

# Honesty-Humility and Openness to Experience as Predictors of Hypothesis Confidence Among High School Students

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## 1 Abstract

Recent research has suggested that confidence and personality are prominent predictors of academic achievement. Confidence is believed to be influenced by personality as well. The present research explores the relationship between personality and confidence within the educational context of hypothesis generation. The personality traits of Honesty-Humility and Openness to Experience are introduced as prominent traits with regard to (over-)confidence. High school children ( $n = 151$ ) in the first form (age 11-14) were assessed on personality using the HEXACO-SPI. Subsequently, participants completed four assignments on hypothesis generation using digital simulations in the field of science education. For each assignment they could indicate their level of Hypothesis Confidence on a meter. The hypotheses were assessed on accuracy to signal possible (over)confidence bias. Findings indicate that boys have a higher level of both Hypothesis Confidence and Overconfidence than girls. A regression model with Gender, Age, Accuracy, Honesty-Humility and Openness to Experience turned out to explain a significant amount of variance in Hypothesis Confidence. Furthermore, the narrow personality traits of Openness to Experience and Honesty-Humility were found to explain more incremental variance than accuracy, gender and age. Overall, it was concluded that Hypothesis Confidence is indeed partly personality-rooted. Recommendations emphasize that educators should take individual differences causing variance in confidence into account, especially personality and gender. The study concludes proposing guidelines for the development of an intervention directed at enhancing confidence by creating self-awareness into personality. Since personality and confidence predict academic achievement, this will in the long run reflect positively in academic performances as well.

**Keywords:** Honesty-Humility; Openness to Experience; Hypothesis Confidence; Hypothesis Generation; Self-Assessment; High School Education

## 2 Introduction

In the last decade, both confidence (Stankov et al., 2012; Stankov, Morony & Lee, 2014) as well as personality (Nofle & Robins, 2007; de Vries, de Vries & Born, 2011; Richardson, Abraham & Bond, 2012) have been proposed as important predictors of academic achievement. With regard to the relationship between both predictors, it has been suggested that confidence (bias) itself may also find its roots in personality (Williams, Paulhus & Nathanson, 2002; Schaefer et al., 2004). Instead of solely regarding confidence and personality as predictors of achievement, more research on the influence of personality on confidence in academic settings will be desirable. That is, is confidence primarily related to experiencing (academic) success, or is it more personality-rooted?

When children engage in self-assessment of personality or confidence, biases regarding the amount of realism are common. Earlier research by Bouffard et al. (1998) concluded that children are generally too optimistic when assessing themselves or their achievements. The development of a realistic self-perception is influenced by both natural aging and cognitive development (Bouffard et al., 1998). Assessment based principally on personal desires and receiving predominately positive feedback have been proposed as important causes for this effect (Bouffard et al., 2011; Ávila et al., 2012; Lipko-Speed, 2013). It should be taken into account that self-assessment is not always the reflection of a realistic self-perception. These errors in self-judgement can affect both personality and confidence.

This research project will examine the role of personality as a predictor of confidence. The assessment will take place in an educational setting in which junior

high school children (Dutch: Brugklassers) engage in hypothesis construction. Children are encouraged to formulate hypothesis while experimenting within science-education simulations. Their level of confidence will be operationalized in the variable Hypothesis Confidence. Simultaneously, the formulated hypothesis will be assessed in order to include the variable Hypothesis Accuracy as well. In doing so, the role of personality on Hypothesis Confidence can be analyzed in comparison to the role of the student's Accuracy. Finally, the scores on Hypothesis Confidence and Hypothesis Accuracy are compared in order to see if confidence of the student reflects confidence bias. This will be operationalized in the variable Hypothesis Overconfidence. The current study serves two purposes. First, the study analyses whether testing on gender will lead to significant differences in the mean scores on Hypothesis Confidence and Hypothesis Overconfidence. Second, the study investigates the relations of gender, age, Hypothesis Accuracy and personality with Hypothesis Confidence. The ultimate goal will be to investigate if Hypothesis Confidence can be predicted by personality over accuracy, gender and age. And, if so, address its implications for the educational field.

### 3 Theoretical Framework

#### 3.1 Overconfidence and Overclaiming

It is common knowledge that people generally display too much confidence when assessing their own performances (Schaefer et al., 2004). This self-assessment bias can result in overconfidence: a positive bias on the difference between confidence and correctness (Pallier et al., 2002). Furthermore, the process of overclaiming - i.e. falsely claiming to be familiar with (non-existent) items - is a form of self-enhancement, which has also been linked to overconfidence (Paulhus et al., 2003). That is, results of these studies seem to suggest that – on average – self-assessed confidence tends to be too high, potentially causing overconfidence and overclaiming behaviors.

Overconfidence can be regarded from the perspective of error in performance judgement, as well as holding too much commitment to initial beliefs. Moore and Healy (2008) identify these as two sub definitions within individual performance overconfidence: 1) overestimation; thinking too high on one's personal ability and 2) overprecision; too much certainty in one's beliefs. Contextual factors such as gender and task domain

also play a role. For instance, boys are reported to score higher on overconfidence when performing mathematical tasks, whereas in social oriented tasks both genders tend to be overconfident (Dahlbom et al., 2011; Jakobsson, Levin & Kotsadam, 2013). Somewhat contrastingly, Nekby, Thoursie and Vahtrik (2008) suggest that when females enter a male-dominated environment, they tend to equal men on both performance and confidence. Since this research will take place in the context of science education, these gender differences will be likely to have influence on the results.

Overclaiming is regarded as another possible indicator of a positive self-representation (Dunlop et al., 2016). However, Williams, Paulhus, and Nathanson (2002) have suggested that subjects might not be deliberately claiming to have more knowledge than they actually possess. They state that overclaiming is a rather non-conscious process, influenced by both a personality and a memory bias component (Williams et al., 2002). In sum, overclaiming can be perceived as undeliberate positive self-representation whereby personality may, again, be one of the influencing factors. In line with the aforementioned findings and those in the introduction, it can be expected that:

*Hypothesis 1: Boys have a higher level of Hypothesis Confidence than girls.*

*Hypothesis 2: Boys have a higher level of Hypothesis Overconfidence than girls.*

*Hypothesis 3: Age is negatively related to Hypothesis Confidence.*

*Hypothesis 4: Age is negatively related to Hypothesis Overconfidence.*

#### 3.2 Personality and Confidence

It was already pointed out that confidence bias may find its roots in personality (Williams et al., 2002; Schaefer et al., 2004). A commonly used model to describe a person's personality is the Five-Factor Model (FFM) or the 'Big Five' (B5). In this model, personality is defined by the five factors: Agreeableness, Conscientiousness, Extraversion, Neuroticism and Openness to Experience (Goldberg, 1981). Ashton and Lee (2007) state that lexical investigation indicated that personality consistently showed six factors. They have proposed the HEXACO-model, introducing Honesty-Humility (or Integrity) as the previously unexplained factor in addition to the existing Big Five. Based on

literature, Honesty-Humility and Openness to Experience arise as the most prominent traits of personality influencing confidence. Therefore, Honesty-Humility and Openness to Experience will be the personality traits of choice for this research project.

Schaefer et al. (2004) found Openness to Experience to have a positive relationship with confidence, although no relationship with overconfidence emerged. This implies that scoring high on Openness to Experience also leads to higher scores on self-reported confidence. In the specific context of the development of children, high maternal-rated Openness to Experience at a young age was associated with self-confidence in adolescence (Abe, 2005). Caprara et al. (2011) established positive correlations of Openness to Experience with both high school grades and academic efficacy. Since self-confidence has been suggested as an operationalization of perceived behavioral control or self-efficacy (Ajzen, 1991), higher scores on confidence are again to be expected. Marcus, Lee, and Ashton (2007) found a significant negative correlation of Honesty-Humility with counterproductive academic behavior, which comprises of behaviors such as misrepresentation, false claims and cheating. Honesty-Humility has also been researched in the context of social-desirability and interpersonal relationships. A correlation between Honesty-Humility and agreement between self- and other-rated personality analysis has been reported (de Vries, Zettler & Hilbig, 2014; Ashton, Lee & de Vries, 2014). A high Honesty-Humility implies that these children do not present themselves differently compared as to how they are regarded by others. This might decrease the presence of overconfidence, since they will be likely not to present themselves as more confident as they actually are.

A specific interplay of high Openness to Experience and low Honesty-Humility can also be connected to overconfidence. Overconfident behavior is prominent among narcissists. Tangney (2000) proposed that a narcissist uses overconfidence as compensation due to a damaged perception of self. A positive relationship between Openness to Experience and narcissistic behavior has been found (Paulhus & Williams, 2002; Wu & LeBreton, 2011). Simultaneously, Honesty-Humility correlated negatively to narcissism (Lee & Ashton, 2005). Furthermore, a similar interplay between both traits also surfaced in the context of overclaiming. Dunlop et al. (2016) found a positive relation with Openness to Experience, whereas Honesty-Humility was unrelated to overclaiming. The relationship of Openness to Experience

with narcissism and overclaiming has been investigated with both Big Five and HEXACO instruments.

All in all, Openness to Experience seems to be positively related to confidence, whereas Honesty-Humility seems to manifest itself as reducing overconfidence. It can be argued that while high scores on Openness to Experience result in higher scores on confidence, high scores on Honesty-Humility will increase the amount of realism of the self-reported confidence level. Therefore, the following is to be expected:

*Hypothesis 5: Openness to Experience is positively related to Hypothesis Confidence.*

*Hypothesis 6: Honesty-Humility is negatively related to Hypothesis Confidence*

### **3.3 Hypothesis Generation**

Hypothesis generation is considered an important task in several learning forms, such as discovery learning and Inquiry-Based Learning (IBL) (de Jong et al., 2005; Pedaste et al., 2015). In such learning forms, emphasis is being put on finding and describing relations among concepts. Prior knowledge influences the way hypotheses are constructed. When prior knowledge is present, a more theory-driven strategy is common. In the absence of prior knowledge, students tend to focus on data-driven experimentation (Lazonder, Wilhelm & Hagemans, 2008). Hypothesis-driven behavior can be regarded as generating and testing hypotheses. Lazonder, Hagemans, and De Jong (2010) found that the presence of domain information before and during tasks resulted in more hypothesis-driven behavior. Contrastingly, hypothesis-driven behavior was less common when no domain information was presented at all. This suggests that children with little prior knowledge use simulations more freely as tools for experimenting, whereas children with more prior knowledge will test their initial assumptions in a more systematic way. Consequently, high prior knowledge may lead to overprecision because of an (over-)commitment to initial assumptions. In the context of research on confidence, presenting no domain information will be ideal. Although hypothesis-driven behavior might be less prominent, it intends to control for overconfidence due to less attachment to initial beliefs. Also, students will focus more on data-driven experimentation.

Little research exists in the field of confidence and hypothesis forming. Baily, Daily, and Philips (2011)

investigated the relationship between confidence and hypothesis generation in the context of Need for Closure (NFC). Findings included that people who prefer closed answers (and dislike ambiguity) constructed lower quality hypothesis, but had a higher amount of confidence in them (Baily et al., 2011). A negative relationship between Openness To Experience and Need for Closure has been found (Leary & Hoyle, 2009; Onraet et al., 2011). Low openness might thus cause people to hold on to initial assumptions, while also being highly confident. Therefore, the following is to be expected:

*Hypothesis 7: Openness to Experience is negatively related to Hypothesis Overconfidence*

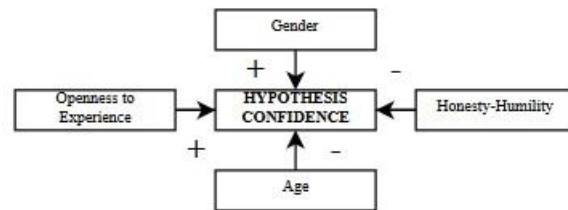
### 3.4 The Current Study

In resume, the first objective will be to investigate if the scores on Hypothesis Confidence and Hypothesis Overconfidence differ significantly when testing on gender. The second objective will be to investigate if Age, Honesty-Humility and Openness to Experience, can be regarded as significant predictors of Hypothesis Confidence. To make statements on incremental variances of independent variables, hierarchical multiple regression will be applied with personality traits, as well as Hypothesis Accuracy, gender and age. Based on the rationale above, the following is to be expected:

Because younger children are generally overconfident and a more realistic self-perception develops over time (Bouffard et al, 1998), a negative influence of age on Hypothesis Confidence is expected. Furthermore, since this research project takes place in the context of science education, boys will be more likely to demonstrate overconfident behavior than girls (Dahlbom et al., 2011; Jakobsson et al., 2013). This will presumably lead to higher scores on Hypothesis Confidence and Hypothesis Overconfidence. As presented in the conceptual framework, people scoring high on Openness to Experience are more likely to present themselves as confident (Paulhus & Williams, 2002; Schaefer et al., 2004; Abe, 2005; Caprara et al., 2011; Wu & LeBreton, 2011; Dunlop et al., 2016) while higher scores on Honesty-Humility are expected to cover for overconfidence (Lee & Ashton, 2005; Marcus et al., 2007; Dunlop et al., 2016). In Figure 1 a model displaying hypothesized influences of the independent variables on Hypothesis Confidence is presented.

The relationship between personality and Hypothesis Overconfidence will also be addressed. However, the presented literature explored relationships between personality and overconfidence in various settings or in general personality characteristics like narcissism. Only Openness to Experience could be related directly to overconfidence in the specific setting of hypothesis construction. Considering this, only a hypothesis on the relationship between Openness to Experience was presented. The relationship of Honesty-Humility and Hypothesis Overconfidence will be addressed exploratory, mainly based on correlations.

**Figure 1.** Hypothesized influences of independent variables on Hypothesis Confidence



## 4 Method

### 4.1 Research Design

This research project was based on a cross-sectional design. It's main aim was to establish a statistical relationship between variables. Based on literature and results, guidelines for dealing with individual differences within hypothesis generation or other educational assignments can be proposed. Instead of focusing on a specific school or intervention, its main purpose will be to identify general relationships and provide remarks for future directions.

### 4.2 Participants

The sample was derived from two high schools ( $k = 2$ ) in the Twente region of the Netherlands. Schools and classes participated on a voluntary basis based on their availability. The sampling method can thus be considered non-probability convenience sampling. In total 161 junior high school children (Dutch: Brugklassers) in

HAVO/VWO education took part in the project. Due to some children being absent in one of the sessions the final sample totaled a number of 154 ( $N = 154$ ) participants. The sample consisted of 76 girls and 78 boys with an average age of  $M = 12.44$  ( $SD = .55$ ).

### 4.3 Measures

#### 4.3.1 Personality Traits

The HEXACO personality traits of Honesty-Humility and Openness to Experience were assessed by means of a questionnaire based on the HEXACO simplified personality inventory or HEXACO-SPI. This simplified Dutch questionnaire is especially designed for, and tested by, children aged 11-13 and non-native Dutch speakers (De Vries & Born, 2013). All questions can be answered on a five-point Likert-scale, ranging from strongly disagree (1) to strongly agree (5). The personality traits are each comprised of four facets. For Honesty-Humility these are: Sincerity, Fairness, Greed Avoidance and Modesty. Openness to Experience can be divided into: Aesthetic Appreciation, Inquisitiveness, Creativity and Unconventionality (Ashton & Lee, 2007). A detailed definition for the broad traits and facets within the HEXACO-model is presented in Lee and Ashton (2004). For data-analysis purposes, each of these facets can be measured individually as well.

#### 4.3.2 Hypothesis Confidence

The learning simulations were developed by Phet Interactive Simulations, associated with the University of Colorado at Boulder. The simulations and accompanying

questions were presented to the students by means of a GoLab: an online learning environments project co-funded by the European Commission within the 7th Framework Programme. The GoLab was constructed specifically for this research, whereas the simulations were already existing. For further reading see: <http://www.golabz.eu/> ; <https://phet.colorado.edu/>. Four assignments on hypothesis construction in three different simulations were presented in the GoLab. The topics of the simulations were: mixing colors, weight balance and area and perimeter relations. As explained before, no domain related information was presented during the research project since this could interfere with the results. The topics were not selected or discussed by the schools or participating classes. In order to assess if the content was suitable for the target group, a science education teacher has reviewed the simulations and assignments.

After each assignment, children could formulate an hypothesis by dragging building blocks with predefined terms. The children could indicate their level of confidence via a meter. Confidence level is hereby measured on a scale from 0 to 100, in fixed intervals of 10. The cumulative score was subsequently divided by four. This resulted in a score on the variable Hypothesis Confidence, ranging from 0 to 100. The default score was automatically set at 50 for each assignment. However, entries with a default score were only considered valid when they were accompanied by a hypothesis. Otherwise, the entry was considered missing, and excluded from the data. Lastly, if children formulated two or more hypotheses in one assignment, only the first one was assessed. An example from the actual project consisting of a hypothesis and a confidence score is presented in Figure 2.

**Figure 2.**  
The 'hypothesis scratchpad'; used for hypothesis generation.



Notes. The fixed terms are presented in blocks at the top of the scratchpad. The hypothesis can be formulated by dragging the blocks to the compartment beneath 'Hypotheses'. At the right side, Hypothesis Confidence can be indicated via the confidence meter.

### 4.3.3 Hypothesis Accuracy

The formulated hypotheses were assessed by two raters on the level of accuracy. The hypotheses were coded on three levels: 0) missing or incomplete, 1) complete, incorrect and 2) complete, correct. Inter-rater reliability was measured by means of Cohens Kappa and the raters were found to agree varying from moderately to substantially (see Table 1). Subjects with different scores on assignment were assessed again. A cumulative score was subsequently composed for both raters for each participant. This resulted in a final score on Hypothesis Accuracy for each participant, ranging from 0 to 8.

**Table 1**  
Initial Interrater Reliability on the Assessed Assignments

	$\kappa$	SE	p	95% CI	
				LB	UB
Assignment 1	.79	.05	.00	.69	.89
Assignment 2	.53	.08	.00	.38	.60
Assignment 3	.68	.05	.00	.58	.79
Assignment 4	.45	.06	.00	.33	.56

### 4.3.4 Hypothesis Overconfidence

Scores on Hypothesis Confidence were compared to those on Hypothesis Accuracy. This in order to assess whether the scores of Hypothesis Confidence reflected a realistic self-perception. This resulted in a final score on Hypothesis Overconfidence, ranging from -50, indicating underconfidence, to +50, indicating overconfidence. A score being (close to) zero indicates a very high amount of realism, i.e. the amount of confidence matching the amount of accuracy on hypotheses. Stankov et al. (2012) describe the aforementioned use of positive and negative scores as a common method to describe realism of confidence judgement. This variable will be used primarily to answer hypothesis 2, 4 and 7 on the influences of gender, age and Openness to Experience on Hypothesis Overconfidence.

## 4.4 Procedure

Participating children engaged in two sessions of 30 minutes. In the first session, the research project was introduced via a PowerPoint presentation. Apart from research purposes and assignments, children were made aware that participation was voluntary and anonymous. Before the start of their first task, all children were

provided with the opportunity to read and sign the informed consent form. Since the sample consisted of minors, parents/caregivers had been sent an informed consent form in advance. Subsequently, students filled in the items of the HEXACO-SPI. In the second session, the children completed the assignments presented in the GoLab. The children worked on these assignments individually, using a computer, laptop or iPad. Participating schools and classes have been provided the opportunity to schedule sessions consecutive or at separate moments, based on preferences or availability. Since the sessions consist of distinctive topics and activities, these differences are not likely to have an effect on the outcomes of this study.

## 5 Results

### 5.1 Preliminary Analysis

In total, 79.22% of participants in the dataset provided scores on all of the assessed items (32 personality items and 4 hypotheses). The fourth hypothesis was the item with the highest amount of missing data, with 8.44% of participants missing. Little's MCAR test on personality items and assignments suggested that the missing values were missing at random ( $\chi^2(838) = 854.25, p = .34$ ). Multiple Imputation was subsequently used to complete the dataset.

The personality questionnaire was assessed on alpha reliabilities. Both the traits of Honesty-Humility ( $\alpha = .70$ ) and Openness to Experience ( $\alpha = .80$ ) scored sufficiently on Cronbach's alpha analysis. In comparison to the broad traits, the alpha's of the facets of Honesty-Humility ( $\alpha$ 's range, .23 - .65) and Openness to Experience ( $\alpha$ 's range, .42 - .81) were more divergent.

Kolmogorov-Smirnov testing was applied in order to investigate distributions of the continuous variables. The test turned out to be non-significant for Openness to Experience ( $D = .06, p = .20$ ) and Hypothesis Confidence ( $D = .07, p = .20$ ), indicating a normal distribution. Although Honesty-Humility had a significant score on the K-S test ( $D = .09, p = .01$ ), further testing resulted in a non-significant result on the Shapiro-Wilk test ( $W = .99, p = .15$ ). Therefore, we proceed assuming a normal distribution for all the variables the children were assessed on.

The collected data was analyzed on scores regarding the personality traits and corresponding facets, as well as

the scores on Hypothesis Confidence, Hypothesis Accuracy and Hypothesis Overconfidence. Presented in Table 2 are the means, standard deviations and ranges for the personality traits and the continuous variables.

## 5.2 Pearsons's Correlation

In Table 3, intercorrelations of the personality traits and continuous variables are presented. Notable are the significant correlations of Gender ( $r = .18, p < .05$ ), the broad personality trait Openness to Experience ( $r = .18, p < .05$ ) and its facet Inquisitiveness ( $r = .24, p < .01$ ) with Hypothesis Confidence. These relationships are in line with hypotheses 1 and 5. Gender correlated significantly to Hypothesis Overconfidence ( $r = .28, p < 0.01$ ), as did Honesty-Humility ( $r = -.18, p < 0.05$ ). In contradiction to hypothesis 7, a significant (negative) correlation with Openness to Experience could not be found. Age had – also contradicting hypotheses - no significant correlation with neither Hypothesis Confidence nor -Overconfidence.

## 5.3 Independent Samples T-tests

Two independent samples T-tests were conducted comparing scores of boys and girls on Hypothesis Confidence and Hypothesis Overconfidence. Testing showed that the mean scores of girls ( $M = 65.56, SD = 17.82$ ) and boys ( $M = 71.67, SD = 16.06$ ) on Hypothesis Confidence were significantly different ( $t(152) = -2.24, p = .03$ ). T-testing was also used to compare the differences within gender and age on scores on Hypothesis Overconfidence. Testing showed that the mean scores of girls ( $M = -2.42, SD = 12.45$ ) and boys ( $M = 5.14, SD = 13.65$ ) were again significantly different;  $t(152) = -3.69, p = .00$ .

The results of T-testing indicate that gender causes significant differences on Hypothesis Confidence and Hypothesis Overconfidence. Boys score higher on both variables than girls, hereby confirming hypotheses 1 and 2.

**Table 2**  
Descriptive Statistics of Age, Personality Traits and Continuous Variables

Variable	M	SD	Range	
			Observed	Possible
Age	12.44	.55	11 - 14	
H-Sincerity	11.98	2.82	6 - 19	4 - 20
H-Fairness	12.36	3.15	5 - 19	4 - 20
H-Greed Avoidance	10.54	2.34	4 - 16	4 - 20
H-Modesty	14.30	2.64	8 - 20	4 - 20
O-Aesthetic Appreciation	10.08	3.63	4 - 19	4 - 20
O-Inquisitiveness	11.58	3.87	4 - 20	4 - 20
O-Creativity	14.03	3.00	6 - 20	4 - 20
O-Unconventionality	11.28	2.41	6 - 17	4 - 20
Honesty-Humility	49.18	7.68	26 - 69	16 - 80
Openness to Experience	46.96	9.07	22 - 74	16 - 80
Hypothesis Confidence	68.65	1.38	10 - 100	0 - 100
Hypothesis Accuracy	5.27	2.02	0 - 8	0 - 8
Hypothesis Overconfidence	1.41	13.57	-23.75 - 43.75	-50 - 50

**Table 3**  
Intercorrelation of Gender, Age, Personality Traits and Continuous Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-														
2	.00	-													
3	-.20*	-.11	-												
4	-.42**	-.04	.44**	-											
5	-.30**	-.01	.23**	.45**	-										
6	-.22**	-.11	.30**	.31**	.12	-									
7	-.26**	.10	.11	.26**	.20*	.10	-								
8	.18*	.07	.12	.19*	.23**	.06	.57**	-							
9	-.13	-.01	-.02	.17*	.11	-.02	.36**	.38**	-						
10	-.23**	.10	-.19*	.04	.17*	-.18*	.04	.01	.39**	-					
11	-.41**	-.10	.72**	.82**	.62**	.62**	.24**	.21**	.09	-.06	-				
12	-.13	.09	.04	.25**	.26**	.01	.78**	.78**	.74**	.42**	.20*	-			
13	.18*	-.15	-.15	.10	.10	-.05	.05	.24**	.10	.11	.00	.18*	-		
14	-.18*	-.01	.00	.17*	.32**	.06	.31**	.18*	.12	.14	.19*	.28**	.22**	-	
15	.28**	-.08	-.10	-.09	-.23**	-.09	-.26**	-.01	-.05	-.06	-.18*	-.14	.43**	-.79**	-

\* $p < .05$ ; \*\* $p < .01$

Notes. 1 = Gender; 2 = Age; 3 = H-Sincerity; 4 = H-Fairness; 5 = H-Greed Avoidance; 6 = H-Modesty; 7 = O-Aesthetic Appreciation; 8 = O-Inquisitiveness; 9 = O-Creativity; 10 = O-Unconventionality; 11 = Honesty-Humility; 12 = Openness to Experience; 13 = Hypothesis Confidence; 14 = Hypothesis Accuracy; 15 = Hypothesis Overconfidence.

## 5.4 Multiple Regression Analyses

Two hierarchical multiple regression analyses were conducted, discriminating between broad and narrow personality traits. Both analyses consisted of background variables Age and Gender in step 1 and Hypothesis Accuracy in step 2. The personality traits were subsequently introduced in the third and last step. Regression analysis revealed that both the first ( $F(5, 148) = 5.03, p < .01$ ) and the second overall model ( $F(11, 142) = 3.83, p < .01$ ) were significant. The background variables and Hypothesis Accuracy were significant predictors of Hypothesis Confidence. Concerning the broad traits, only Openness to Experience ( $\beta = .17, p < .05$ ) emerged as a significant and positive predictor, as predicted in hypothesis 5. Nonetheless, Honesty-Humility did not emerge as a significant (negative) predictor, contradicting hypothesis 6. The explained incremental variance of broad personality ( $\Delta R^2 = .03, p > .05$ ) was fairly low and nonsignificant. It can be observed that both the background variables ( $R^2 = .05, p < .05$ ) and Accuracy ( $\Delta R^2 = .07, p < .01$ ) account for more variance at a higher significance level.

In the second model two narrow traits of Honesty-Humility, Sincerity ( $\beta = -.23, p < .05$ ) and Fairness ( $\beta = .25, p < .05$ ) and one facet of Openness to Experience, Inquisitiveness ( $\beta = .22, p < .05$ ) arose as significant predictors of Hypothesis Confidence. In contrast to the first regression analysis, the incremental variance of combined narrow personality traits ( $\Delta R^2 = .11, p < .05$ ) was larger and statistically significant. The incremental variance of narrow personality traits was also larger than those of Hypothesis Accuracy and the background variables Gender and Age. The results of the multiple regression analyses are displayed in Table 4.

The variance inflation factors (*VIF*) are also reported. According to Miles and Shevlin (2001), values larger than 4 generally alert for possible multicollinearity issues. The *VIF* values all fall within the rule of thumb of being smaller than 4, indicating that multicollinearity will not be a large problem in this model. Spurious relations or suppressor variables cannot be ruled out, and will therefore be addressed in the discussion section.

**Table 4**  
Hierarchical Regression Analysis with Broad and Narrow Personality Traits as predictors

HEXACO-SPI broad traits	Hypothesis Confidence			
	<i>Final</i> $\beta$	<i>Final</i> <i>VIF</i>	$R^2$	$\Delta R^2$
<i>Step 1</i>			.05*	
Gender	.25**	1.23		
Age	-.16*	1.03		
<i>Step 2</i>			.12**	.07**
Hypothesis Accuracy	.22*	1.12		
<i>Step 3</i>			.15**	.03
Honesty-Humility	.01	1.27		
Openness To Experience	.17*	1.13		

HEXACO-SPI narrow traits	Hypothesis Confidence			
	<i>Final</i> $\beta$	<i>Final</i> <i>VIF</i>	$R^2$	$\Delta R^2$
<i>Step 1</i>			.05*	
Gender	.23*	1.86		
Age	-.18*	1.05		
<i>Step 2</i>			.12**	.07**
Hypothesis Accuracy	.20*	1.23		
<i>Step 3</i>			.23**	.11*
Honesty-Humility				
Sincerity	-.23*	1.38		
Fairness	.25*	1.74		
Greed Avoidance	.01	1.48		
Modesty	-.03	1.22		
Openness To Experience				
Aesthetic Appreciation	-.09	2.06		
Inquisitiveness	.22*	2.19		
Creativity	-.04	1.50		
Unconventionality	.11	1.45		

\* $p < .05$ ; \*\* $p < .01$ .



## 6 Discussion

### 6.1 Gender

T-testing revealed significant differences in the scores on Hypothesis Confidence comparing boys and girls. Furthermore, boys also displayed significant more overconfident behavior than girls. This confirms the hypotheses (1 and 2) and the presented research addressing the contextual influences on (over-)confident behaviors (Nekby et al., 2008; Jakobsson et al., 2013). The broad personality trait Honest-Humility strongly correlates with Gender ( $r = -.42, p < .01$ ). On narrow level, it can be observed that Gender is (very) significantly correlated with 7 out of 8 narrow traits. Preferably, conclusions concerning the relationship between personality and Hypothesis Confidence should also be perceived from a gender-based perspective.

Confidence has been identified as an important non-cognitive predictor of achievement. One might argue that high confidence should thus be reflected in achievement or grades. The positive and significant correlation between Hypothesis Confidence and Hypothesis Accuracy ( $r = .22, p < .01$ ) initially confirms this relationship. However, multiple authors have addressed the fact that girls in general score higher on GPA in divers subjects and school types (e.g. Pomerantz, Altermatt & Saxon, 2002; Buchmann & DiPrete, 2006). In addition to boys being overconfident, Pomerantz et al. (2002) found that despite better performance, girls have a less positive self-image. Since, also in the present study, girls tend to display underconfident behaviors, a direct relationship of confidence and achievement might not be visible. Due to the differences between boys and girls on (over)confidence, it is plausible to assume that gender suppresses the positive relationship of Hypothesis Confidence and Hypothesis Accuracy.

### 6.2 Age

Age turned out to be a significant negative predictor of Hypothesis Confidence in both of the regression models, confirming hypothesis 3. Also, age did not correlate significantly with any other variable (Table 3) and can thus be considered as fairly independent. Caprara et al. (2011) consider Openness to Experience as a stable personality trait when comparing the same individuals at 13 and 16 years. The range of this sample was also rather small. It will therefore be unlikely that age differences had a substantial effect on the variance within personality, especially within Openness to Experience. It should

further be considered that participants are in the same form and type of education. An influence of age on Hypothesis Accuracy should thus be negligible, which is confirmed by inter-correlation ( $r = .01, p > .05$ ). Correlation between age and Hypothesis Overconfidence was negative as hypothesized, but rather weak all the same ( $r = -.08, p > .05$ ). In connection with the hypotheses, we can conclude that age is an independent and genuine negative predictor of Hypothesis Confidence (hypothesis 3). The hypothesized negative relation with overconfident behaviors (hypothesis 4) cannot be confirmed convincingly.

### 6.3 Broad versus Narrow Personality

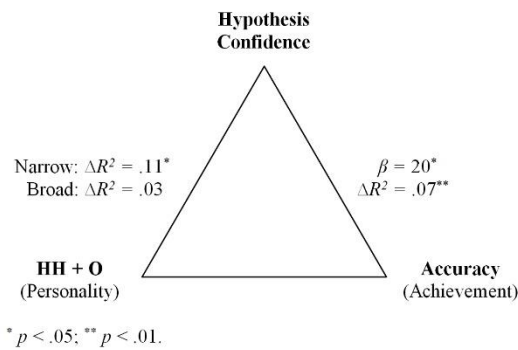
In the regression model with the broad traits as predictors, Openness to Experience turned out to be a significant positive predictor of Hypothesis Confidence. This confirms both hypothesis 5 and the presented literature describing a positive relation between Openness to Experience and confidence. Honesty-Humility was hypothesized diminish over (over-)confident behaviors. The Beta-coefficient was close to zero ( $\beta = .01, p > .05$ ) indicating a negligible predictive value. The relationship is nonetheless not negative, nor significant. Hypothesis 6 can therefore not be confirmed. The overall model predicts variance in Hypothesis Confidence quite substantially and significantly ( $R^2 = .15, p < .01$ ). However, the incremental variance of the broad personality traits is low and insignificant ( $\Delta R^2 = .03, p > .05$ ). The previous two steps in the regression model both have higher determination coefficients which are significant. Whereas the overall regression model can be regarded as a significant predictor of Hypothesis Confidence, the broad personality traits have low incremental validity.

The regression model with narrow personality traits accounted for a higher percentage of variance within Hypothesis Confidence. Furthermore, the incremental variance of personality increased significantly compared to the model with solely broad traits. In comparison with step 1 (gender and age) and step 2 (Hypothesis Accuracy) narrow personality accounted for the most variance ( $\Delta R^2 = .11$ ). This meaning that, in this situation, personality predicts confidence over achievement which has also been opted by other sources (e.g. Nofle & Robins, 2007). This is valuable for educators since it implies that confidence cannot be enhanced by merely positive feedback or experiencing success in academics. Attention should be given to the personality-rooted component as well.

The difference in predictive validity of narrow traits versus broad traits is part of the bandwidth-fidelity dilemma, described by Cronbach and Gleser (1965). This dilemma focusses on the choice between broad or narrow personality traits as measurement instruments. Hogan and Roberts (1996) have opted that this choice should be construct-dependent. Solely broad traits might be unable to account for the variance in the dependent variable when this variable is very specific (narrow) (Hogan & Roberts, 1996; Schneider, Hough & Dunnette, 1996). In terms of criterion validity, Hypothesis Confidence seems to be such a specific dependent variable.

Figure 3 presents the results regarding Honesty-Humility (HH) and Openness to Experience (O) as predictors of Hypothesis Confidence (confidence), set out against the influence of Hypothesis Accuracy (achievement).

**Figure 3**  
Found Relationships of Personality and Hypothesis Accuracy with Hypothesis Confidence.



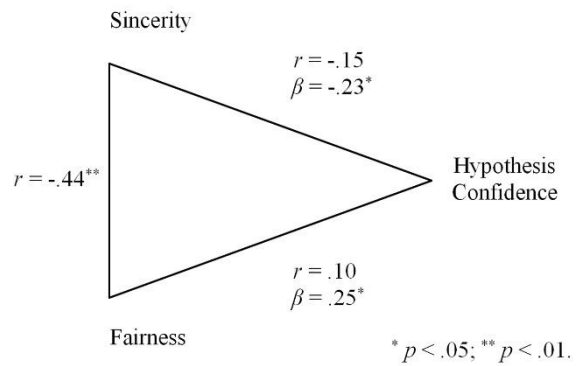
### 6.4 Significant Personality Facets

The coefficients of the narrow traits were both positive and negative, indicating antagonistic covariation within the regression model. Sincerity, Fairness and Inquisitiveness arose as significant predictors of Hypothesis Confidence. However, only Inquisitiveness ( $r = .24, p < .01$ ) also correlated significantly to Hypothesis Confidence. Inquisitiveness is related to an interest in learning and education, in both social and scientific domains (Lee & Ashton, 2004). This project took place in an educational setting in which inquiry is prominent. It is therefore quite unsurprising that a positive relationship

between Inquisitiveness and Hypothesis Confidence emerged.

The narrow Honesty-Humility facets Sincerity and Fairness also arose as significant predictors. Lee and Ashton (2004) consider sincere people as to be genuine in interpersonal relations, whereas fair people are described as being avoidant of fraud or corruption. The significant relationships of both traits with Hypothesis Confidence are solely visible in the regression analysis. Pearson's correlations turned out to be insignificant. Their relationship with Hypothesis Confidence is likely a spurious one, due to their high intercorrelation ( $r = .44, p < .01$ ) causing collinearity (see Figure 4). Although collinearity might be sample-dependent, literature suggests a strong relation between the two traits. Scholars have argued that Sincerity and Fairness relate to the honesty component of Honesty-Humility (Ashton et al., 2004; Ashton & Lee, 2007). Therefore, their strong relationship is not inexplicable. Several authors have proposed using the Variance Inflation Factor (VIF) as a factor for increasing the sample size to avoid collinearity issues (e.g. Hsieh et al., 2003; O'Brien, 2007). A repetition of this research project with a larger sample size could thus result in less collinearity. Without such extra research, it will be uninviting to draw strong conclusions on the actual influences of Sincerity and Fairness on Hypothesis Confidence.

**Figure 4**  
Possible Spurious Relationships of Sincerity and Fairness with Hypothesis Confidence



## 6.5 Personality and Overconfidence

Openness to Experience was indeed negatively correlated to Hypothesis Overconfidence. The higher Need for Closure of people with low openness seems a satisfying explanation. Nevertheless, this correlation was non-significant. Therefore, hypothesis 7 cannot be confirmed convincingly. Inspection of inter-correlation further revealed that Honesty-Humility had a significant negative correlation to Overconfidence ( $r = -.18, p < .05$ ). Honesty-Humility was unrelated to Hypothesis Confidence, but this does not necessarily imply that these scores are realistic (i.e. underconfidence, based on this correlation). Meagher et al. (2015) found that intellectual arrogance (IA) was significantly positively related to academic achievement. At the same time, a relationship with intellectual humility (IH) could not be found (Meagher et al., 2015). Considering this, a very high score on Honesty-Humility might be disadvantageous for confidence (and realism), especially within an educational setting.

Likewise, all of the narrow traits correlate negatively with Hypothesis Overconfidence, although varying on significance level. Literature has suggested that a confidence bias might be rooted in personality (Williams et al., 2002; Schaefer et al., 2004). However, a majority of the presented research regarded confidence biases from the perspective of overconfidence. High Honesty-Humility has consequently been proposed as diminishing overconfident behaviors. In this research project, all measured personality traits seem to be more related to underconfidence than overconfidence. Based on correlations, a strong relationship of Honesty-Humility and Openness to Experience with an overconfidence (bias) cannot be detected.

Finally, it is unclear if confidence biases are caused by problems with estimation or precision. Based on the T-tests and descriptives, we can only say that there exists some overconfidence within the sample. It is unknown if this is caused by attachment to initial assumptions (overprecision) or overestimating performances in the assignments. According to Moore and Healy (2008) this is a well-known problem in (over)confidence research. Although it is fairly measurable to examine if confidence biases exist within a sample, the root-causes are in most cases difficult to assess.

## 6.6 Limitations and Future Directions

Concerning measurements of personality and Hypothesis Confidence, it ought to be considered that participants were either assessed concurrently, or with some days in between. Due to variance in activities, the content validity is unlikely to be threatened. Time threats, such as differences in mood or motivation at varying moments, could have resulted in small bias. Furthermore, measurements were obtained via snapshot survey and one-shot experiments. Longitudinal research should provide more insights to the influences of personality, gender and age on (hypothesis) confidence. Participants were derived from pre-higher education junior high classes. This has resulted in a rather uniform sample. Older children should have a more realistic self-perceptions when it comes to (self-)assessment of personality and confidence. Also, it has yet to be investigated if the results of this study are representative for other types of education among high school students.

The differences in predictive validity using broad or narrow bandwidth in personality traits has been addressed in this study. More research on both bandwidth-fidelity and collinearity within the regression models will be needed. As proposed earlier, research with a larger sample could indicate if intercorrelations have a mathematical (collinearity) or a causal explanation. Also, more research into the specific (antagonistic) relations among the facets needs to be conducted. The educational field has to deal with children differing in personality, which remains a rather complex issue. Permanently acquiring insights into this phenomena is essential, since education should emphasize on dealing with the individual differences of students.

The discussion on the relationship between personality and Hypothesis Overconfidence was fairly exploratory in nature. More (statistical) research, not solely based on correlations, should provide more robust insights into this relationship. Also, the accuracy of the hypotheses had a fixed scale with only three conditions. More differentiation within the accuracy assessment could lead to more detailed insights into overconfidence as well. Lastly, the root-cause for overconfidence is difficult to assess. It is not clear if this should be perceived from an overestimation or overprecision perspective. Solutions can be semi-structured interviews to assess the way how the children approached the assignment. Also, a pre-experimental hypothesis before actually engaging in the

simulations could be helpful. In this way, the differences in pre- and post-experimental hypotheses can be assessed.

## **7 Conclusion**

### **7.1 Resume**

The T-tests, in combination with regression analyses, reveal that gender and age play a significant role in the differences and variance within scores on Hypothesis Confidence. In addition, gender also accounted for significant differences on the scores of Hypothesis Overconfidence. Age arose to be a negative predictor of Hypothesis Confidence in the regression analyses. These results are all in line with the proposed hypotheses 1, 2 and 3. The fourth hypotheses could only be backed up by analysis of correlation, which remained rather weak. The regression analysis with broad traits confirmed a significant positive relation between Openness to Experience and Hypothesis Confidence (hypothesis 5), whereas Honesty-Humility could not be related significantly to Hypothesis Confidence (hypothesis 6). Apart from narrow personality being a significant predictor of Hypothesis Confidence, the incremental variance exceeded that of Hypothesis Accuracy, gender and age as well. This implicates that, at least for some children, personality will have more influence on their confidence in an educational setting than their academic performance. Lastly, although Openness to Experience was hypothesized to have a negative relationship with Overconfidence, their correlation was insignificant (hypothesis 7). Exploring the role of Honesty-Humility, this personality trait did turn out to have a significant negative relationship with Hypothesis Overconfidence. This correlation was much stronger than its correlation with Hypothesis Confidence. This information will lead to recommendations for educational field, intended at generating awareness among educators and children into valid personality

### **7.2 Recommendation for the Educational Field**

In the ideal situation, a research project such as this will lead to the development of an evidence-based program. This program could be developed by an educational scientist. Its main goal should be increasing self-confidence in an educational setting. While developing such a program, three important aspects, derived from this research project, should be considered. Firstly, this project confirms that Hypothesis Confidence is indeed

(partly) personality-rooted. Moreover, this is already visible at a relative young age within this sample. Educators should be aware that confidence in an academic setting is not solely dependent of achievements or feedback. Generating awareness into the existence of various personality characteristics is therefore a valid feature of such a program. Secondly, gender was found to have recurring influence on various variables in the model. It manifested itself as influencing Hypothesis Confidence and Overconfidence as well as being correlated to almost all personality facets. It will therefore be important to take gender differences into account when wanting to increase confidence among children at school. Although it might seem controversial in the eyes of some educators or parents/caregivers, the program should ideally have specific requirements and approaches for boys and girls. Thirdly, realism of confidence has also been explored in this research. Ideally, children will learn to reflect how personality characteristic, such as those of Honesty-Humility and Openness to Experience, are applicable to themselves in educational settings. Children will thus develop more accurate insights into their personality and self-confidence, and how this reflects in their educational task-approaches. In both literature and this research project the inherent relationships of personality, confidence and achievement have been made visible. The implementation of the proposed program will in the long run be beneficial for children's academic achievements as well.

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