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Financial literacy and the role of numeracy–How individuals' attitude and affinity with numbers influence financial literacy

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ABSTRACT

Being financially literate is an important life skill that is equally important for one's own sake as well as for society. Findings indicate that individuals are financially illiterate while interventions to increase the level of financial literacy are ineffective. The effect of financial literacy on financial behavior reported in correlation studies may be driven by some unknown third variable, such as individual cognitive ability. The current study investigated the role of cognitive and emotional factors in attaining financial literacy. In a representative sample of the general population, our regression models indicate that a central component of financial literacy can be traced to numeracy and the emotional attitude towards numbers (i.e. mathematics anxiety). Thus, a driving force behind becoming financially literate resides in the ability to understand numbers and having an emotional attitude towards numbers that does not interfere with an individual's daily engagement in activities involving mathematics and financial decisions.

1. Introduction

As members of today's society we have never been so riddled with difficult financial choices. During the past decades we have been faced with increasingly complex financial products (Lusardi, 2015), such as different mortgage forms, payday loans, student loans, complex retirement plans, credit cards and so on. The financial future is truly in the hand of the single individual. Being *financially literate*, thus being able to make sound financial choices based on basic knowledge of financial concepts, is therefore an important life skill that is equally important for one's own sake as well as for the society in which one is embedded (Lusardi, 2012; Lusardi and Mitchell, 2014). Extant findings indicate that many individuals around the world are financially illiterate, at least when measuring their literacy on measures of financial literacy (e.g., Lusardi and Mitchell, 2014). This is troubling, given the surge in introductions of novel and sophisticated financial products, but also for more basic everyday situations in which individuals and their families are faced with economical decisions that are equally as important as long term financial investments. A natural reaction by policymakers has been to issue different interventions to increase the level of financial literacy through various means, such as financial education and courses (Hilgert et al., 2003; Lusardi and Mitchell, 2007). However, in a recent meta-analysis of 188 studies by Fernandes et al. (2014) in which they analyzed the role of financial literacy and financial education on financial behavior, the results were disheartening; financial literacy could only explain 0.1% of the variance in financial behavior. The authors also noticed a pattern in which correlation studies of financial literacy and outcomes reported larger effect sizes than studies employing interventions of financial literacy (Fernandes et al., 2014). Possible explanations suggested by the authors include that the effect of financial literacy on financial behavior reported in correlation studies may be driven be some unknown third variable, such as individual cognitive ability. This would explain why interventions targeting financial literacy, such as participating in courses in finance and economics, lack potency. Despite the uniform agreement that financial literacy is important for financial behavior and well-being, there are still important questions to be answered. For example, who becomes financially literate and what are the factors and abilities that leads to literacy? In the current study, we investigate these questions and try to identify the purported third variable suggested by Fernandes et al. (2014). To this end, we examine the role of cognitive and emotional factors in achieving financial literacy. We will argue that a substantial portion of financial literacy as a construct may be captured by *numeracy*. Numeracy can be defined as the ability to process basic

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numerical concepts, quantitative estimations, probability, and ratios (Peters et al., 2006; Cokely et al., 2012). Indeed, the predominant way in which financial literacy is measured is through the administration of a three-item pen-and-pencil test requiring participants to correctly answer problems involving various financial concepts and numbers (Lusardi and Mitchell, 2007). The creators of the instrument claim that the test taps into three aspects of financial literacy: (1) Numeracy/knowledge of interest compounding, (2) knowledge of inflation, and (3) knowledge of risk diversification. These questions involve knowledge of financial concepts, such as inflation, interest rates, and risk diversification. But beyond the conceptual understanding, two of these questions require a firm grasp of numbers, percentages, and calculation procedures. Thus, a substantial portion of the construct of "financial literacy" may in fact be explained by numeracy, whereby numeracy may provide the computational engine behind financial decision making based on conceptual knowledge of finance. Indeed, previous research has shown that numeracy is a predictor of financial behavior (Ghazal et al., 2014). What Ghazal and colleagues also found was a link between numeracy, confidence, and deliberation and that each predictor was associated with decision making performance (Ghazal et al., 2014). The purpose of the current study is to investigate the role of these cognitive and emotional factors in attaining financial literacy. In a representative sample of the general population in Sweden, we administered at set of tests that measure various aspects of cognitive abilities and behaviors related to financial literacy. The ambition is to find a candidate for the purported "third variable" that drives financial literacy's success in predicting financial behavior (Fernandes et al., 2014). Given that the effects of interventions of financial literacy are miniscule, we hope to identify alternative targets for interventions that may equip individuals with a more potent tool to achieve financial success and desirable financial behavior. By controlling for age and education, which have been linked to financial literacy previously (Lusardi and Mitchell, 2007), we investigated cognitive aspects, such as numeracy and cognitive reflection (i.e. deliberation), and emotional factors, such as financial anxiety, self-efficacy (i.e. confidence), and math anxiety. Numeracy, cognitive reflection, and confidence have been shown to be predictive of superior decision making (Ghazal et al., 2014), and we expect to find a link to financial literacy. An individual's confidence, or *self-efficacy,* refers to the belief that one can succeed at a given task and that one can cope well with various challenges one might face throughout life (Bandura, 1994; Bandura, 2006) and that one can perform well in a specific domain without being overwhelmed. This optimistic attitude, in the face of possible adversity, may result in diligent and favorable personal financial outcomes. Indeed, financial self-efficacy has been tied to desirable financial behavior independently of financial literacy (Farrell et al., 2016), so we expect that general self-efficacy will be beneficial for attaining financial literacy and that they therefore are related. Cognitive reflection is the mechanism by which intuitive errors are identified and corrected, and scores on the three-item Cognitive Reflection Test (CRT) have been linked to normative decision making (Frederick, 2005). However, the role of cognitive reflection is controversial insofar as the tool to measure it is infected with aspects of numeracy (Weller et al., 2013; Baron et al., 2014), and researchers have found numeracy to be a stronger predictor than the CRT of normative decision making (Sinayev & Peters, 2015).

The emotional aspects, financial anxiety and math anxiety, are hypothesized to interfere independently, through slightly different behavioral mechanisms, with individuals' ability to attain financial literacy. Financial anxiety, measured through questionniare items like "*I get unsure by the lingo of financial experts*", captures the negative feelings associated with inadequacy about financial situations. Math anxiety is typically defined as "…feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations." (Richardson and Suinn, 1972. P. 551). Mathematics anxiety, however, is neither directly related to actual mathematics ability nor general personality traits or anxious dispositions (Ramirez et al., 2013), but rather is a specific negative attitude towards numbers specifically. Math anxiety has consistently been tied to poor math performance and also to indirect life-long effects in terms of education and career choices (Ashcraft, 2002). This effect is thought to be driven by the impairment of working memory resources during mathematical processing (i.e, Ashcraft and Faust, 1994) and recent research has tied math anxiety to basic processing of numbers (Georges et al., 2016; Maloney et al., 2010). Individuals with high math anxiety performed worse than their peers on simple number processing tasks, such as enumeration of items displayed on a computer screen (Maloney et al., 2010). Therefore, we suspect that math anxiety interferes with attaining financial literacy by inhibiting the acquisition of mathematical competency throughout the school years, and we also expect that math anxiety will have a direct influence on everyday economic decision making by impairing working memory performance and manipulation of numbers. Thus, we administered a measure of math anxiety and a measure of financial anxiety to separate these mechanisms.

Theoretically, financial literacy is seen as an investment decision like any other. People will invest in financial literacy if it is assumed to give them a positive return, i.e. the cost of acquiring financial skills is lower than the expected benefit of doing so. Previous literature has argued that the main benefit for investing in financial literacy is increased net returns on investments by making more informed financial choices. Elsewhere we argue that another benefit might be lower financial anxiety. However, financial literacy as a concept on its own has been largely neglected from both a theoretical and an empirical perspective. Many studies have shown the direct effect of financial literacy on different financial behaviors but few have focused on the financial literacy construct in itself. This study therefore makes an attempt to empirically address this question. Since a theoretical framework is lacking we make use of pervious literature to establish what constructs may influence financial literacy in itself rather than financial behaviors.

To forego the results, in this paper we report a multiple regression analysis based on a representative sample of 2,063 individuals. We find that numeracy is the strongest predictor of financial literacy. Also, we find that math anxiety is a stronger predictor of financial literacy than financial anxiety. These two main findings highlight the intimate coupling between financial literacy and affinity with – and emotional attitude towards – numbers. We will end by discussing that by targeting numeracy as an educational intervention, we would not only raise the level of numeracy in the general population, which is a worthwhile endeavor in itself, but we may simultaneously raise the level of financial literacy in society as well. We also highlight that women may be more susceptible to the negative effects of math anxiety on financial literacy.

2. Method

2.1. Participants and procedure

An online survey was created and sent out to a representative sample of Swedish adults (N = 2063, 51% women and 49% men). The survey collected demographic information concerning age, education and income. The mean age in the sample was 49.15 years (SD = 16.10) and 28.4% of the sample had a bachelor's degree or higher. Self-reported monthly income, at the household level, showed that 15% below earned 15 000 SEK before tax and 14% reported having a monthly income exceeding 55 000 SEK. Through the survey platform we also administered a self-report questionnaires regarding attitude towards math (math anxiety) and financial decisions (financial anxiety) and self-efficacy. In the survey we also administered tests measuring numeracy and cognitive reflection ability (CRT). See Appendix A for an overview of the measures used and the percent correct for each item of these instruments.

2.2. Measures of financial literacy, cognitive factors, and emotional factors

2.2.1. Measure of financial literacy

In order to measure financial literacy we included four knowledge based questions (see Appendix A for the questions and response accuracies on these questions). The questions are as follows: 1) "Suppose you had 100 kr in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?", 2) "Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as or less than today with the money in this account?", 3) "Buying a single company's stock usually provides a safer return than a stock mutual fund.", 4) "If interest rates rise, what will typically happen to bond prices?". The first three questions (the same as in Lusardi and Mitchell, 2014) test very basic financial knowledge, the first one is a simple numeracy/interest rate question, the second one is tests the subject's knowledge about inflation. The third question asked about the concept of diversification. The last question is a bit more advanced testing the participant's knowledge about the relationship between bond prices and interest rate. All questions have been used in previous studies, for example by Van Rooij et al.(2012). The total number of correctly answered questions (0–4) was used as an index of financial literacy. Cronbach's alpha for this composite measure showed an internal consistency of 0.56.

2.2.2. Measure of cognitive reflection

To measure cognitive reflection, or deliberation, we administered the CRT containing the three original items from Frederick (2005). The problems are phrased in such a way that intuitive but wrong solutions have to be inhibited and overridden. The questions are the following: 1) "A bat and a ball cost $1.10. The bat costs $1.00 more than the ball. How much does the ball cost?", 2) "If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?", 3) "In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?". The number of correctly answered problems was used as an index of cognitive reflection ability. Cronbach's alpha was calculated and showed a reliability coefficient of 0.63

2.2.3. Measure of numeracy

Numeracy was measured using a combined score of the three items from Schwartz et al. (1997) and with the Berlin Numeracy Test (BNT), developed by Cokely et al. (2012) and validated in Swedish by Lindskog et al. (2015). This scale was chosen since it specifically tests statistical numeracy and risk literacy, both of importance when dealing with financial issues. The combination of the questions from Schwartz et al. (1997) and the BNT was used due to the investigation of a representative sample of the general population, whereas the BNT was primarily developed to assess numeracy in educated samples. The combined use of these instruments has also been advocated by Cokely et al. (2012). The BNT consists of four items (see Appendix A) amounting for a total of 7 numeracy problems to be solved. Cronbach's alpha was calculated at 0.58, which is similar to other numeracy measures (Lipkus, Samsa, & Rimer, 2001) and the BNT (Cokely et al., 2012).

2.2.4. Measures of anxiety and self-efficacy

Emotional attitude towards mathematics and numbers was assessed using a subset of questions from the *Mathematics Anxiety Scale-UK* (MAS-UK; Hunt et al., 2011). The MAS-UK is a questionnaire containing a number of statements concerning varying situations such as *"I feel worried when working out how much change a cashier should have given me in a shop after buying several items."*. The respondent then indicates on a Likert type scale from 1 ("*Not at all*") to 5 ("*Very much*") how worried they feel in the corresponding situation. We included five items from the MAS-UK. The total sum of the responses was used as an index of math anxiety. Cronbach's alpha was 0.91.

Similarly, financial anxiety was measured using a four item questionnaire containing statements that the respondent had to indicate the degree to which they agree on a 5-point Likert scale. The financial anxiety scale was developed by Fünfgeld and Wang (2009) and contains statements like "*I am anxious about financial and money affairs"* and "*I get unsure by the lingo of financial experts"*. The sum of the responses was used an index of financial anxiety. Cronbach's alpha was calculated at 0.67.

Self-efficacy was measured using a subset of questions from the questionnaire developed by Schwarzer et al. (1997). Five items were used and took the form of statements like "*Thanks to my resourcefulness, I know how to handle unforeseen situations*" and *"When I am confronted with a problem, I can usually find several solutions."* The participants had to indicate from 1–4 whether they agree or not and the sum of the responses was used as an index of self-efficacy. Cronbach's alpha was calculated at 0.77.

3. Results

When analyzing the regression model we ensured that multi-collinearity was not an issue. The Variance Inflation Factor (VIF) was below 1.70 and tolerance was above 0.88. Means and standard deviations for all measures and the correlations between them can be found in Table 1. See also Appendix B for a supplementary table and a figure showing summary statistics. The baseline regression simply includes the control variables of age, income, gender and education, represented by a vector X_i:

$$Finlit_i = \beta X_i + u_i$$

Previous studies have shown that women, elderly people and low income groups have particularly low levels of financial literacy.

Table 1
Descriptive statistics, and correlations among the measures. Significant correlations in bold ($p < 0.001$).

Tasks	*M*	*SD*	2	3	4	5	6	7	8	9
1. Age (in years)	49.13	16.14	−0.01	**−0.14**	**.20**	**−0.06**	−0.02	**.10**	**−0.16**	**−0.30**
2. Income	3.79[a]	2.31	–	**.25**	**.19**	**.18**	**.15**	**.20**	**−0.15**	**−0.17**
3. Education	3.30[b]	1.36		–	**.24**	**.28**	**.23**	**.14**	**−0.09**	**−0.12**
4. Financial literacy	2.07	1.16			–	**.52**	**.42**	**.19**	**−0.21**	**−0.37**
5. Numeracy	2.54	1.87				–	**.61**	**.09**	**−0.12**	**−0.32**
6. Cognitive reflection task (CRT)	0.90	1.02					–	**.08**	**−0.11**	**−0.31**
7. Self-efficacy	14.19	2.22						–	**−0.20**	**−0.26**
8. Financial anxiety	8.72	2.58							–	**.36**
9. Mathematics anxiety	10.39	5.26								–

[a] Aggregated household income is measured from 1(<15.000 SEK) to 8(>75.000 SEK).
[b] Education is measured from 1 (elementary school) to 5 (Bachelor's degree or more).

Table 2
Financial literacy score is used as the dependent variable in all specifications. Last tgree columns include interaction terms of gender, income and CRT.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8) Standardized variables	(9)	(10)	(11)
Numeracy score		0.278***					0.224***	0.360***	0.225***	0.224***	0.224***
		(0.0115)					(0.0140)	(0.0140)	(0.0141)	(0.0140)	(0.0140)
CRT score			0.372***				0.124***	0.109***	0.125***	0.122***	0.161***
			(0.0216)				(0.0244)	(0.0244)	(0.0244)	(0.0244)	(0.0297)
Self-efficacy				0.0522***			0.0343***	0.0661***	0.0343***	0.0354***	0.0338***
				(0.0108)			(0.00956)	(0.00956)	(0.00955)	(0.00945)	(0.00953)
Math anxiety					−0.0520***		−0.0156***	−0.0705***	−0.0129*	−0.0158***	−0.0158***
					(0.00484)		(0.00475)	(0.00475)	(0.00696)	(0.00474)	(0.00474)
Financial anxiety						−0.0381***	−0.0216***	−0.0593***	−0.0217***	−0.0291***	−0.0211***
						(0.00781)	(0.00694)	(0.00694)	(0.00695)	(0.00862)	(0.00695)
Math anxiety*female									−0.00444		
									(0.00819)		
Financial anxiety*Low Income[a]										0.0176	
										(0.0136)	
CRT score*female											−0.0835**
											(0.0388)
Female	−0.692***	−0.427***	−0.541***	−0.678***	−0.603***	−0.657***	−0.373***	−0.160***	−0.327***	−0.381***	−0.301***
	(0.0467)	(0.0431)	(0.0450)	(0.0465)	(0.0462)	(0.0472)	(0.0429)	(0.0429)	(0.0917)	(0.0428)	(0.0578)
Age	0.0143***	0.0162***	0.0148***	0.0136***	0.00933***	0.0131***	0.0133***	0.184***	0.0133***	0.0133***	0.0133***
	(0.00147)	(0.00130)	(0.00139)	(0.00147)	(0.00155)	(0.00151)	(0.00137)	(0.00137)	(0.00137)	(0.00135)	(0.00136)
Upper secondary education	0.317***	0.185***	0.250***	0.302***	0.276***	0.316***	0.165**	0.070**	0.164**	0.163**	0.164**
	(0.0772)	(0.0689)	(0.0723)	(0.0765)	(0.0748)	(0.0768)	(0.0670)	(0.0670)	(0.0671)	(0.0671)	(0.0670)
University education < 3 years	0.603***	0.360***	0.480***	0.576***	0.527***	0.588***	0.316***	0.097***	0.314***	0.319***	0.318***
	(0.0882)	(0.0802)	(0.0832)	(0.0876)	(0.0862)	(0.0881)	(0.0788)	(0.0788)	(0.0789)	(0.0792)	(0.0788)
University educatio > =3 years	0.791***	0.435***	0.565***	0.754***	0.686***	0.772***	0.361***	0.139***	0.360***	0.371***	0.357***
	(0.0811)	(0.0738)	(0.0778)	(0.0809)	(0.0799)	(0.0811)	(0.0724)	(0.0724)	(0.0725)	(0.0723)	(0.0724)
Income 15 000–24 999 SEK	0.120	0.0862	0.118	0.0844	0.0870	0.112	0.0534	0.0186	0.0526		0.0534
	(0.0806)	(0.0724)	(0.0758)	(0.0807)	(0.0793)	(0.0808)	(0.0722)	(0.0722)	(0.0723)		(0.0721)
Income 25 000–34 999 SEK	0.103	0.0159	0.0647	0.0569	0.0557	0.0819	−0.0371	−0.0127	−0.0373		−0.0353
	(0.0816)	(0.0722)	(0.0758)	(0.0820)	(0.0797)	(0.0818)	(0.0719)	(0.0719)	(0.0719)		(0.0718)
Income 35 000–44 999 SEK	0.312***	0.205***	0.269***	0.262***	0.248***	0.281***	0.143*	0.042*	0.144*		0.144*
	(0.0894)	(0.0776)	(0.0851)	(0.0892)	(0.0870)	(0.0891)	(0.0777)	(0.0777)	(0.0778)		(0.0775)
Income 45 000–54 999 SEK	0.303***	0.106	0.164*	0.249**	0.193**	0.282***	0.0169	0.004	0.0163		0.0148
	(0.0990)	(0.0884)	(0.0928)	(0.0993)	(0.0978)	(0.0994)	(0.0889)	(0.0889)	(0.0888)		(0.0891)
Income 55 000–64 999 SEK	0.252**	0.0867	0.171*	0.194*	0.160	0.208**	0.000261	0.000061	0.00126		−0.00274
	(0.0998)	(0.0894)	(0.0933)	(0.101)	(0.0972)	(0.100)	(0.0889)	(0.0889)	(0.0889)		(0.0888)
Income 65 000–74 999 SEK	0.472***	0.327***	0.393***	0.395***	0.366***	0.426***	0.219**	.0443**	0.220**		0.222**
	(0.106)	(0.0946)	(0.0990)	(0.107)	(0.106)	(0.106)	(0.0937)	(0.0937)	(0.0938)		(0.0937)
Income >75 000 SEK	0.295***	0.161*	0.245**	0.219**	0.201**	0.250**	0.0667	0.0160	0.0672		0.0633
	(0.103)	(0.0908)	(0.0950)	(0.104)	(0.0996)	(0.103)	(0.0912)	(0.0912)	(0.0913)		(0.0910)
Low income[a]										−0.216	
										(0.161)	
Observations	2060	2060	2060	2060	2060	2060	2060	2060	2060	2060	2060
R-squared	0.215	0.384	0.310	0.224	0.261	0.225	0.409	0.409	0.409	0.406	0.410

Robust standard errors in parentheses.
[a] = Low income coded as being included in the two lowest levels of income.
*** p < .01.
** p < .05.
* p < .1.

Therefore we expect the coefficient on gender and age to be negative and positive for increased levels of income. To investigate whether the relative contribution of numeracy, cognitive reflection, and the emotion measures goes above and beyond age, income, gender and education, we performed OLS regression according the following model specification:

$$Finlit_i = \beta_1 Numeracy_i + \beta_2 CRT_i + \beta_3 Self\ efficacy_i + \beta_4 Math\ anxiety_i + \beta_5 Financial\ anxiety_i + \beta X_i + u_i$$

where X_i is a vector of control variables including age, education, income and gender. Previous studied have shown that women, elderly people and low income groups have particularly low levels of financial literacy. Therefore we expect the coefficient on gender and age to be negative and positive for increased levels of income. We expect the coefficients of numeracy, cognitive reflection and self-efficacy to have a positive sign, with an unknown effect size. The sign for math anxiety should be negative.

3.1. Regression analysis of financial literacy

Table 2 summarizes the results of the regression analysis of financial literacy. The relationship between years of education and financial literacy has been established previously by Lusardi and Mitchell (2007). The authors divided their respondents into four groups depending on their degree of education: Less than high school, high school, some college, and college or more. The groups differed on all items of financial literacy, but the lowest group with no high school diploma fared substantially worse than the other groups (Lusardi and Mitchell, 2007). In our data, we could find the same general pattern. Age and education was positively related with financial literacy. The first model, which included age, gender, income and education, resulted in $R^2 = 0.22$ explaining variation in financial literacy. Above and beyond those 22% of the variance that were explained by our first model, the second model included the cognitive and emotional factors account for an additional 19%, $\Delta R^2 = 0.19$. Thus, the final model explains a total of 41% of the variance, $R^2 = 0.41$. Looking at the standardized beta weights in the final model (column 8 in Table 2), numeracy contributes the most to financial literacy ($\beta = 0.36$), followed by age ($\beta = 0.18$) and gender ($\beta = -0.16$). Given that we find that numeracy is the strongest predictor of financial literacy even when already including education and income in our model, our results are congenial with Grohmann et al. (2015). The cognitive reflection task, measuring deliberation, also contributed to financial literacy ($\beta = 0.11$), after inclusion of numeracy in the model. But it did not predict financial literacy nearly to the same extent as numeracy. Interestingly, mathematics anxiety was significantly related to financial literacy ($\beta = -0.07$), even after the inclusion of financial anxiety ($\beta = -0.06$) and self-efficacy ($\beta = 0.07$).

To investigate whether the relationship between financial anxiety and financial literacy was moderated by income level, we calculated a multiple regression model in which we input two centered variables (financial anxiety and income) and the interaction term (financial anxiety × income) in a model to see whether the interaction term was significant beyond financial anxiety and income. The model showed significant main effects of both financial anxiety and income (both $p < 0.001$), but we found no significant interaction effect ($p = .195$). This suggests that financial anxiety affects financial literacy irrespective of income level. The same procedure was used to investigate whether gender played a role in the relationship between math anxiety and financial literacy. Thus, we calculated an interaction term (gender × math anxiety) and inserted it in a multiple regression model together with the main effects of gender and math anxiety as predictors of financial literacy. We found significant main effects of both gender and math anxiety (p's < 0.001) but no significant interaction effect ($p = .588$). With respect to the CRT, studies have found systematic gender differences where men tend to perform better than women (Brañas-Garza et al., 2015). Studies also indicate that there is a biological link between CRT and gender, driven by prenatal exposure to testosterone (Bosch-Domènech, Brañas-Garza, and Espín, 2014) so we investigated whether there was an interaction effect of gender and CRT. Indeed, the interaction term (gender × CRT) was significant ($p < .05$) indicating that the effect of CRT on financial literacy was more pronounced in females.

To further investigate the role of certain predictors, we looked into the correlations between predictors. Noteworthy is the fact that CRT and numeracy show a strong correlation ($r = 0.61$, $p < .001$), and that there is a moderate correlation between math anxiety and financial anxiety ($r = 0.36$, $p < .001$). In addition, math anxiety correlates with numeracy even when controlling for financial anxiety ($r = -0.30$, $p < 0.001$) and that math anxiety correlates with financial literacy while controlling for financial anxiety and self-efficacy ($r = -0.30$, $p < .001$). As a brief summary of the results, it is clear that affinity with, and attitude towards, numbers are closely tied to attaining financial literacy. Financial literacy, numeracy, and cognitive reflection are believed to be separate constructs or skills, they are all measured using scales containing problems involving numbers. Interestingly, mathematics anxiety is negatively related to financial literacy even when taking finanical anxiety into account. In addition, these predictors show a significant relationship while including age, gender, income, and education in the model. This further reinforces the interpretation that the ability to process numbers and ratios, as well as the emotional attitude towards numbers specifically, is a key component of attaining financial literacy. These findings and what they might entail for our understanding of financial literacy is further discussed below.

4. Discussion

The objective of the current study was to examine the role of cognitive and emotional factors in achieving financial literacy while controlling for known predictors such as age, income, gender, and education. Illuminating the role of specific predictors could give insight as to why interventions aimed at increasing financial literacy in the population seemingly fail at establishing a long-term effect.

The final model, which included the cognitive factors, as significantly predictive of finanicial literacy where the most noteworthy contribution was made by numeracy. The link between numeracy and financial literacy is not new (e.g., Lusardi, 2012) and Grohmann et al. (2015) found that numeracy mediated the influence of financial socialization, education quality, and economics education on financial literacy. Whether cognitive reflection and numeracy are separate constructs or whether they measure the same underlying latent factor is currently being debated (cf. Liberali et al., 2012), but a recent paper argues that normative decision making skills and financial outcomes are due to numeracy rather than cognitive reflection (Sinayev and Peters, 2015). In our representative sample, we find a strong correlation between CRT scores and numeracy ($r = 0.61$, $p < 0.001$) and CRT and the zero-order correlation and the added contribution of the model indicates that the CRT and numeracy scale tap substantially into intersecting cognitive components. In all likelihood, the ability to detect and inhibit intuitive errors in reasoning, being able to make deliberate computations (i.e. cognitive reflection) and understanding and using numbers (i.e. numeracy) are foundational capacities for acquiring financial literacy. Even though financial literacy, numeracy, and cognitive reflection are believed to be separate constructs or skills, they are all measured using scales in which problems concerning numbers are used. The financial literacy scale taps into both conceptual knowledge of financial matters (e.g., interest rate and inflation) and matematical operations (ratios and percentages), as well as the computational capacity to solve the numerical problems (e.g., attention, effort, and deliberation). As these constructs are currently measured, the predictive component of these variables to

normative decision making and financial success is likely driven by being able to understand numerical concepts. Future studies should also investigate the extent to which other cognitive and emotional variables also predict financial literacy. Our final model resulted in $R^2 = 0.41$, which means that there are other unexplored variables that may predict financial literacy. For example, it may be the case that measures of executive function, which is a cognitve measure of inhibitory control, working memory resources, and shifting between tasks and strategies, could be a potent predictor of financial literacy. We included the CRT as an index of deliberation and inhibition of intuitive responses, which likely taps into executive functions (e.g., Sinayev and Peters, 2015). Additional mechanisms mediating the link between CRT, gender and financial literacy are also plausible, and it has been suggested aspects of impatience (Bosch-Domènech et al., 2014) or time preference (Fredericks, 2005) may drive some of these effects. Thus, it is important to tease apart the biological mechanisms and psychological constructs that we use to identify the mechanisms by which they affect financial literacy (cf. Bosch-Domènech et al., 2014; Brañas-Garza et al., 2015). Nevertheless, financial literacy should be more throughly investigated within a lab setting, allowing for administration of supervised traditional cognitive performance instruments, such as working memory, intelligence, and other executive functions. Still, the downside to such an approach is the loss of power that results from more laborious participant recruitment and data collection. However, to obtain a more nuanced and better understanding of financial literacy we should employ complementary approaches, utilizing both lab studies with an increase in rigorous testing and experimental control, and survey studies, such as the current study, which allows for easier participant recruitment and ease of data collection. Future studies should also examine the degree to which the current findings extend to other measures of financial literacy, such as the instrument developed by Fernandes et al. (2014) that contains items less infused with numerical information and calculations. Fernandes et al. (2014) also highlighted the likelihood that financial literacy's predicitive power of down-stream economic behavior may be driven by extraneous factors, such as numeracy and confidence with information search. Thus, we corroborate Fernandes et al. (2014) and urge for follow-up studies to disentangle to the role of cognitive, emotional, and motivational factors.

The interpretation that affinity with numbers is the critical ingredient in achieving financial literacy is reinfored by our current model in which mathematics anxiety is negatively related to financial literacy even when taking finanical anxiety into account. Financial anxiety, measured through items like "*I get unsure by the lingo of financial experts*", captures the negative feelings associated with inadequacy about financial situations. Mathematics anxiety, however, is neither directly related to actual mathematics ability nor general personality traits or anxious dispositions (Ramirez et al., 2013), but rather is a specific negative attitude towards numbers specifically. Financial literacy is therefore predicted by the cognitive aspect of numeracy, which entails being capable of understanding and using numbers, and the emotional aspect of numbers, which is more concerned with the strong negative emotion that is felt as soon as an individual engages in an activity involving numbers (Ashcraft and Faust, 1994). The negative feelings of anxiety during math calculations take up working memory resources that in turn impedes performance. Research indicates that math anxiety persists into adulthood because of avoidance behavior of engagement in daily activities and decisions that require arithmetic (Hembree, 1990; Krinzinger et al., 2009). Impaired working memory capacity when doing calculations in the context of financial matters and everyday economic decisions is surely something that interferes with attaining financial literacy. In the same vein, if the negative feelings associated with numbers and mathematics are so distressful that individuals prefer to avoid engaging in financial decision-making, this will likely have a deleterious effect on both attaining financial literacy to begin with and also have a more direct influence *in situ* on financial behavior (e.g., not paying a bill). So while everyone agrees that educational policies should be formed that raises the level of financial literacy in individuals and in society as a whole, the question remains as to what the most effective course of action is. Financial education, in various forms, have been tried and tested in both schools (Cole et al., 2015) and at work places (Lusardi, 2004) but the meta-analysis made by Fernandes et al. (2014) indicates that the interventions are ineffective. The source behind the lack of potency of these interventions is unclear, but one interpretation is that the interventions are not targeting the underlying factor that drives the correlation between financial literacy and desirable financial behavior. In the light of the current results and our model, we argue that a candidate mechanism that is responsible for desirable economical decision making and downstream financial behavior can be traced to individuals' ability to use and understand numbers. Corroborating this notion, Cole et al. (2015) investigated whether changes in high school curricula could have an impact on financial outcomes, which it did. However, personal finance courses had no effect on financial outcomes, but mathematics training lead to improvements on several indices of positive financial behavior and outcomes (Cole et al., 2015). It should be noted that this effect could be found in high school students, whose mathematical skills and cognitive maturity are non-rudimentary, so the effects of interventions on mathematics on younger students enrolled in elementary school are plausibly even larger. Research indicates that math anxiety starts in early childhood and persists into adulthood (Hembree, 1990), so targeted mathematics interventions early in the educational system could strengthen mathematics ability while ameliorating the negative emotions that hamper the acquisition of financial literacy and financial outcomes. Addressing math anxiety as early as possible is important because of the risk that math anxiety may snowball in ways that lead to increased anxiety, dislike, and avoidance of math (Wigfield and Meece, 1988).

It stands to reason, however, that both knowledge about financial concepts and the ability to use said concepts for making calculations are imperative for financial literacy, economic outcomes and well-being. Nevertheless, if we are to implement targeted interventions that are designed to increase the level of financial literacy in the general population, these interventions must be directed at the active ingredient in achieving financial literacy. Given that previous intervention studies and meta-analyses indicate that the interventions have been misdirected (e.g., Cole et al., 2015; Fernandes et al., 2014) we suggest that resources be directed towards enhancing knowledge of mathematics to increase numeracy rather than financial literacy. Our current model of predictors of financial literacy, together with the fact that two questions on the financial literacy scale require a firm grasp of numbers, percentages, and calculation procedures, supports the interpretation that numeracy is a critical factor. While knowledge of financial concepts, such as inflation and risk diversification, is undoubtedly important for being financially literate, if individuals cannot do basic calculations, understand ratios and percentages, any conceptual knowledge of financial matters acquired will be rendered moot. Arguably, numeracy provides the computational engine behind financial decision-making based on conceptual knowledge of finance. If we can redistribute the real costs and opportunity costs of financial education and courses and instead ensure that the most vulnerable socioeconomic groups in society learn basic mathematics in schools, much is to be gained for both individuals and society as a whole. The overall value of having adequate mathematics abilities cannot be overstated and studies have shown that lacking mathematics ability was even more detrimental to health and income than being unable to sufficiently read and write (Parsons and Bynner, 2005). Another study has estimated the societal costs of insufficient mathematics abilities in the population to be around £2.5 billion (Gross et al., 2009). By increasing the level of numeracy in the population, by as little as one half of a standard deviation, will increase the country's GDP per capita by 0.86% (OECD, Paris, 2010). Thus, targeting numeracy as a plausible mechanism to simultaneously raise the level of financial literacy in society

is relevant to policymakers. Although Cole et al. (2015) found that mathematics training lead to improvements on several indices of positive financial behavior, one limitation is that current study is correlational in nature. In addition, and as mentioned earlier, we utilized a limited test battery of cognitive abilities and emotional factors that we hypothesized to predict financial literacy. This is in all likelihood not an exhaustive set variable that ultimately influence financial literacy. With respect to the current analyses, this also raises the issue of endogeneity, in so far as that there may be other unobserved variables drive the observed effects. As such, these findings should be investigated in conjunction with other important cognitive and emotional constructs that also may be involved in achieving financial literacy in controlled experimental settings. Still, future studies should also tease out what aspects of mathematics and basic number skills are pertinent to achieving numeracy and, in the end, financial literacy. For example, how important is just having a firm grasp of basic arithmetic? How important is understanding of ratios and percentages or having a good grasp probability? Previous researchers have highlighted the fact that scales and tools to measure different cognitive constructs, such as cognitive reflection and numeracy, to a large extent involve overlapping cognitive processes such as reflection and the processing of numbers (e.g., Liberali et al., 2012). The tool for measuring financial literacy, although informative, likely suffers from the same impurities as the CRT and the numeracy task. Echoing Sinayev and Peters (2015), we urge for efforts of refining these tools to better capture the essence of the underlying constructs that we are interested in, to increase both validity and reliability. An example would be to develop additional items on the financial literacy scale that do not involve doing mathematical calculations. Being fluent with numbers is undeniably part of being financially literate, so we are not questioning the validity of the financially literacy scale by having items involving numbers, but if we want to understand the underlying abilities and processes that leads to financial literacy, we should expand our toolbox to include finer instruments.

In sum, we argue that a driving force behind becoming financially literate resides in the ability to understand numbers and having an emotional attitude towards numbers that does not interfere with an individual's daily engagement in activities involving mathematics and financial decisions. Thus, by targeting numeracy as an educational intervention, we would not only raise the level of numeracy in the general population, which is a worthwhile endeavor in itself, but we may simultaneously raise the level of financial literacy in society as well. This potential dual-effect of increasing numeracy in the population is worthy of further exploration.

Appendix A. Overview of measures in the current study

Table A1
Table A1. Items included in the measures of Financial literacy, Numeracy, and CRT.

	Financial literacy	Percent correct answers
1	Suppose you had 100 kr in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?	77.2
2	Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy more than, exactly the same as or less than today with the money in this account?	63.1
3	Buying a single company's stock usually provides a safer return than a stock mutual fund.	51.0
4	If interest rates rise, what will typically happen to bond prices?	15.7
	Numeracy	Percent correct answers
1	*Imagine that we throw a fair coin 1000 times. How many times do you think the coin will show tails?	67.1
2	*In a small American lottery the chance of winning 10 $ is 1%. What is your best guess about how many people will win the 10 dollar prize if 1000 people each by a single ticket?	62.2
3	*In another lottery the chance of winning a car is 1 in 1000. What percent of tickets win a car?	49.9
4	*Out of 1,000 people in a small town 500 are members of a choir. Out of these 500 members in the choir 100 are men. Out of the 500 inhabitants that are not in the choir 300 are men. What is the probability that a randomly drawn man is a member of the choir? Please indicate the probability in percent	22.7
5a	#Imagine we are throwing a five-sided die 50 times. On average, out of these 50 throws how many times would this five-sided die show an odd number (1, 3 or 5)?	25.9
5b	+Imagine we are throwing a loaded die (6 sides). The probability that the die shows a 6 is twice as high as the probability of each of the other numbers. On average, out of these 70 throws how many times would the die show the number 6?	32.5
6	¤In a forest 20% of mushrooms are red, 50% brown and 30% white. A red mushroom is poisonous with a probability of 20%. A mushroom that is not red is poisonous with a probability of 5%. What is the probability that a poisonous mushroom in the forest is red?	41.0
	Cognitive reflection	Percent correct answers
1	A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?	19.5
2	If it takes 5 machines 5 min to make 5 widgets, how long would it take 100 machines to make 100 widgets?	39.1
3	In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	30.9

Note: *Shown to whole sample #shown to those who answered numeracy question 4 incorrectly
+Shown to those who answered numeracy question 4 correctly ¤shown to those who answered numeracy question 5b correctly.

Table A2
Items included in The Financial Anxiety Scale (FAS) and The Financial Security Scale (FSS).

The Financial Anxiety Scale (FAS), Cronbach's α = 0.68

	Mean	St. Dev	Range
1 I get unsure by the lingo of financial experts	3.14	1.12	1–5
2 I am anxious about financial and money affairs	2.88	1.08	1–5
3 I tend to postpone financial decisions as long as possible	2.51	1.18	1–5
4 After making a decision, I am anxious whether I was right or wrong	2.70	1.12	1–5
FAS average	**2.81**	**0.80**	**1–5**

Self-efficacy

	Mean	St. Dev	Range
I can always solve difficult problems if I try hard enough	3.01	0.57	1–4
If someone opposes me I usually find other solutions to get what I want	2.67	0.65	1–4
I find it easy to reach the goals I have set for myself	2.75	0.63	1–4
I am sure that I will be able to effectively handle unexpected situations, should they arise	2.81	0.65	1–4
When I am faced with a problem I can usually find several solutions to it	2.93	0.61	1–4
FAS average	**2.84**	**0.45**	**1–4**

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socec.2018.03.004.

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