read my text. A special thank for my supervisor Evelyn Kroesbergen for the feedback when necessary but also for the freedom I could take. I have learnt a lot from it. Thanks!

Abstract

Previous studies suggest that gifted children often underachieve although it is unclear what distinguishes underachievers from highly achieving gifted children. To understand the distinction, the current study explored the association with working memory and learning style. From a screening sample of 763 children from 27 various primary schools in the Netherlands, 341 children from grade 3 and 4 were included in this study. From these children, 32 were selected as gifted through high scores on IQ and creativity measures. The relationship between (underachieving) gifted children and working memory and learning style is investigated through the results of the Monkey Game, Lion Game and the questionnaire Learning & Thinking. It is found that gifted children do not more often underachieve although they have a better working memory than the typically developing children and the underachieving gifted have a lower working memory than the achieving gifted. No support is found for a difference in learning style in (underachieving) gifted children.

Keywords: Gifted, underachievement, creativity, working memory, learning style

What distinguishes underachievers from highly achieving gifted children?

The widespread attention for gifted students started relatively late (Dai, Swanson, & Chenc, 2011; Onderwijsraad, 2004), although the identification of gifted children is very important to provide appropriate support (Huang, 2008). In research, the distinct needs and psychological underpinnings of giftedness should be examined because education is not well tailored to the needs of gifted students. Evidence-based programs are necessary (Dai et al., 2011; Onderwijsraad, 2004; Van Tassel-Baska, 2006), especially for underachieving gifted children. Too often, for no plausible reason, gifted children underachieve (Driessen, Mooij, & Doesborgh, 2007; Whitmore, 1986). The percentage underachievers is estimated at 50% (National Commission on Excellence in Education, 1983). Other research has shown that 15-40% of gifted students are at risk for underachievement (Seeley, 1993). Because of the large number of underachievers, the topic of this thesis will be underachievement in gifted children.

This subject involves some limitation because the identification of giftedness is still problematic. As it is not exactly clear what is meant by "gifted" (Bergman, Corovic, Ferrer-Wreder, & Modig, 2014; Hoogeveen, Van Hell, Mooij, & Verhoeven, 2005; Leikin, Paz-Baruch, & Leikin, 2013). Giftedness is defined by various researchers as a high intelligence quotient. Mostly, the upper top of students are meant (Renzulli, 2011; Van Viersen, Kroesbergen, Slot, & De Bree, 2016). There is an inconsistency about what this upper top means in the literature, various percentages are used, ranging from 2-10% (Bergman et al., 2014; Driessen et al., 2007; Guldemond, Bosker, Kuyper, & Van der Werf, 2003). A high intelligence is not the only condition for identifying giftedness (Almeida, Araújo, Sainz-Gómez, & Prieto, 2016; Renzulli, 2011). According to Renzulli (2011) a high degree of creativity is also a prerequisite for giftedness. Creativity can be defined as the potential to provide new solutions to problems (Jauk, Benedek, Dunst, & Neubauer, 2013). There is a relationship between intelligence and creativity (Kim, 2006; Subotnik, Olszewski-Kubilius, & Worrel, 2011), but the size of the link differs, due to differences regarding the sample, measures and the construct of creativity (Jauk, Benedek, & Neubauer, 2014). Because of the large differences in the identification of gifted children (Reis & McCoach, 2000), giftedness will be defined as scoring in the top 10% based on an intelligence test and in the top 20% on creativity tasks.

In creativity a distinction can be made between creative potential, the ability to generate something useful and novel, and creative achievements, the actual realization of the potential (Jauk et al., 2013). The focus in the present study will be on creative potential. Creative potential is reduced when school rates are higher (Holland, 1962; Renzulli, 2011), whereas it is logical that gifted children score higher in general. Creative potential is measured by means of tests that measure divergent thinking (Jauk et al., 2013; Runco & Acar, 2012). Divergent thinking is the ability to create various ideas or solutions for problems from new information from different perspectives (Jauk et al., 2013; Runco & Acar, 2012). Gifted children think more divergently (Runco, 1986). Other research by Karwowski and Gralewski (2003) has shown that intelligence and divergent thinking are hardly correlated in gifted students.

This study focuses especially on those gifted students that underachieve. Underachievement in gifted students is defined as a discrepancy between ability and achievement (Driessen et al., 2007; Frick et al., 1991; Reis & McCoach, 2000; Whitmore, 1986). Interventions of underachieving gifted children so far have limited success and research concerning underachieving is very scarce (Reis & McCoach, 2000). Gifted children fail to perform at a level commensurate with their abilities (Driessen et al., 2007; Reis & McCoach, 2000; Whitmore, 1986). Other research has shown that there is a link between giftedness and underachievement too (Kroesbergen, Van Hooijdonk, Van Viersen, Middel-Lalleman, & Reijnders, 2016; Rayneri, Gerber, & Wiley, 2003; Rayneri, Gerber, & Wiley, 2006). Gifted children, about half of them, perform less well on standard tests (Green, Fine, & Tollefson, 1988; Reis & McCoach, 2000). Counselling interventions are used to change personal or family dynamics that contribute to underachievement. Many early attempts of counselling treatments were unsuccessful (Baymur & Patterson, 1965). The most well-known interventions have special classrooms for gifted underachievers (Fehrenbach, 1993; Whitmore, 1986), whereas flexible, student-centred approaches help reverse underachievement in gifted students (Baum, Renzulli, & Hébert, 1995).

The main explanations for the relatively high number of underachievers in the group of gifted children, are deficits in working memory, learning style and environmental factors such as parents and school (Hébert, 2001; Lee-Corbin & Denicolo, 1998). In this study, the focus will be on working memory and learning style.

Working memory is a cognitive system in which information is temporarily stored and manipulated (Kornmann, Zettler, Kammerer, Gerjets, & Trautwein, 2015; Leikin et al., 2013). Working memory is an important predictor of school performance (Alloway & Alloway, 2010; Subotnik, Olszewiski-Kubilius, & Worrel, 2011) because it has unique links to academic attainment (Ackerman, Beier, & Boyle, 2005; Alloway & Alloway, 2010; Vock, 2005). This also applies to gifted children (Leikin et al., 2013). Research among 3189 typically developing children from age 5, 6, 8 and 9 has shown that low working memory skills are a risk factor for educational underachievement in primary school. About two thirds of them performed poorly on reading and mathematics (Alloway, Gathercole, Kirkwood, & Elliot, 2009). Other research has shown that working memory is even a better predictor of school performance than intelligence in younger children (Alloway & Alloway, 2010; Hoard, 2015). In addition to various studies on working memory and school performance, there have been several studies that investigated the role of memory in the description of gifted children. These studies have shown that gifted children have a higher working memory capacity and a more efficient working memory than typically developing children (Alloway & Elsworth, 2012; Kornmann et al., 2015; Vock, 2005). Other research has shown that there was a small difference between gifted and typically developing students in working memory (Leikin et al., 2013). However, it should be noted that these studies defined giftedness only as high intelligence (Vock, 2005). Research among 81 gifted and typically developing children from in average 9.73 years old (n_{gifted} = 42) has shown that gifted children have a better visual-spatial working memory and a slightly better verbal memory than typically developing children (Kornmann et al., 2015).

In addition to IQ and working memory, there are also differences in learning style of gifted compared to typically developing children. A distinction can be made between inter alia verbal and visual-spatial learners (Price & Dunn, 1997; Rayneri et al., 2003). Verbal learners learn step by step and have a preference for verbal and auditory teaching (Silverman, 2000) while visual-spatial learners have a preference for teaching by footage (Webb, Gore, Amend, & De Vries, 2007) and they visualise the whole concept (Silverman, 2000). However, they may experience difficulties on easy tasks but are excellent in complex tasks. Research among 750 fourth, fifth and sixth graders has shown that lots of children use the visual-spatial learning style, 63% have a (slight) preference on visual-spatial learning (Silverman, 2013). Gifted children often have a preference on visual-spatial learning (Rayneri et al., 2003; Rayneri et al., 2006; Silverman, 2013; Van Garderen & Montague, 2003), but not all the visual-spatial learners are gifted (Silverman, 2013; Van Garderen & Montague, 2003). This can be explained because the right-brain from gifted children is better developed and this is associated with creativity, seeing the big picture, non-rational and (visual-) spatial thinking (Rayneri et al., 2003). Other research about the preference in learning style, has shown that there are no significant differences between gifted and typically developing students between learning styles (Griggs & Dunn, 1984; Van Garderen & Montague, 2003). But it has been shown that learning style plays a role in performance (Rayneri et al., 2006).

There is a link between underachievement and a mismatch between the learning styles of high-ability students and the approaches used in classrooms (Baum, Renzulli, & Hébert, 1995; Redding, 1990; Whitmore, 1986). Research among 80 gifted sixth, seventh, and eight graders towards underachievement has shown that 20% has grade-point averages (GPA) below 85 on a 100-point scale what means that they underachieve. The results of the Learning Style Inventory has shown that the underachievers made even more use of the visual-spatial learning style instead of the verbal learning style compared to the achievers (Rayneri et al., 2003)

In this study the following question will be answered: What distinguishes underachievers from highly performing gifted children? Based on previous research, various hypotheses are formulated with regard to (i) underachievement ii) creative potential and underachievement (iii) working memory and underachievement (iv) learning style and underachievement. The hypotheses are:

i. 1. Gifted children more often underachieve on standardized tests compared to typically developing children (Green, Fine, & Tollefson, 1988; Reis & McCoach, 2000).

ii. 2. Gifted underachievers shows higher creativity than the high achieving gifted children (Kroesbergen et al., 2016; Redding, 1990; Whitmore, 1980)

iii. 3. Gifted children have a better working memory than typically developing children (Alloway & Elsworth, 2012; Kornmann et al., 2015; Vock, 2005).

4. The working memory of the underachieving gifted children is lower than of the gifted children who perform on level (Alloway et al., 2009).

iii. 5. Gifted children prefer the visual-spatial learning style instead of the verbal style (Rayneri et al., 2003; Rayneri et al., 2006; Silverman, 2013; Van Garderen & Montague, 2003).

6. Gifted underachievers show a stronger preference for visual-spatial learning than gifted children who perform at the expected level (Rayneri et al., 2003; Rayneri et al., 2006).

Method

Participants

In this study gifted and typically developing elementary school children in third and fourth grade have participated. These children are from 27 various primary schools in the Netherlands from the districts Utrecht, Groningen and Friesland. Only children with the permission of their parents have participated in the study. From the 763 children who have received a consent form, eventually 760 children (99.6%) participated in the study. The children whose data about their intelligence, creativity and school achievement were missing, were excluded. Finally, 341 children were included in the analyses ($n_{grade\ 3}$ = 269, $n_{grade\ 4}$ = 72), of which 52.8% boys. The gifted children were selected based on intelligence and creativity. They had to score in the top 10% scores on one of the two IQ tests and in the top 20% of one of the two creativity tests.

Measuring instruments

Intelligence. The Dutch Intelligence Test for Education([NIO] Van Dijk & Tellegen, 2004) consists of six components, but only two subtests are used in this study to obtain a quick view on intelligence and to select the gifted children. The top 10% of the population is considered as highly intelligent (Bergman et al., 2014). The verbal intelligence is measured by means of the subtest Categories, in which the children have to find a logical connection between concepts, in which way these words are related for example rain-wet. The children have to choose between several options. The reliability from this test good (α = .86). In addition, the visual-spatial intelligence is measured by the subtest Fold-Out, children should be able to imagine three-dimensional images as to two-dimensional and vice versa. They have to choose which two-dimensional imagines are the right options to get the three-dimensional figure. The reliability (α =.82) of this subtest is good (Van Dijk & Tellegen, 2004). Since the standard scores of the NIO are based on students of grade 6 to grade 9, the results should be interpreted carefully.

Creative potential. To assess children's creative potential, a Dutch translation of the Torrance Test of Creative Thinking ([TTCT] Torrance, 2008) and the Test for Creative Thinking Drawing Production ([TCT-DP] Urban & Jellen, 1996) were used. Kim (2006) recommends using two creativity tests, to increase the reliability. Of the TTCT only activity 2 was administered, because of limited time. This test measures verbal creativity and children have to write down things they can make with an empty box. The TTCT has an intra class correlation for fluency of .99, for originality .98 and for flexibility .95. The test-retest reliability is between .50 till .93 (Torrance, 2008). The TTCT may be considered as a reasonably reliable instrument (Kim, 2006). The TCT-DP measures visual creative potential. The children were asked to finish the drawing. The test has an intra class correlation of .81. Urban (2005) has reported that the parallel test reliability varied between .62 and .70.

Academic skills. CITO is the most widely used standard in primary schools in the Netherlands for measuring school performances (Van Krieken, 1987). The open and multiple choice questions are about different topics. The CITO scores that have been used are provided by the schools. These are the results of the CITO Rekenen-Wiskunde (mathematics), CITO Spelling and CITO Begrijpend Lezen (reading comprehension). The reliability coefficient of the CITO Rekenen-Wiskunde is .92 (Janssen, Verhelst, Angels, & Scheltens, 2010). Regarding to the CITO Spelling the reliability is .93 (De Wijs, Kamphuis, Kleintjes, & Tomesen, 2010). In addition, the reliability coefficient for the CITO Reading is .84 (Feenstra, Petite, Kamphuis, & Krom, 2010). The reliability of the CITO test is classified as good (Field, 2013).

Working Memory. The Monkey Game (Van de Weijer-Bergsma, Kroesbergen, Jolani, & Van Luit, 2016) has been used to measure verbal working memory. This game is a backward word span task. The children have to remember and recall the spoken words backward. This game has an internal consistency of .89 (Van de Weijer-Bergsma et al., 2016). In order to measure the visual-spatial working memory, the Lion Game is used (Van de Weijer-Bergsma, Kroesbergen, Prast, & Van Luit, 2015). This game is also a complex span task, where children have to search for coloured lions. The children have to remember where a lion with a certain colour appeared last. This test has an internal consistency of .86 -.90 (Van de Weijer-Bergsma et al., 2015).

Learning style. The questionnaire Learning & Thinking is used to measures the preference of learning style and skills of children for both a visual and a verbal learning style. There are several statements and the children have to answer whether the statements applies to them. This instrument is developed at the University of Utrecht in collaboration with the SBN (Stichting Beelddenken Nederland) and the University of Groningen. De questionnaire is developed based on literature research of existing questionnaires that aimed to measure visual-spatial learning (Blazhenkova & Kozhevnikov, 2009; Mann, 2005).

Procedure

Firstly, primary schools have been selected through a convenience sample. These schools have a cooperation contract with the University of Utrecht to join a broader study. The parents of the students in these schools have been given the opportunity to give active informed consent. As this study is part of a larger research, not all the acquired data is used. The information obtained by the EMT, Klepel, CB&WL and the World Game is not used. Use has been made of the information from the instruments described in the section 'measuring instruments'. The examination of the NIO, TTCT, TCT-DP and one questionnaire, in that order, were conducted in a classroom setting. After these tests, the children did the Monkey and Lion Game on the computer. The total research lasted about one and a half hour. The CITO scores were provided by the teacher after request.

Data analysis

Bayesian statistics were used to examine the differences in underachieving between gifted and typically developing children and the connection with creative potential, working memory and learning style. Bayesian model selection was performed using the BIEMS software package to quantify the relative evidence that the data provide for two competing hypotheses (Mulder & Wagenmakers, 2016). Bayesian statistics have a few benefits compared to classical frequentist methods. A *p* value can only be used to falsify the null hypothesis (Wagenmakers, Verhagen, & Ly, 2016) and they overestimate the evidence against the null hypothesis (Johnson, 2013). Bayesian statistics enables to test multiple hypotheses without the loss of power (Van de Schoot et al., 2011). Furthermore, it is not based on normality or asymptotic assumptions what permits that it is suitable for small sample sizes (Gill, 2008). A distinction can be made between several models in the Bayesian statistics whereas Model 1 is the informative hypothesis, Model 2 is an hypothesis stating that the groups do not differ and Model 0 is the unconstrained. The unconstrained model is to protect against incorrectly choosing formulated hypothesis (Van de Schoot et al., 2011).

The first step of the Bayesian analyses is the calculation of the Bayes factor (BF) of an informative hypothesis versus the unconstrained hypotheses. BF contains the amount to which the data is supported by a hypothesis in comparison with the alternative hypothesis. A BF below 1 indicates that the alternative hypothesis is more supporting, a BF between 1 en 3 represents a small effect of the informative hypothesis, a BF between 3 and 10 means that there is substantial evidence to support the informative hypothesis, and above 10 indicates strong evidence for the informative hypothesis. After calculating the BF, the posterior model probabilities (PMPs) can be computed. This representing the relative support for a specific hypothesis within a set of hypothesis (Klugkist, Van Wesel, & Bullens, 2011). The PMPs are mutually compared, with a maximum of one.

Results

Table 1 shows the sample sizes, means, standard deviations, minimum and maximum of achievement of the gifted and typically developing children. Note that achievement scores are regressed on IQ, and thus represent the deviation from what is expected based on their intelligence. A negative score implies underachievement. Besides the achievement, the descriptives of creative potential, working memory and learning style of the gifted and typically developing children are given.

Table 1

Descriptive variables of achievement, creative potential, working memory and learning style of the gifted (and typically developing children)

	Gifted children					Typically developing children				
Component	N	M	SD	Min	Max	N	M	SD	Min	Max
Achievement	32	.22	.91	-2.23	1.91	309	-.02	1.00	-2.73	3.25
Visual-spatial CP	32	30.00	8.41	13	46	309	21.80	9.43	6	55
Verbal CP	32	23.07	9.96	4	36	309	16.56	8.27	1	45
Verbal WM	18	61.56	7.14	49.25	75.00	218	53.39	12.24	8.08	82.17
Visual-spatial WM	18	75.50	11.65	48.25	93.50	218	68.18	14.84	10.00	99.00
Verbal LS	28	2.85	0.61	1.67	4.00					
Visual-spatial LS	28	2.84	0.62	1.88	4.00					

Note. CP = creative potential; WM = working memory; LS = learning style; N = sample size; M = mean; SD = standard deviation; Min = minimum; Max = maximum

Table 2 shows the sample sizes, means, standard deviations, minimum and maximum of creative potential, working memory and learning style of the underachieving gifted and achieving gifted children.

Table 2

Descriptive variables of creative potential, working memory and difference in learning style of the underachieving gifted and achieving gifted children

	Underachieving					Achieving				
Component	N	M	SD	Min	Max	N	M	SD	Min	Max
Visual-spatial CP	14	28.71	8.80	13	42	18	31.00	8.20	16	46
Verbal CP	14	28.52	7.44	10	36	18	18.83	9.74	4	36
Verbal WM	8	60.24	9.97	49.25	74.67	10	62.61	6.64	52.25	75.00
Visual-spatial WM	8	73.69	12.35	56.00	93.50	10	76.96	11.51	48.25	89.50
Difference VS-V	11	-0.06	0.32	-0.63	0.48	17	0.02	0.55	0.67	1.40

Note. CP = creative potential; WM = working memory; VS = visual-spatial; V = verbal; N = sample size; M = mean; SD = standard deviation; Min = minimum; Max = maximum

Underachieving gifted and typically developing children

Table 3 shows the BFs and PMPs for all the three models in the analysis on the gifted versus typically developing children, presenting the results for underachieving. Model 1 stated that gifted children more often underachieve on standardized test compared to typically developing children ($\mu_G < \mu_{TD}$), and Model 2 stated that there is no difference between gifted and typically developing children ($\mu_G = \mu_{TD}$).

Table 3

Model comparisons of achieving of gifted versus typically developing children

	Model 0 (G, TD)		Model 1 (G < TD)		Model 2 (G = TD)	
Component	BF	PMP	BF	PMP	BF	PMP
Achievement	1.00	0.36	0.21	0.08	1.58	0.57

Note. G = gifted children; TD = typically developing children; BF = Bayes factor; PMP = posterior model probability.

The results showed that Model 2 received about 1.5 times more support from the data than Model 0, this is a small effect. The gifted children did not differ from typically developing children.

Creative potential

Underachieving versus achieving gifted children. Table 4 shows the model comparisons for the analysis on creativity of the underachieving gifted versus the achieving gifted children. Model 1 stated that the underachieving gifted children show higher creativity than achieving gifted children ($\mu_{UG} > \mu_{AG}$), and Model 2 stated that there is no difference in the use of creativity between underachieving and achieving gifted children ($\mu_{UG} = \mu_{AG}$).

Table 4

Model comparisons of creativity of underachieving versus achieving gifted children

	Model 0 (UG, AG)		Model 1 (UG > AG)		Model 2 (UG = AG)	
Component	BF	PMP	BF	PMP	BF	PMP
Creativity	1.00	0.37	1.66	0.61	0.06	0.02
Visual-spatial	1.00	0.30	0.50	0.15	1.79	0.54
Verbal	1.00	0.33	1.99	0.65	0.07	0.02

Note. UG = underachieving gifted children; AG = achieving gifted children; BF = Bayes factor; PMP = posterior model probability

For creativity, overall, Model 1 received 1.7 times more support from the data, which means that there is a small effect. The underachievers show more creativity than the achieving gifted children. For the individual components, Model 1 received most support from the data for verbal creativity, about 2 times more than the alternative hypothesis. However, Model 2 received most support from the data from visual-spatial creativity, about 2 times more than the alternative hypothesis. Especially in the verbal domain, underachieving gifted children are more creative than the highly achieving gifted children.

Working memory

Gifted versus typically developing children. Table 5 displays the model comparisons on the working memory of the gifted versus typically developing children. Model 1 stated that gifted children have a better working memory than typically developing children ($\mu_G > \mu_{TD}$), and Model 2 stated that there is no difference between gifted and typically developing children ($\mu_G = \mu_{TD}$).

Table 5

Model comparisons of the working memory of gifted versus typically developing children

	Model 0 (G, TD)		Model 1 (G > TD)		Model 2 (G = TD)	
Component	BF	PMP	BF	PMP	BF	PMP
Working memory	1.00	0.20	3.74	0.77	0.14	0.03
Verbal	1.00	0.32	1.99	0.64	0.10	0.03
Visual-spatial	1.00	0.30	1.93	0.57	0.43	0.13

Note. G = gifted children; TD = typically developing children; BF = Bayes factor; PMP = posterior model probability

For working memory, overall, Model 1 received 3.7 times more support from the data, which means that there is a substantial evidence supporting the informative hypothesis. For the individual components, Model 1 received most support from the data, on average about 1.41 times more than the alternative hypothesis.

Underachieving versus achieving gifted children. Table 6 shows the model comparisons for the analysis on the working memory of the underachieving gifted versus achieving gifted children. Model 1 stated that the working memory of the underachieving gifted children is lower than of the achieving gifted children ($\mu_G < \mu_{AG}$), and Model 2 stated that there is no difference between underachieving and achieving gifted children ($\mu_G = \mu_{AG}$).

Table 6

Model comparisons of the working memory of underachieving gifted versus achieving gifted

	Model 0 (UG, AG)		Model 1 (UG < AG)		Model 2 (UG=AG)	
Component	BF	PMP	BF	PMP	BF	PMP
Working memory	1.00	0.23	2.01	0.46	1.40	0.32
Verbal	1.00	0.25	1.43	0.36	1.53	0.39
Visual-spatial	1.00	0.26	1.35	0.35	1.50	0.39

Note. UG = underachieving gifted children; AG = achieving gifted children; BF = Bayes factor; PMP = posterior model probability

The results of the model comparisons of the working memory showed that Model 1, overall, received about 2 times more support from the data than the alternative hypothesis, but this is a small effect.

Learning style

Gifted children. Table 7 shows the model comparisons for the analysis on the preference of learning style of the gifted children; verbal or visual-spatial. Model 1 stated that the gifted children prefer the visual-spatial learning style instead of the verbal style ($\mu_{VS} > \mu_{V}$), and Model 2 stated that gifted children have no preference between the visual-spatial and the verbal learning style ($\mu_{VS} = \mu_{V}$).

Table 7

Model comparisons of the preferred style of gifted children; visual-spatial versus verbal

	Model 0 (VS, V)		Model 1 (VS > V)		Model 2 (VS = V)	
Component	BF	PMP	BF	PMP	BF	PMP
Preferred style	1.00	0.15	1.00	0.15	4.51	0.69

Note. VS = visual-spatial style; V = verbal style; BF = Bayes factor; PMP = posterior model probability

The results from table 7 showed that Model 2 received about 4.5 times more support from the data than Model 0, which means there is a substantial evidence supporting the informative hypothesis. Gifted children have no preference between de visual-spatial and the verbal learning style.

Visual-spatial style underachieving versus achieving gifted. Table 8 displays the model comparisons of the difference between the visual-spatial and verbal learning style of the underachieving versus achieving gifted children in favour of the visual-spatial style.

Model 1 stated that underachieving gifted children have a stronger preference for visual-spatial learning and achieving gifted children ($\mu_{UG} > \mu_{AG}$), and Model 2 stated that there is no difference between underachieving gifted and achieving gifted children ($\mu_{UG} = \mu_{AG}$).

Table 8

Model comparisons of the difference of the visual-spatial and verbal learning of underachieving versus achieving gifted

	Model 0 (UG, AG)		Model 1 (UG > AG)		Model 2 (UG = AG)	
Component	BF	PMP	BF	PMP	BF	PMP
Difference VS-V	1.00	0.30	0.68	0.20	1.70	0.50

Note. UG = underachieving gifted children; AG = achieving gifted children; VS = visual-spatial; V = verbal; BF = Bayes factor; PMP = posterior model probability

The results from table 8 showed that Model 2 received about 1.7 times more support from the data than the alternative hypothesis, but this is a small effect. There is no difference between underachieving or achieving gifted children in the visual-spatial learning style.

Discussion

Too many gifted children underachieve (Driessen et al., 2007; Whitmore, 1986) and it is still not clear why they underachieve (Reis & McCoach, 2000). This study investigated what underachievers distinguishes from achieving gifted children, so that education can meet the needs of these children (Dai et al., 2011; Onderwijsraad, 2004; Van Tassel-Baska, 2006). According to Reis and McCoach (2000) and Green and colleagues (1988) gifted children more often underachieve on standardized tests compared to typically developing children. This is not confirmed in this study. There is no difference between gifted and typically developing children in underachievement on standardised tests. It is possible that the expected result is not found, because standardized tests do not reflect the actual school experience. Therefore it is possible that the tests may not be indicative of the student's performance (Reis & McCoach, 2000). In this study the definition of Renzulli (2011) for giftedness is used in which giftedness is besides a high IQ also a high degree of creativity. This study has shown that underachievers show more creativity than the highly achieving gifted children. This is consistent with other research (Kroesbergen et al., 2016; Redding, 1990; Whitmore, 1980). It can be explained because underachievers (with high creativity) are not challenged and stimulated enough in school (Kim, 2011), so they are looking for this challenge. Due to this, they show even more creativity. Especially in the verbal domain, underachieving gifted children are more creative. When underachievers are challenged, this is especially on a verbal way because education nowadays is mainly verbally oriented (Mann, 2005; Silverman, 2000).

Explanations, that are investigated in this study, for the relatively high number of underachievers in the group of gifted children, are working memory and learning style. This study has shown that gifted children have a better verbal and visual-spatial working memory than typically developing children. This is in agreement with other research (Alloway & Elsworth, 2012; Kornmann et al., 2015; Vock, 2005). This could be explained because the working memory capacity of gifted children is higher and more efficient (Alloway & Elsworth, 2012; Kornmann et al., 2015; Vock, 2005). The working memory, overall, of underachieving gifted children is lower than of the highly achieving gifted children. This is consistent with the findings from Alloway and colleagues (2009). These results mean that underachieving gifted children should get more direct instructions and accompaniment in education (Gathercole, Lamont, & Alloway, 2006). This is a way to get education more tailored to the needs of gifted students.

In addition to working memory, it is investigated if there are differences in learning style among gifted children. This study has shown that gifted children have no preference between de visual-spatial and the verbal learning style. This is in contrast with other research, which found a preference for the visual-spatial learning style (Rayneri et al., 2003; Rayneri et al., 2006; Silverman, 2013; Van Garderen & Montague, 2003). Possibly these differences in findings could be explained by differences in age of the participants and Van Garderen and Montague (2003) used an interview about problem solving to find out what the learning style is of the children. There is even no difference in underachieving and achieving gifted children in de preference for the visual-spatial learning style. This is also in contrast with other research (Rayneri et al., 2003; Rayneri et al., 2006). This could be explained because of age differences and Reyneri and colleagues (2003) have used a measuring instrument whereas a distinction is made between 22 learning styles. Therefore the children could choose from various styles, not restricted to only two of them.

Nevertheless, this study has a few limitations. Through missing variables from children, there is a small sample size with 32 gifted children (9.3%) and results are possible not found because of this. Therefore it is hard to generalize the results. In future research this study could be repeated with a larger sample, where creativity is taken into account for the definition of giftedness. Besides creativity, task commitment could also been add to the definition. Furthermore, in the current study only subtests of the NIO and TTCT were done. When full versions were used, this would increase reliability and validity. However, this study is one of the few studies that focused on giftedness through high intelligence and creativity. This while this definition is being used more and more often (Drent & Van Gerven, 2007).

In conclusion, this study has not found support that gifted children more often underachieve on standardized tests compared to typically developing children. Although gifted children do have a better working memory than the typically developing and the underachieving gifted children have a lower working memory than the achieving gifted children. No support was found for a difference in learning style in (underachieving) gifted children.

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