Studia Psychologica, Vol. 60, No. 3, 2018, 137-149 doi: 10.21909/sp.2018.03.758

Memorizing 2D Tactile Right-Angle-Shapes by Congenitally Blind and Sighted Adults

Magdalena Szubielska, Emilia Zabielska-Mendyk
The John Paul II Catholic University of Lublin
Lublin, Poland

The study was designed to compare the ability of congenitally blind and sighted individuals to memorize embossed 2D right-angle-figures with varied number of angles displayed against a grid or in a frame. We hypothesized that blind adults learn embossed shapes: 1) faster than sighted participants – this assumption was verified positively; 2) more accurately – which was not confirmed. The grid interfered with sighted people in solving the task, but it had no impact on the performance of participants with blindness. These results can be explained by referring to the memorizing strategies used by those who do and do not have visual experience. Sighted individuals use visual strategies more often than congenitally blind participants. The strategies identified in both groups were used either in isolation or in combination with a verbal or a kinesthetic strategy.

Key words: visuo-spatial processes, touch, imagery strategies, blindness

The purpose of this study was to examine the ability of congenitally blind and sighted individuals to memorize spatial information presented in the form of raised-line images of geometric patterns – right-angle-shapes, with varying numbers of angles presented against a grid or in a frame. We were particularly interested in the amount of time needed for learning the tactile figures, the shapes recognition accuracy, and the mental imagery strategies used by both groups.

Acknowledgments
This work was supported by Ministry of Science and Higher Education, Poland, grant no. N N106 064235. We want to thank Marcin Machowski for his help in data collection and Professor Bogusław Marek and his team for their help in preparing the tactile stimuli.

Correspondence concerning this article should be addressed to Magdalena Szubielska, Ph.D., The John Paul II Catholic University of Lublin, Institute of Psychology, Aleje Raclawickie 14, Lublin, 20-950, Poland. E-mail: magdasz@kul.pl

Received August 3, 2017

Previous research findings show differences between blind and sighted individuals in the processing of two-dimensional shapes explored by touch, interestingly often suggesting blind participants' advantage in this matter. Blind participants are more successful than sighted participants in differentiating two-dimensional angles (Alary et al., 2008), identifying curvatures (Davidson, 1972), naming basic embossed geometrical figures (i.e., square, rectangle, triangle) (Theurel et al., 2012), distinguishing a figure from the background and naming incomplete raised-line shapes (Ballesteros et al., 2005). Furthermore, in comparison to sighted individuals, blind participants are faster to match shapes of geometrical figures to their cut-outs in a board (Postma et al., 2007) and to distinguish figures embedded against a background in raised-line drawings (Heller et al., 2003). The above advantages of blind over sighted individuals in the processing of two-dimensional haptic stimuli may be associated with experience in using tactile aids and with the practice of active exploratory strategies (cf. D'Angiulli &

Kennedy, 2001; Davidson, 1972; Perkins & Gardiner, 2003; Russier, 1999; Symmons & Richardson, 2000), as well as greater haptic sensitivity of blind than sighted participants (Sathian & Prather, 2006). In view of the blind individuals' capacities related to the processing of shapes perceived haptically, we predict that: (H1) Congenitally blind participants learn 2D embossed right-angle-shapes faster than sighted individuals.

Blind participants are as successful as sighted individuals in tasks involving retention of a spatial haptic stimulus in working memory (cf. Cornoldi & Vecchi, 2003; Vecchi, 1998; Vecchi, Monticell, & Cornoldi, 1995). Research into recognition of two-dimensional shapes established that congenitally blind individuals recognize shapes equally accurately (Bailes & Lambert, 1986; Picard et al., 2010), or indeed more accurately (Pathak & Pring, 1989 – the study of children), in comparison to blindfolded sighted participants. Due to the haptic perception and recognition capacities in people who are blind, we predict that: (H2) Congenitally blind participants recognize 2D embossed right-angle-shapes more accurately than sighted individuals.

Vecchi, Monticelli and Cornoldi (1995) conducted a series of experiments investigating variables affecting visuo-spatial working memory capacity. They claim that visuo-spatial working memory has two components, a passive store and active imagery operations. Their first experiment consisted of two stages and involved blind and sighted participants. The stimuli consisted of a 5 x 5 two-dimensional matrix of squares. During the first stage, participants performed two types of tasks in succession: 1) an active pathway task, which involved tracking a verbally presented pathway through a matrix; 2) a passive positions task, which involved memorizing the spatial position of squares presented in a matrix explored through touch. In the active pathway task, blind participants were less successful than sighted participants in identifying the final position of the target when the task was more complex, i.e. the pathway involved more movements in the 2D matrix. In the passive positions task, the increasing complexity impaired the performance in both groups: memory for the spatial configuration was better when it comprised four targets rather than eight. During the second stage, participants had to perform the two tasks (active pathway and passive positions) simultaneously. In the active pathway task, differences in the performance of the blind and sighted participants can clearly be seen – blind participants performed this task significantly worse than sighted participants. This result is in line with other studies using tasks requiring active visuo-spatial working memory, which have shown that such tasks present a greater challenge to blind participants than sighted participants (cf. Cornoldi & Vecchi, 2003; Vecchi, 1998). In the dual task condition, performance on the passive positions task was influenced by memory load in the sighted group only. When they had to remember five target objects the performance of the active pathway task was worse than when they only had to remember two, whereas the blind group performed similarly in both conditions. The results of this second stage suggest that blind people find retaining a spatial stimulus in working memory a relatively easy task, regardless of the complexity of the additional active task. In our study, the recognition task can be treated as a dual task situation – it requires retaining the representation of a model figure in memory (passive task) and creating a representation of a test figure explored by touch (active task – due to the sequentiality of haptic cognition, the creation of mental representation requires the assembling of elements into a whole). Despite the active nature of creating a mental representation of the haptic pattern, blind people cope with such tasks as well or even better than sighted people (cf. Ballesteros et

al., 2005; Theurel et al., 2012). Therefore, we expect that: (H3) Only sighted participants more accurately recognize 2D tactile right-angle-shapes with fewer angles, compared to a greater number of angles (we do not predict the same difference in participants with blindness).

The blind group's performance on the passive positions tasks (both alone and in the dual task condition) was somewhat inconsistent (Vecchi et al., 1995). When performing the task alone, blind participants did less well in the complex condition, whereas in the dual task stage their performance was similar in the simple and complex stimulus conditions. However, the number of target objects to be retained in memory in the simple and complex conditions differed in the single and dual task conditions (single task: 4 and 8; dual task: 2 and 5). This, together with the difference in experimental procedure, makes direct comparison problematic. It is possible that the memory load only affects the passive component of visuo-spatial working memory when the number of elements to be remembered exceeds Miller (1956) the "magic" number (7). This is the maximum number of elements that can be held in working memory efficiently.

While comparing the function of visuo-spatial working memory in congenitally blind and in sighted individuals, we should consider mental strategies employed by these two populations. In experiments known to us, where researchers investigated strategies used by blind and sighted participants to encode raised-line patterns and retain these in memory, i.e. in tasks engaging the passive component of visuo-spatial working memory, no relationships were identified between the applied strategy and accuracy of the pattern recognition (Lebaz, Picard, & Jouffrais, 2010; Picard et al., 2010). These studies suggest that sighted participants tend to more often employ visual strategies, i.e. visuo-spatial strategy alone or in combination with verbal or kinesthetic strategy. On the other hand blind individuals (studies have focused on both early and late blind participants) prefer non-visual strategies, i.e. spatial, kinesthetic and verbal, each of these may be employed either as a leading strategy or in combination with one of the remaining strategies. Visuo-spatial strategy, which involves creating a mental representation of a pattern, requires visualization. Unlike visual strategy, spatial strategy lacks visual clues and mental representation focuses on the spatial arrangement, e.g. directions or relationships between components of the figure. Verbal strategy involves making a description of a spatial stimulus with the use of words (e.g., right, left, oblique, zigzagging). Kinesthetic strategy makes use of motor memory. We expect that similar differences in the applied strategies as reported by Lebaz and colleagues (2010), and Picard and associates (2010), will be identified in congenitally blind and sighted participants, in a study designed to use different research material – 2D tactile right-angle-shapes. The following hypothesis was formulated: (H4) While memorizing a figure, sighted individuals use visual strategies more often than congenitally blind participants. The study also investigated the following problem: (P1) What specific strategies, within the categories of visual and non-visual (spatial, verbal, kinesthetic or mixed) strategies are used by individuals with and without visual experience?

To the best of our knowledge there is no research directly comparing memorizing of non-figurative 2D spatial stimuli presented against a grid and without a grid[1]. In a single experiment, researchers displayed spatial haptic stimuli either against a grid (Cornoldi & Vecchi, 2003; Vecchi, 1998; Vecchi et al., 1995), or without a grid, in an embossed frame (Bailes & Lambert, 1986) or on a completely empty surface,

[1] Although, such conditions were compared by Szubielska and Zabielska-Mendyk (2018), but in the experiment on mental rotation.

on a Swell paper – in the latter case the edge of the paper constituted the frame (Picard et al., 2010). On the one hand, lines of the grid may be a distractor, making it difficult to distinguish the raised-line figure from the background. Heller and colleagues (2003) showed that in a task which involved tracing, with preferred index finger, of a figure embedded in a raised-line drawing, the accuracy decreased if the figure was presented against a background consisting of a greater number of intersecting lines, in comparison to the background consisting of fewer lines. The effect was observed in groups of both blindfolded sighted participants and congenitally blind individuals. On the other hand, a grid facilitates the use of verbal strategy of memorizing, called coordinate XY, which involves remembering coordinates of specific squares of the grid occupied by elements of the memorized stimulus (Szubielska, 2014; Vanlierde & Wanet-Defalque, 2004). Where the time allowed for exploring the shape is unlimited, individuals employing this strategy can accurately memorize the coordinates of all squares of the grid, which are occupied by the figure. In turn, sighted people prefer visualization strategy (Vanlierde & Wanet-Defalque, 2004, although Szubielska, 2014 stated that they use it as frequently as the XY verbal strategy). To determine whether a background in the form of a grid makes it easier or more difficult to memorize 2D right-angle-shapes by people who are blind or sighted, the following problem was investigated: (P2) Do people who are blind, solve the task most accurately when they both learn and recognize a figure in the context of the grid, due to their preferred imagery strategies, while the sighted people – when they learn and recognize a pattern in the context of the frame?

Method

Participants

The final sample consisted of 22 individuals (6 women), half of whom were congenitally blind (they were at most able to sense light and had never been able to see) and half of whom had normal vision. There were initially 12 blind participants, but the scores of one blind female participant and her sighted match had to be discarded because the blind participant often confused the model and test figures; this may have reflected a misunderstanding of the instructions or an attention deficit. Sighted controls were matched to blind participants with respect to gender, age, handedness and level of education. The mean age of the blind group was 24.27

Table 1 *Detailed information on the congenitally blind participants*

	Sex	Age	Handedness	Education	Aetiology	Light/darkness sensitivity
CB1	M	25	Right	High	Retinoblastoma	No
CB2	M	30	Right	High	Optic nerve atrophy	Yes
CB3	M	27	Right	High	Retinopathy of prematurity	Yes (left eye)
CB4	M	24	Right	Secondary	Retinopathy of prematurity	Yes
CB5	F	22	Right	Secondary	Optic nerve hypoplasia	Yes
CB6	M	18	Right	Secondary	Retinopathy of prematurity	No
CB7	M	36	Right	Secondary	Retinopathy of prematurity	No
CB8	M	18	Right	Secondary	Retinopathy of prematurity	Yes
CB9	F	23	Right	Secondary	Optic nerve hypoplasia	Yes
CB10	M	25	Left	Secondary	Retinoblastoma	No
CB11	F	19	Right	Secondary	Optic nerve atrophy	No

years (range: 18 -36 years). All blind participants could read Braille and had some experience of using tactile graphics. The detailed characteristics of the groups are shown in Table 1. The mean age of the sighted group was 24.18 years (range: 18-36 years).

Materials

Testing material consisted of 80 tactile images, each with a surface area of 40 square centimeters; half were used in the learning stage (target figures) and the rest were presented in the recognition stage (test figures). Images consisted of an asymmetric, non-figurative planar shape, displayed either against a 100-square grid (2 cm x 2 cm) or in a frame (see Figure 1). In the frame condition the figure (convex; 0.5 mm high; dotted texture) was placed inside a 20 cm square with a raised profile (1 mm high). In the grid condition the texture of the raised grid (1 mm high) differed from that of the figure (convex; 0.5 mm high; dotted texture); we confirmed during a pilot study that the two textures were easy to distinguish. Each shape consisted of 20 square cells (the borders between cells were detectable when shapes were displayed against a grid; they were not perceptible when figures were presented in a frame). Target shapes varied in terms of number of angles, low: 10 angles or high: 20 angles (see Figure 1). All the angles were right angles.

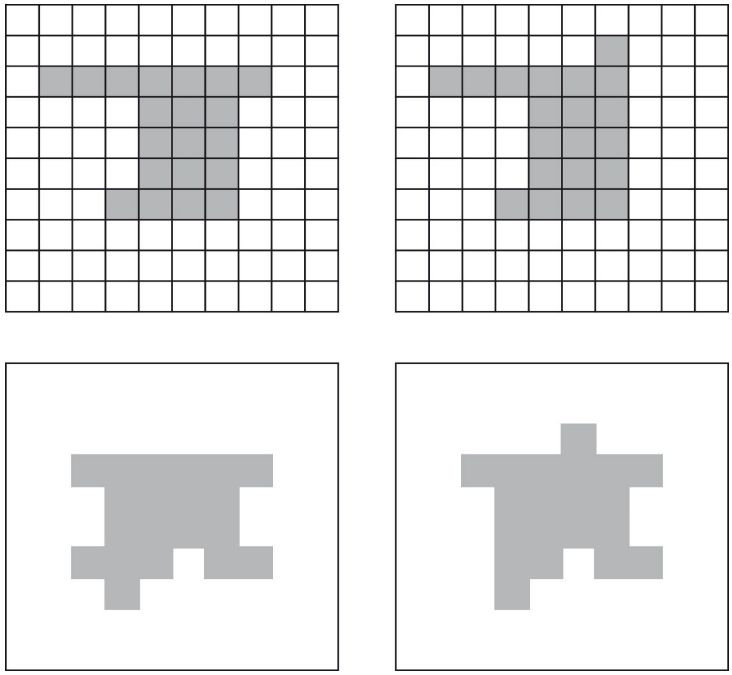

Figure 1 Examples of experimental stimuli. Model figures (left) and test figures (right) displayed against a grid and in a frame. Examples of figures with low-angle number are presented in the upper row, while figures with high-angle number are presented in the lower row.

Procedure

The participants' task was to memorize a tactile target shape and there was no limit to the amount of time they could take. The instructions were as follows: "Your task is to memorize the shape of a figure, which you will explore by touch. Tell the experimenter when you think you have memorized the figure". Participants decided when they had memorized the figure; the learning phase ended when they made their declaration and the recognition test was administered without delay. This consisted of presenting a test figure and requiring the participant to decide if it was identical in shape to the target figure. Test figures were either identical to the target figure or differed with respect to the position of one cell (see Figure 1). Performance accuracy was assessed using a binary scale, with points scored for both hits and correct rejections. Sighted participants were blindfolded throughout the experiment.

Both target and test figures could be presented in the grid or in the frame, giving the following conditions: 1) learning with frame – recognition with frame (frame-frame), 2) learning with frame – recognition with grid (frame-grid), 3) learning with grid – recognition with grid (grid-grid), 4) learning with grid – recognition with frame (grid-frame). The pairings were presented in random order. Each pairing of contexts was used for ten trials (five each for stimuli with low and high numbers of angles; also in random order). Before performing each condition participants performed three training trials which involved figures containing 12 to 18 angles. After completion of four conditions participants were asked to describe how they coded the 2D tactile shapes (see Cornoldi et al., 2009, and Picard et al., 2010 for a similar procedure).

A stopwatch was used to measure learning time. Learning time was measured from the moment the tactile graphic was first touched to the moment the participant informed the experimenter that he or she had memorized the model.

Results

Exploration Time in the Learning Phase

We performed ANOVA with mean exploration time as the dependent variable, number of angles (low; high), learning condition (frame; grid) and testing condition (frame; grid) as within-participants factors and visual status (sighted; congenitally blind) as between-participants factor. Descriptive statistics for mean learning time are presented in Table 2.

Mean exploration time was longer in sighted participants ($M = 113.28$, $SE = 13.40$) than in blind participants ($M = 46.24$, $SE = 13.40$; $F(1,20) = 12.51$, $MSE = 15805.03$, $p = .002$, $\eta^2 = .38$).

It took longer to explore stimuli consisting of 20 angles ($M = 92.22$, $SE = 9.63$) than stimuli consisting of 10 angles ($M = 67.30$, $SE = 10.26$; $F(1,20) = 16.98$, $MSE = 1630.01$, $p < .001$, $\eta^2 = .46$).

In the learning condition mean exploration time was longer when stimuli were presented against a grid ($M = 95.46$, $SE = 12.17$) rather than in a frame ($M = 64.06$, $SE = 7.11$; $F(1,20) = 25.98$, $MSE = 1669.82$, $p < .001$, $\eta^2 = .56$). The same effect was observed for learning condition – mean exploration time was longer when the participant knew that a test figure will be presented against a grid ($M = 88.07$, $SE = 12.38$) not in a frame ($M = 71.44$, $SE = 7.49$; $F(1,20) = 4.62$, $MSE = 2632.05$, $p = .044$, $\eta^2 = .19$).

There were no significant interactions (double, triple, or fourfold) of visual status with the other factors analyzed ($ps > .05$).

Performance Accuracy in the Recognition Phase

We performed ANOVA with mean accuracy as the dependent variable and number of angles

Table 2 *Descriptive statistics for exploration time in the learning phase (in seconds). Table presents mean learning time (M), standard deviation (SD), minimum (Min) and maximum (Max) for every experimental condition for both sighted and congenitally blind participants*

Condition		*M*	*SD*	Min	Max
Frame-Frame Low-angle	Blind	19.75	10.61	5.65	36.93
	Sighted	66.75	38.19	16.58	135.00
Frame-Grid Low-angle	Blind	29.27	22.13	6.35	71.89
	Sighted	75.96	57.86	19.73	223.14
Grid-Frame Low-angle	Blind	39.23	23.86	8.26	81.44
	Sighted	107.84	43.23	41.45	198.93
Grid-Grid Low-angle	Blind	46.72	30.12	9.42	116.05
	Sighted	126.95	55.85	45.86	211.37
Frame-Frame High-angle	Blind	40.42	24.86	7.45	82.88
	Sighted	106.73	67.61	26.03	233.43
Frame-Grid High-angle	Blind	67.25	73.10	5.77	216.60
	Sighted	132.25	115.04	28.17	441.28
Grid-Frame High-angle	Blind	62.31	40.56	7.88	136.82
	Sighted	128.52	49.60	43.48	222.56
Grid-Grid High-angle	Blind	64.93	41.11	9.01	146.29
	Sighted	161.24	83.45	45.20	310.93

(low; high), learning condition (frame; grid) and testing condition (frame; grid) as within-subjects factors and visual status (sighted; congenitally blind) as the between-subjects factor. Descriptive statistics for accuracy are presented in Table 3.

There were no main effects of number of angles ($F(1,20) = .02$, $p = .882$), learning condition ($F(1,20) = 3.33$, $p = .083$) or visual status ($F(1,20) = 0.01$, $p = .933$).

Mean accuracy was higher when test stimuli were presented in a frame ($M = 3.81$, $SE = .12$) rather than against a grid ($M = 3.38$, $SE = .20$; $F(1,20) = 4.98$, $MSE = 1.65$, $p = .037$, $\eta^2 = .20$). There was an interaction of number of angles and learning condition $F(1,20) = 6.59$, $p = .02$. Bonferroni post-hoc test showed that when participants were learning stimuli presented in a frame, the accuracy was higher for low angle condition ($M = 3.91$, $MSE = .16$) than for high angle condition ($M = 3.57$, $MSE = .16$, $p = .049$). Also, for low angle condition the accuracy was higher when the participant learned the stimuli in a frame ($M = 3.91$, $MSE = .16$) than against a grid ($M = 3.25$, $MSE = .24$, $p = .012$).

There was also a three-way interaction between learning condition, testing condition and visual status ($F(1,20) = 6.80$, $MSE = 1.24$, $p = .017$, $\eta^2 = .25$) (see Figure 2). Bonferroni post-hoc test revealed that only in the sighted group there were differences in accuracy. When sighted participants were learning in a frame condition and were tested in a frame condition ($M = 4.41$, $MSE = .17$) the accuracy was higher than when they were learning in a frame condition and tested against a grid condition ($M = 3.14$, $MSE = .31$; $p < .001$). The accuracy was also higher for sighted participants when they learned in a frame condition and tested in a frame condition ($M = 4.41$, $MSE = .17$) than when

Table 3 *Descriptive statistics for performance accuracy in the recognition phase. Table presents mean accuracy (M), standard deviation (SD), minimum (Min) and maximum (Max) for every experimental condition for both sighted and congenitally blind participants*

Condition		*M*	*SD*	Min	Max
Frame-Frame Low-angle	Blind	4.27	.65	3	5
	Sighted	4.45	.93	2	5
Frame-Grid Low-angle	Blind	3.64	.67	3	5
	Sighted	3.27	1.35	1	5
Grid-Frame Low-angle	Blind	3.45	1.37	1	5
	Sighted	3.09	1.45	0	5
Grid-Grid Low-angle	Blind	3.18	1.54	1	5
	Sighted	3.27	1.56	0	5
Frame-Frame High-angle	Blind	3.55	.93	2	5
	Sighted	4.36	.67	3	5
Frame-Grid High-angle	Blind	3.36	1.36	1	5
	Sighted	3.00	1.26	1	5
Grid-Frame High-angle	Blind	3.64	1.03	2	5
	Sighted	3.64	1.12	2	5
Grid-Grid High-angle	Blind	3.55	1.29	1	5
	Sighted	3.73	.90	2	5

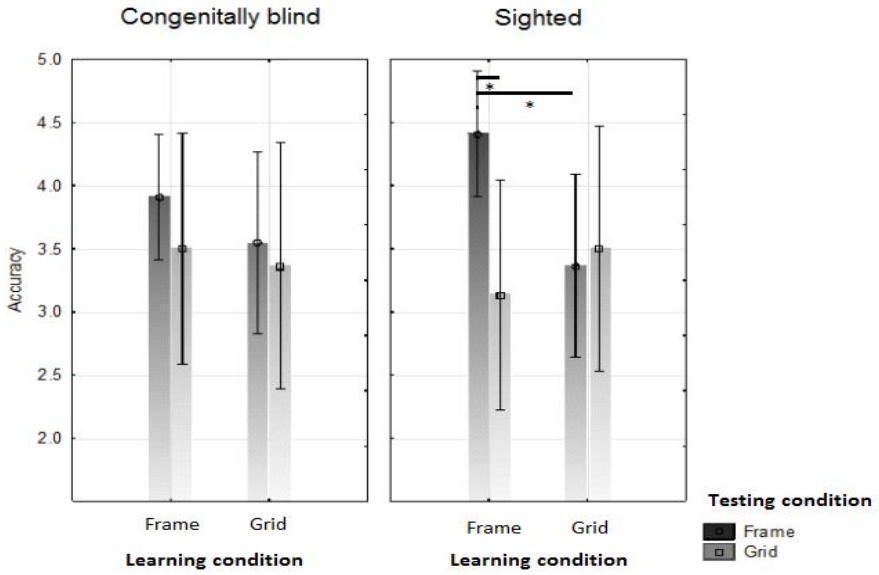

Figure 2 Interaction of accuracy (tactile pattern recognition performance) relative to learning condition, testing condition and visual status (error bars represent +/- standard errors).

they learned against a grid condition and tested in a frame condition *(M* = 3.36, *MSE* = .25; p = .003; $p < .001$) (See Figure 2).

There were no more significant interactions (double, triple, or fourfold) of visual status with the other factors analyzed (*ps* > .05).

Self-Reported Strategies

Each participant's verbal report was examined by two independent judges. They classified the reports according to the strategies used to memorize the tactile figures. The judges were provided with definitions and sample statements reflecting the use of visuo-spatial, spatial, verbal and kinesthetic strategy; these originated from the study by Picard and colleagues (2010). The statements of all the participants were assessed four times, concerning the four defined imagery strategies. The following strategy descriptions were given to the judges: 1) "Participants imagined how parts of the configuration or the whole pattern appeared, relying on visual imagery" – visuo-spatial strategy; 2) "Participants used descriptive words to encode spatial information" – verbal strategy; 3) "Participants imagined how parts of the configuration or the whole pattern appeared without recourse on visual cues – spatial strategy; 4) "Participants imagined how parts of the configuration or the whole pattern appeared relying on motor or kinesthetic information – kinesthetic strategy (Picard et al., 2010, p. 230). Sample statements by which it was identified that the participant used the 1) visuo-spatial, 2) verbal, 3) spatial, and 4) kinesthetic strategy were: 1) "I searched for outlines and drew a figure in my head", "I try to imagine the shape, see it with my mind's eye"; 2) "I counted cells, I counted the distance from the edge and the gap between elements", "I studied the figure from top to bottom, counting how many grates are in a row, how many empty grids were there"; 3) "First, I memorized the middle, then the periphery and associated the image with something known", "I memorized using the principle of a city plan (narrow fragments are streets, wider are squares); I memorize each piece, fragments; the whole shape does not mean anything to me"; 4) "I memorized the entire shape by running my finger along the edge", "I have a measuring tape in my fingers (width of the fingers, spacing) – I am applying distance measure, checking on the sides or diagonally". The judges agreed on 80 out of 88 cases. The disparities in their decisions were resolved during a discussion.

Sighted participants used the visuo-spatial strategy significantly more frequently than the blind participants, $\chi^2(1) = 22$, $p < .001$, and sighted participants used the spatial strategy significantly less frequently than the blind participants, $\chi^2(1) = 22$, $p < .001$. All the sighted participants applied visual strategies and none of them used spatial strategies, and all the blind participants employed non-visual strategies and none of them declared using visual strategies. The groups of blind and sighted participants did not differ in the frequency of using verbal strategy, $\chi^2(1) = .75$, $p = .386$, or kinesthetic strategy, $\chi^2(1) = .31$, $p = .58$.

It was determined that seven different strategies were used (see Table 4), including four types classified as visual, and three types classified as non-visual strategies. Using the Q Cochran's test, the frequency of application of those strategies in the groups of blind and sighted people was examined. There were no significant differences in the group of people with blindness, $Q(2) = 5.09$, $p = .078$, or sighted, $Q(3) = 3.18$, $p = .364$.

In their statements the participants spontaneously made comments regarding whether the grid facilitated or distracted memorization of a figure placed against it. Five congenitally blind and five sighted participants admitted directly that grids interfered with their performance. Four blind participants (and no sighted individuals) admitted directly that the grids were

Table 4 *Numerical distributions of the congenitally blind and blindfolded sighted participants according to the strategy used*

Strategy	Blind (N)	Sighted (N)
Non-visual	11	0
spatial	3	0
spatial and verbal	7	0
spatial, verbal and kinesthetic	1	0
Visual	0	11
visuo-spatial	0	5
visuo-spatial and verbal	0	3
visuo-spatial and kinesthetic	0	1
visuo-spatial, verbal, and kinesthetic	0	2

helpful. Furthermore, eight blind participants and five sighted participants reported that they counted the squares while memorizing the figures.

Discussion

The study tested four research hypotheses related to memorization of 2D embossed right-angle-shapes: (H1) Congenitally blind participants learn shapes faster than sighted individuals; (H2) Congenitally blind participants recognize 2D embossed right-angle-shapes more accurately than sighted individuals; (H3) Only sighted participants will more accurately memorize shapes with fewer angles compared to a greater number of angles; (H4) While memorizing a figure, sighted individuals use visual strategy more often than people who are congenitally blind. The study also investigated two questions: (P1) What specific strategies – spatial, verbal, kinesthetic or mixed, are used by blind and sighted individuals? (P2) Do people who are blind, solve the task most accurately when they both learn and recognize a figure in the context of the grid, due to their preferred imagery strategies, while the sighted people – when they learn and recognize a pattern in the context of the frame?

The findings support the first hypothesis. The congenitally blind participants needed less time than the sighted individuals to learn 2D embossed right-angle-shapes, regardless of the number of angles in the figures and regardless of the form of presentation, against a grid or in a frame. The evidence is consistent with earlier studies suggesting that the time required for exploring a stimulus by touch is longer in the case of sighted individuals, compared to blind individuals (Heller, 2006; Postma et al., 2007).

The second hypothesis was not confirmed. Participants with congenital blindness and blindfolded sighted participants did not significantly differ in the accuracy of recognizing 2D embossed right-angle-shapes. Finding no significant differences between people who are blind and those who see but are blindfolded in recognizing tactile patterns is not an isolated result (cf. Bailes & Lambert, 1986; Cornoldi & Vecchi, 2003; Picard et al., 2010; Vecchi, 1998; Vecchi, Monticell, & Cornoldi, 1995). It is possible that visual experience does not differentiate the performance of tasks that require tactile perception. Differences obtained in research in this area are rare (e.g., Pathak & Pring, 1989), and studies with statistically significant results are preferred in the scientific literature (cf. Picard et al., 2010).

The third hypothesis was not confirmed either. The accuracy of recognizing figures with fewer or larger number of angles did not differ significantly, neither in the blind and nor in the sighted participants. Increasing complexity did not impair the performance in either group, which is inconsistent with the other studies' results (Vecchi et al., 1995). The fact that we did not limit exploration time may explain the discrepancies between our findings and those of Vecchi and colleagues (1995) (importantly, these researchers applied spatial stimuli which differed from ours, and this may have contributed to the different findings acquired in the two experiments). In our study the participants needed more time to learn the figures with more angles, compared to the figures with fewer angles, which means that the effect of complexity of 2D tactile right-angle-shapes in the load of the passive component of visuo-spatial working memory was observed in the dependent variable of learning time but not in recognition accuracy.

The fourth hypothesis and the first research problem was related to the strategies of memorizing embossed figures applied by the congenitally blind and sighted participants. The hypothesis was verified positively. It was determined that the blindfolded sighted individuals employed visual strategies only, while the blind participants employed non-visual strategies[2]. These findings are consistent with those reported by Picard and colleagues (2010), and Vanlierde and Wanet-Defalque (2004). It was confirmed that in the process of creating mental representation of a pattern, sighted participants try to visualize it while blind individuals with no visual experience refer to spatial categories. Like Picard and colleagues (2010), we established that strategies in both the visual and non-visual categories include pure (visuo-spatial and spatial, respectively) and mixed strategies. In the visual category the following mixed strategies were identified: visuo-spatial combined with verbal, visuo-spatial combined with kinesthetic, as well as visuo-spatial combined with both verbal and kinesthetic. The frequency of application of those strategies did not differ significantly in the group of sighted individuals. Mixed strategies in the non-visual category included spatial strategy combined with verbal, as well as spatial combined with verbal and kinesthetic. The frequency of application of those strategies did not differ significantly in the group of people with blindness.

The second research question was related to the effect of the grid and the frame in the performance of a memory task by people who are blind or sighted. Regardless of visual status, the grid condition made the task of learning embossed figure more complex – as evidenced by the interaction effect of the number of angles and learning condition for accuracy (when participants were learning stimuli presented in a frame, the recognition accuracy was higher for low angle condition than for high angle condition; for low angle condition the recognition accuracy was higher when participant learn stimuli in a frame than against a grid). But, in the case of the sighted participants, a grid was a more considerable distractor than in case of individuals with congenital blindness. In the group of blindfolded sighted participants, the accuracy was higher, when the shape: was learned in a frame and tested in a frame than learned in a frame and tested against a grid; was learned in a frame and tested in a frame than learned against a grid and tested in a frame. In the group of people who are blind, there were no differences in the accuracy of figure recognition, which were learned and which were recognized in different conditions (frame or grid).

[2] The result of people who are congenitally blind may seem obvious, but there are some controversial reports that individuals who are blind can use visual imagery (Bertolo et al., 2003), and that early blind participants can use the visualization strategy (Vanlierde & Wanet-Defalque, 2004).

During conversations after the end of the experiment nearly half of the participants (both blind and sighted) spontaneously reported that the grid interfered with the performance of the task. None of the sighted participants found the grid to be helpful. Some participants with blindness admitted that the grid was of help to them, but it may have been related to the used memory strategy. Eight of the blind participants (nearly 73% of the group) reported that in order to memorize the figure they counted the squares, which means they used a strategy similar to coordinate XY strategy (cf. Szubielska, 2014; Vanlierde & Wanet-Defalque, 2004). Interestingly, even when the grid was not there, some participants tried to employ this strategy, as illustrated by a statement of one of the participants with blindness, "I tried to superimpose a grid over the figure". The fact that the grid is a distractor in exploring a pattern placed against it is also reflected by the longer learning time of target figures when they were placed against a grid than when they were placed in a frame. Interestingly, participants also tended to spend more time learning target figures when they expected the test figure to be presented against a grid (frame-grid; grid-grid) than when they expected it to be placed in a frame (frame-frame; grid-frame). In the interpretation of the results we will again refer to the time-consuming verbal XY strategy (cf. Szubielska, 2014; Vanlierde & Wanet-Defalque, 2004), possibly employed by the participants (both blind and sighted people), who reported having counted the squares. As a reminder, prior to each series of tasks, the participants performed test trials, therefore they always knew beforehand the condition of the target and the test figures presentation. Keeping in mind the comment contributed by one of the participants, who said that he tried to superimpose the grid onto the figure, we can suspect that when they expected the test figure to be displayed against a grid, even if at the exploration stage the figure was presented in a frame, some participants tried to count which squares of the imagined grid were occupied by the figure.

Distraction effects of the complex grid background in the accuracy of the sighted participants' performance may have been linked to the difficulty in distinguishing the figure from the background (Heller et al., 2003) or with the difficulty of visualizing it in the context of a grid (all sighted participants used visual memory strategies). Increasing complexity of an imagined stimulus results in the creation of more degraded visual image (Kosslyn, 1975).

The present study supports the claim made by Vecchi and colleagues (Cornoldi & Vecchi, 2003; Vecchi, 1998) that individuals without visual experience do not have an impairment in the passive component of visuo-spatial working memory compared with sighted individuals. The findings are consistent with results of experiments which have shown that congenitally blind participants memorize two-dimensional shapes at least as accurately as sighted individuals (Bailes, Lambert, 1986; Pathak & Pring, 1989; Picard et al., 2010; Vecchi, Monticelli, & Cornoldi, 1995). They also reflect significant ability of blind individuals to create accurate representations of 2D non-figurative spatial stimuli and maintain it in working memory, which previously has been demonstrated in perception tasks (Alary et al., 2008; Theurel et al., 2012; Ballesteros et al., 2005).

Limitations of the study are related to the number of participants. Small groups of participants were examined, due to the fact that the population of people who are blind from birth, without additional disabilities, is limited (moreover, some of these people have repeatedly been asked to participate in psychological research and are reluctant to take part in the next). Quite often congenital blindness is accompanied by intellectual disability – this situation excludes the participation of a person from an experiment such as ours.

References

Alary, F., Goldstein, R., Duquette, M., Chapman, C. E., Voss, P., & Lepore, F. (2008). Tactile acuity in the blind: A psychophysical study using a two-dimensional angle discrimination task. *Experimental Brain Research, 187*, 587–594.

Bailes, S. M., & Lambert, R. M. (1986). Cognitive aspects of haptic form recognition by blind and sighted subjects. *British Journal of Psychology, 77,* 451–458.

Ballesteros, S., Bardisa, D., Millar, S., & Reales, J. M. (2005). The haptic test battery: A new instrument to test tactual abilities in blind and visually impaired and sighted children. *British Journal of Visual Impairment, 23*, 11–24.

Bertolo, H., Paiva, T., Pessoa, L., Mestre, T., Marques, R., & Santos, R. (2003). Visual dream content, graphical representation and EEG alpha activity in congenitally blind subjects. *Cognitive Brain Research, 15*, 277–284.

Cornoldi, C., Tinti, C., Mammarella, I. C., Re, A. M., & Varotto, D. (2009). Memory for an imagined pathway and strategy effects in sighted and in totally congenitally blind individuals. *Acta Psychologica, 130,* 11–16.

Cornoldi, C., & Vecchi, T. (2003). *Visuo-spatial working memory and individual differences*. Hove, New York: Taylor and Francis/Psychology Press.

D'Angiulli, A., & Kennedy, J. M. (2001). Children's tactual exploration and copying without vision. *International Journal of Rehabilitation Research*, *24*, 233–234.

Davidson, P. W. (1972). Haptic judgments of curvature by blind and sighted humans. *Journal of Experimental Psychology, 93*, 43–55.

Heller, M. A. (2006). Picture perception and spatial cognition in visually impaired people. In M. A. Heller, & S. Ballesteros (Eds.), *Touch and blindness. Psychology and Neuroscience* (pp. 49–71). Mahwah, New Jersey: Lawrence Erlbaum Associates.

Heller, M. A., Wilson, K., Steffen, H., Yoneyama, K., & Brackett, D. D. (2003). Superior haptic perceptual selectivity in late-blind and very-low-vision subjects. *Perception, 32*, 499–511.

Kosslyn, S. M. (1975). Information representation in visual images. *Cognitive Psychology, 7,* 341–370.

Lebaz, S., Picard, D., & Jouffrais, C. (2010). Haptic recognition of non-figurative tactile pictures in the blind: Does life-time proportion without visual experience matter? *Volume of the series Lecture Notes in Computer Science, 6192*, 412–417.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81–97.

Pathak, K., & Pring, L. (1989). Tactual picture recognition in congenitally blind and sighted children. *Applied Cognitive Psychology, 3,* 337–350.

Perkins, C., & Gardiner, A. (2003). Real world map reading strategies. *The Cartographic Journal, 40*, 265–268.

Picard, D., Lebaz, S., Jouffrais, C., & Monnier, C. (2010). Haptic recognition of two-dimensional raised-line patterns by early-blind, late-blind, and blindfolded sighted adults. *Perception, 39,* 224–235.

Postma, A., Zuidhoek, S., Noordzij, M. L., & Kappers, A. M. (2007). Differences between early-blind, late-blind, and blindfolded-sighted people in haptic spatial-configuration learning and resulting memory traces. *Perception*, *36*, 1253–1265.

Russier, S. (1999). Haptic discrimination of two-dimensional raised-line shapes by blind and sighted adults. *Journal of Visual Impairment & Blindness, 93*, 421–426.

Sathian, K., & Prather, S. C. (2006). Cerebral cortical processing of tactile form: Evidence from functional neuroimaging. In M. Heller, & S. Ballesteros (Eds.), *Touch and blindness: Psychology and neuroscience* (pp. 139–155). Lawrence Erlbaum Associates, New Jersey.

Symmons, M., & Richardson, B. (2000). Raised-line drawings are spontaneously explored with a single finger. *Perception, 26*, 621–626.

Szubielska, M. (2014). Strategies for constructing spatial representations used by blind and sighted subjects. *Studia Psychologica, 56*, 273–285.

Szubielska, M., & Zabielska-Mendyk, E. (2018, in press). Mental rotation of figures explored by touch. A study on congenitally blind and sighted individuals. *Roczniki Psychologiczne // Annals of Psychology, 21*.

Theurel, A., Frileux, S., Hatwell, Y., & Gentaz, E., (2012). The haptic recognition of geometrical shapes in congenitally blind and blindfolded adolescents: Is there a haptic prototype effect? *PloS One, 7*:e40251. doi: 10.1371/journal.pone.0040251.

Vanlierde, A., & Wanet-Defalque, M.-C. (2004). Abilities and strategies of blind and sighted subjects in visuo-spatial imagery. *Acta Psychologica, 116*, 205–222.

Vecchi, T. (1998). Visuo-spatial limitations in congenitally totally blind people. *Memory*, *6,* 91–102.

Vecchi, T., Monticellai, M. L., & Cornoldi, C. (1995). Visuo-spatial working memory: Structures and variables affecting a capacity measure. *Neuropsychologia*, *33*, 1549–1564.

Studia Psychologica, Vol. 60, No. 3, 2018, 150-166 doi: 10.21909/sp.2018.03.759

A Time for Being Thankful: Balanced Time Perspective and Gratitude

Malgorzata Szczesniak, Celina Timoszyk-Tomczak
University of Szczecin
Szczecin, Poland

The aim of this report is twofold: 1) to demonstrate how grateful disposition is related to time perspectives in late adolescents and young people in the process of transition into early adulthood; 2) to verify whether age indeed moderates the relationship between the present-hedonistic dimension and gratitude, as well as future and gratitude in such a way that these relationships are stronger in high school students and undergraduates than in graduates. The results provide strong support for the hypothesis that gratitude is higher in the case of the past-positive, present-hedonistic, and future time perspectives. As regards the reverse correlations, deviation from a balanced time perspective is positively associated with gratitude GQ-6 and IPIP-VIA. This suggests that different types of focus on recalling the past, experiencing the present, and facing the future might predict a grateful disposition and gratitude. Moreover, age moderated the relationship between the present-hedonistic perspective and gratitude.

Key words: gratitude, time perspectives, balanced time perspective, adolescents, young adults

Introduction

In recent years a large body of scientific evidence has emerged suggesting that being grateful is associated with several positive outcomes (Robustelli & Whisman, 2018; Wood, Froh, & Geraghty, 2010). Psychologists indicate that gratitude increases well-being in both younger (Jiang, Sun, Liu, & Pan, 2016) and older individuals (Killen & Macaskill, 2015). It correlates negatively with materialism (Polak & McCullough, 2006) and positively with self-esteem (Kashdan, Uswatte, & Julian, 2006; Kong, Ding, & Zhao, 2015), social support, and life satisfaction (Kong, Ding, & Zhao, 2015; Sun & Kong, 2013) on many levels of human life (Wang, Wang, & Tudge, 2015). On the individual level, gratitude refers to experiencing and fostering appreciation of life and its events beneficial to the self. On the relational level, it concerns being grateful for bonds within family settings and friendships. On the organizational level, it relates to grateful relationships within the structural systems, among peers, employers, and employees.

Although there are a very large number of studies that explicitly investigate the topic of gratitude and its links with the aforesaid constructs, a systematic literature review shows that the subject of gratitude and time perspective has been one of the most understudied areas. And yet, if we think of human existence, gratitude represents an important factor of daily life stretched over time, across different developmental stages or mental and physical conditions. For example, for elderly people the awareness of the limited time they have left to live often promotes a sense of gratitude for life itself (Greenstein & Holland, 2015). In fact,

Correspondence concerning this article should be addressed to Malgorzata Szczesniak, Ph.D., University of Szczecin, Faculty of Humanities, Ul. Krakowska 71-79, 71-017 Szczecin, Poland. E-mail: malgorzata.szczesniak@whus.pl

Received October 27, 2017

Carstensen (2011) explains this by pointing out that seniors' time horizons grow shorter as they move toward their later years and recognize the fragility of life. Consequently, they focus mainly on those goals from which they derive emotional meaning and tend to be more appreciative than younger adults (Chopik, Newton, Ryan, Kashdan, & Jarden, 2017). Likewise, terminally ill patients are often grateful just for being alive, which manifests itself in wasting a smaller amount of time on irrelevant things and in enjoying every moment (Daughtery & Hand, 2009). Middle-aged adults are grateful for the enjoyable circumstances experienced, together with the challenges and difficult lessons that allow them to grow (König & Glück, 2014). Even adolescents seem to be attentive to gratitude and time perspective. As a matter of fact, almost 70% of young Americans report expressing gratitude all the time (Wood, Froh, & Geraghty, 2010), implying that their gratefulness is constantly present.

In this context, it seems valuable to undertake a study on the relationship between gratitude and time perspectives, especially in adolescents and younger adults, as the link between the two variables in these particular stages of life is important, though it may appear less evident.

Gratitude

Gratitude is considered an essential aspect of human existence and one of the most indispensable social emotions (Fox, Kaplan, Damasio, & Damasio, 2015; Watkins, 2014). Current perspectives on gratitude provide insights into what gratitude is and how it can influence interpersonal relationships. Gratitude has been defined as a general tendency for people to recognize, appreciate, and respond to other individuals' benevolence and well-being (McCullough, Emmons, & Tsang, 2002), as well as a passing emotion caused by particular situations (Watkins & Bell, 2017). According to Wood and colleagues (2010), gratitude can also be considered as part of a wider life orientation that consists in perceiving and valuing the positive in the world.

Another way of understanding gratitude is provided by Peterson and Seligman (2004), who argue that gratitude is a strength of character and a trait known in all cultures. In this sense, it is a disposition to be aware of and thankful for the good things that happen (Park, Peterson, & Seligman, 2004). Moreover, it denotes a sense of thankfulness and enjoyment in response to obtaining a tangible benefit from another person or to receiving immaterial gifts – for example, in the form of natural beauty, such as awe-inspiring landscape or a work of art (Froh, Miller, & Snyder, 2007; Peterson & Seligman, 2004). Being grateful for what one has is regarded as appropriate, and acts of expressing thankfulness to those who have benefited us are usually considered socially desirable (Jackson, 2016).

Regardless of the conceptualization outlined above, being thankful requires subjective assessment of the gift received or the event experienced. If people consider what they have received or undergone beneficial, even if it involves suffering (König & Glück, 2014), they are prompt to feel or show gratitude. By contrast, if they receive something valuable or meaningful but do not judge it accordingly, they remain thankless. Therefore, subjectivity may explain why some individuals are grateful even in hard times and why others feel entitled to more and persist in demanding more than others.

Time Perspective

Time is one of the most important dimensions of people's individual and social functioning (Lewin, 1946). Human life takes place in time; therefore, time – its role and meaning – is often the subject of psychological research. Time

perspective (TP) is a category relating to subjective perception to the experience of time. Lewin (1942) described TP as a set of individual beliefs about the past and the future, emerging at a particular stage of human life. According to Nuttin (1985), time perspective, attitude toward time, and temporal orientation are the components of *psychological time*, where TP is the configuration of time-bound objects that occupy the mind of an individual in a particular situation.

TP can be defined as a relatively stable, individually diverse dimension, expressing an individual's preferred behaviors and attitudes toward the past, present, and future (Webster, 2011). One of the most influential theories of time perspective is the model proposed by Zimbardo and Boyd (2008), operationalized as an interesting research tool and tested by many researchers in the world. According to these psychologists, TP is a construct that includes personal, often unconscious, attitudes toward time. It is also a process that helps to bring order, consistency, and meaning to life. Time perspective has three fundamental dimensions: past, present, and future (Zimbardo & Boyd, 1999, 2008).

For a long time, research was focused primarily on a single time domain, for example, on the future (Holman & Zimbardo, 2009; Nurmi, 1991). Recently, analytic emphasis has shifted to the role and function of balanced time perspective, which is believed to be related to mental and physical health, as well as to optimal individual and social functioning (Stolarski, Wiberg, & Osin, 2015). Studies suggest that if people have a positive and balanced attitude toward the past, the present, and the future, they may benefit from higher well-being (Oyanadel, Buela-Casal, Araya, Olivares, & Vega, 2014).

Balanced Time Perspective

Balanced time perspective (BTP) is understood as "the mental ability to switch effectively among TPs depending on task features, situational considerations, and personal resources, rather than be biased toward a specific TP that is not adaptive across situations" (Zimbardo & Boyd, 1999, p. 1285). It can also be seen as a frequent and relatively balanced inclination to think positively about both the past and the future (Webster, 2011). Numerous contemporary studies have shown interesting relationships regarding balanced time perspective. BTP has been repeatedly found to correlate with subjective well-being (Boniwell, Osin, Linley, & Ivanchenko, 2010; Drake, Ducan, Sutherland, Abernethy, & Henry, 2008; Hang, Howell, & Stolarski, 2013; Stolarski, 2016; Stolarski, Vowinckel, Jankowski, & Zajenkowski, 2016) and various subjective indicators of well-being, such as subjective happiness, positive affect, negative affect, psychological needs, self-determination, and vitality. This relationship has been well-acknowledged even in circumstances of different BTP operationalization modes (Hang, Howell, & Stolarski, 2013).

It has also been reported that higher BTP is associated with higher life satisfaction and general happiness (Barsics, Rebetez, Rochat, D'Argembeau, & Van der Linden, 2017; Boniwell & Zimbardo, 2004; Simons, Peeters, Janssens, Lataster, & Jacobs, 2016; Webster & Ma, 2013; Gao, 2011), extraversion (Stolarski, 2016; Zajenkowski, Witowska, Maciantowicz, & Malesza, 2016), positive orientation (Sobol-Kwapińska & Jankowski, 2016), satisfaction with interpersonal relations (Stolarski, Wojtkowska, & Kwiecińska, 2016), emotional intelligence (Stolarski, Bitner, & Zimbardo, 2011), and mindfulness (Selma & Sircova, 2013; Stolarski, Wojtkowska, & Kwiecińska, 2016). Moreover, higher BTP is negatively correlated with pathophysiological stress (Olivera-Figueroa, Juster, Morin-Major, Marin, & Lupien, 2015). A more balanced profile of time perspective is related to fluid intelligence and higher executive control, which means that cognitive

abilities play an important role in accepting time balance (Zajenkowski, Stolarski, Witowska, Maciantowicz, & Łowicki, 2016). Time perspective may be important in acquiring skills (crystallized intelligence) and is also thought to influence the results of intelligence tests (Zajenkowski, Stolarski, Maciantowicz, Malesza, & Witowska, 2016). In addition, studies on the relationship between a balanced time perspective and psychological well-being in Chile showed the relativity of the BTP construct. According to researchers, BTP is age-related (Worrell, McKay, & Andrett, 2015) and depends on the social and cultural context (Güell, Orchard, Yopo, & Jamne-Molina, 2015). Webster and Ma (2013) report that, on average, younger adults are inclined to be future-oriented rather than past-oriented, while an average adult tends to be past- rather than future-oriented.

Gratitude, Time, and Age

Although the dimensions of time perspective and their balanced configuration can serve as predictors of numerous essential constituents of life, such as health, happiness, or financial and environmental commitments (Cunningham, Zhang, & Howell, 2015), a systematic literature review does not yield a very large number of studies which explicitly investigate the topic of time perspective and its influence on dispositional gratitude.

Among the first researchers to look for such links were Emmons and McCullough (2003), who observed that approach to the past is crucial to the development of grateful attitudes, which allow people to appreciate their lives in the present. Similarly, Zimbardo and Boyd (2008) postulated a link between a past-positive perspective and dispositional gratitude. They argued that past-positive perspective could play a role in the development of dispositional gratitude. For example, an individual with a past-positive temporal frame may draw on joyful memories associated with the kindness of others. In a more recent study, Watkins (2014) maintains that gratitude amplifies the good in positive memories and that grateful people are more focused on pleasant experiences, being more attentive to what they have than to what they lack. Moreover, Bhullar, Surman, and Schutte (2015) argue that both the past-positive temporal frame, which includes returning to or preserving positive memories of the past, and dispositional gratitude are associated with positive life outcomes such as life satisfaction and well-being. They demonstrate that higher levels of a past-positive temporal perspective are associated with greater gratitude and higher well-being.

Lake (2017) and Roberts (2014) point out that it is even possible to assume the existence of different forms of gratitude in human life. "Past gratitude" appears to be the most common form and consists in being thankful for the good things one has received from others at some point in life. It reflects the positive memories of any constructive or beneficial previous experiences. It relates to positive reminiscence and to recalling pleasant events from the past. According to some researchers (Martínez-Martí & Ruch, 2014; Mehlsen, Platz, & Fromholt, 2003; Palgi & Shmotkin, 2010; Staudinger, Bluck, & Herzberg, 2003), older people tend to focus on the past rather than on other dimensions of time. "Present gratitude" consists in being appreciative of pleasures experienced and gifts received in the "here and now" (Roberts, 2014). This kind of gratitude refers to a positive present event (Zimbardo & Sword, 2017). The focus on the hedonistic present (i.e., present-hedonistic time perspective, PH; Rosenbaum & Ronen, 2013) seems to be characteristic of adolescents in particular. In fact, Zimbardo and Boyd (1999) claim that age is negatively correlated with PH, which confirms that younger people concentrate on "living the moment" to a greater degree than their older counterparts.

Finally, "future gratitude" implies being grateful for the life to come (Roberts, 2014). It is associated with the anticipation of being grateful for future positive experiences (Buck, 2004), as people are often inclined to hold an optimistic view of upcoming events and, consequently, anticipate positive rather than negative episodes (Wang, Gould, & Hou, 2015). Similarly to PH, future time perspective (FTP) is a typical characteristic of adolescents. Empirical research shows that higher chronological age is related to a more limited FTP (Brothers, Chui, & Diehl, 2014; Weiss, Job, Mathias, Grah, & Freund, 2016).

As regards empirical studies on gratitude and temporal perspective, Zhang, Howell, and Stolarski (2013) show that having a BTP is related to high gratitude. Specifically, they prove that individuals with past-positive, present-hedonistic, and future time perspectives report the highest levels of gratitude. By contrast, those with past-negative and present-fatalistic time perspectives report the lowest levels of subjective well-being. In regard to gratitude and future time perspective, Allemand and Hill (2014) assert that individuals who perceive their future time perspective (FTP) as open-ended report higher levels of gratitude in comparison to individuals who view their time as limited. Moreover, the FTP dimension appears to be positively associated with gratitude in the interpersonal domain. People who see their future as full of prospects declare higher levels of gratitude concerning social relationships. In contrast, people who tend to view their future in terms of time limitations, restraints, and boundaries are more grateful for the instrumental areas of life.

Although research on time perspective and gratitude seems clear, a review of the studies on the association between time perspectives and age (Mello & Worrel, 2015) as well as between trait gratitude and age (Chopik, Newton, Ryan, Kashdan, & Jarden, 2017; Froh, Kashdan, Ozimkowski, & Miller, 2009) is not free of inconsistencies and inconclusive findings (Laureiro-Martinez, Trujillo, & Unda, 2017). Some researchers suggest that young people focus more on the future and less on the past and the present (Mello & Worrel, 2006). Other scholars observe that individuals give more attention to the present as they grow older (Zhang & Ho, 2015). Still other research results support the hypothesis suggesting that people in general focus more on the past (Laureiro-Martinez, Trujillo, & Unda, 2017). Similar discrepancies are found in studies on gratitude and age associations. To date, only a few reports have asserted the existence of a positive association between age and gratitude; research results demonstrate, however, that gratitude is higher in older adults than in younger ones (Chopik, Newton, Ryan, Kashdan, & Jarden, 2017; Cosentino, 2014). On the other hand, there are scholars who found little or no associations between age and gratitude (Martínez-Martí & Ruch, 2014; Sood & Gupta, 2012).

In the light of these divergences, the present study is aimed at increasing the overall comprehension of the relationship between gratitude and time perspectives found in adolescents and early adults, including the moderating role of age. We postulate that age can affect the association of PH and FTP with gratitude understood as a disposition and with gratitude understood as a manifestation of character strength. The rationale behind this hypothesis is that during late adolescence and early adulthood young people, thanks to their cognitive development, acquire the ability to reflect on the past, the present, and the future (Blomgren, Svahn, Åström, & Rönnlund, 2016). At the same time, although the two groups are very close to each other in terms of age, developmental changes are quite significant, as adolescents generally start their university studies and early adults usually begin their work and family life. What should also be underlined is that there

are very few studies on the link between the above-mentioned variables (Allemand & Hill, 2014; Chopik, Newton, Ryan, Kashdan, & Jarden, 2017; Lang & Carstensen, 2002), and research in this field is generally focused on specific time dimensions (past, present, or future) (Mello & Worrel, 2015). Based on prior intervention research and on theoretical considerations mentioned above, we formulated the following hypotheses:

1) An increase in past-positive, present-hedonistic, and future dimensions of time perspective will increase gratitude understood as a disposition (GQ-6; McCullough, Emmons, & Tsang, 2002) and as a character strength (IPIP-VIA; Goldberg et al., 2006). The time perspective variables listed will be positive predictors of gratitude.

2) A decrease in the levels of past-negative and present-fatalistic dimensions, which suggest a deviation from balanced time perspective, will increase gratitude understood as a disposition and as a character strength. The time perspective variables listed will be negative predictors of gratitude.

3) Age will moderate the relationship between the present-hedonistic dimension of time perspective and gratitude, as well as between future time perspective and gratitude. More specifically, the relationship will be moderated by age in such a way that the relationship will be stronger in high school students and in undergraduates than in graduates.

Method

Participants and Procedure

The sample consisted of 204 Polish students: high school students (49.5%), undergraduates (20%), and graduates (30.5%). Their age ranged from 17 to 26 ($M = 19.20$, $SD = 2.026$). The sample included an approximately equal number of women and men (44.1% females, 54.4% males, 1.5% did not report their gender). The respondents volunteered to participate in the study, were not rewarded for their participation, and completed a paper-and-pencil survey. Written parental consent was required from all participants under the age of eighteen.

Measures

In order to measure time perspectives and gratitude, we administered a set of questionnaires: the Zimbardo Time Perspective Inventory (ZTPI) by Zimbardo and Boyd (1999), Gratitude Questionnaire – Six Item Form (GQ-6) by McCullough, Emmons, and Tsang (2002), and the International Personality Item Pool – Values in Action (IPIP-VIA) by Goldberg and colleagues (2006).

The Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999), adapted into Polish by Cybis, Rowiñski, and Przepiórka (2012), consists of five scales corresponding to five time orientations: Past-Positive Time Perspective, which measures past events recollected in a positive and nostalgic way (e.g., "It gives me pleasure to think about my past"); Past-Negative Time Perspective, which reflects negative and aversive attitude to the past (e.g., "I think about the bad things that have happened to me in the past"); Present-Hedonistic Time Perspective, which captures pleasure derived from experiencing the "here and now," without considering the past or the future (e.g., "It is important to put excitement in my life"); Present-Fatalistic Time Perspective, which measures focus on the belief that all that happens in life is predetermined and that individual has no influence on their own fate (e.g., "My life path is controlled by forces I cannot influence"); and Future Time Perspective, which measures the respondent's focus on goals and future plans (e.g., "Meeting tomorrow's deadline and doing other necessary work comes before tonight's play"). Responses are rated on a five-

point Likert scale, from *very untrue* (1) to *very true* (5).

Furthermore, we calculated deviation from balanced time perspective (DBTP) in order to determine how ill-balanced each participant was in this respect (Stolarski, Bitner, & Zimbardo, 2011; Zajenkowski, Witowska, Maciantowicz, & Malesza, 2016). The formula that we used for this purpose is based on ZTPI scores and serves as an indicator of BTP (Zhang, Howell, & Stolarski, 2013). From the mathematical point of view, DBTP is the root of the sum of squared deviations of a person's scores (i.e., *ePN*) from the optimal score on each scale (i.e., *oPN*) (Stolarski, Bitner, & Zimbardo, 2011). This method is considered optimal among the existing methods of BTP assessment (Stolarski, Vowinckel, Jankowski, & Zajenkowski, 2016). The formula is as follows:

$$DBTP = \sqrt{(oPN - ePN)^2 + (oPP - ePP)^2 + (oPF - ePF)^2 + (oPH - ePH)^2 + (oF - eF)^2}$$

An ideal score for each TP scale was adopted on the basis of optimal ZTPI raw scores (1.95 [oPN], 4.60 [oPP], 1.50 [oPF], 3.90 [oPH] and 4.00 [oF]) (Zhang, Howell, & Stolarski, 2013; Stolarski, Wiberg, & Osin, 2015).

$$DBTP = \sqrt{(1.95 - 3.42)^2 + (4.60 - 3.13)^2 + (1.50 - 2.42)^2 + (3.90 - 3.96)^2 + (4.00 - 3.10)^2}$$

The lower (i.e., the closer to zero) the DBTP score, the higher the level of balanced time perspective (Zhang, Howell, & Stolarski, 2013).

The Gratitude Questionnaire-6 (GQ-6; McCullough, Kilpatrick, Emmons, & Larson, 2001; McCullough, Emmons, & Tsang, 2002; Emmons, 2004) is a 6-item self-report assessment instrument measuring the experience of gratitude in everyday life (example items: "I have so much in life to be thankful for" or "As I get older I find myself more able to appreciate the people, events, and situations that have been part of my life history"). Participants respond to each item based on a 7-point Likert-type scale (1 – *strongly disagree*; 7 – *strongly agree*). In this sample, the GQ-6 had satisfactory internal consistency (.75).

We also used elements of the *International Personality Item Pool – Values in Action* (IPIP-VIA) by Goldberg and colleagues (2006). The participants rated each gratitude item on a 5-point scale (1 – *very much unlike me*, 5 – *very much like me*). Examples of items are: "Express my thanks to those who care about me" (positive statement) or "Do not see the need to acknowledge others who are good to me" (reverse-coded). The gratitude dimension in our study had good internal consistency (.81).

Results

All the data collected from the above questionnaires were analyzed with the Statistical Package for Social Sciences (SPSS, Version 20). The descriptive statistics (means and standard deviations) for the time perspective dimensions, gratitude, age, and deviation from balanced time perspective are presented in Table 1. We also computed Pearson's *r* correlations between these variables.

As in past research (Zhang, Howell, & Stolarski, 2013), both GQ-6 and IPIP-VIA gratitude scores were positively related to past-positive, present-hedonistic, and future time perspectives. Contrary to what we had expected, however, there was no significant association between gratitude and the remaining dimensions of time perspective, namely past-negative and present-fatalistic. Moreover, as hypothesized, the results revealed that deviation from balanced time perspective correlated negatively with GQ-6 and IPIP-VIA gratitude.

To test if the positive correlates of time perspective could serve as positive predictors of gratitude understood as a disposition and a character strength, with negative correlates having a negative impact on them, we performed a stepwise linear progressive regression analy-

sis (Table 2). The results indicate that the best predictor of GQ-6 gratitude is the past-positive dimension, which explains almost 10% of variance in the dependent variable, $\Delta R^2 = .09$, $R = .304$, $F_{(194, 1)} = 19.630$, $p = .001$. None of the remaining time perspective dimensions accounted for a significant proportion of variance in GQ-6 gratitude level (past-negative, $p = .599$; present-hedonistic, $p = .094$; present-fatalistic, $p = .066$; future, $p = .053$; and balanced time perspective, $p = .060$). The results of the stepwise regression analysis suggest that GQ-6 gratitude may be higher in individuals who reinterpret their past in a positive manner.

The results also show that the best predictors of IPIP-VIA gratitude, which explain almost 20% of variance in the dependent variable ($\Delta R^2 = .205$, $R = .467$, $F_{(185, 3)} = 16.879$, $p = .001$), are the following dimensions of time perspective: past-positive, present-hedonistic, and future. The results of the stepwise regression analysis suggest that IPIP-VIA gratitude may be higher in individuals who have a sentimentally good view of past events, enjoy pleasures experienced "here and now," and strive for long-term goals (Zimbardo & Boyd, 1999).

Finally, in order to check whether age was a moderator of the relationship between gratitude (dispositional and seen as a character strength) and time perspectives (present-hedonistic and future), we performed a moderation analysis with the PROCESS macro developed by Andrew F. Hayes (2018). Hypothesis 3 predicted that participants' age and hedonistic and future time perspectives would interact to affect gratitude, thus resulting in a more positive relationship between hedonistic/future perspectives and gratitude (dispositional gratitude and gratitude as a character strength) in high school students than in undergraduates and graduates.

Table 1 *Means, standard deviations, and correlations between variables*

	M	*SD*	1	2	3	4	5	6	7	8
1. Past-positive	3.13	0.90								
2. Past-negative	3.42	1.08	-.11							
3. Present-hedonistic	3.96	0.66	.35**	-.01						
4. Present-fatalistic	2.42	0.87	.14*	.21**	.10					
5. Future	3.10	0.92	.15*	.03	.00	.03				
6. GQ-6 gratitude	5.08	1.05	.30**	-.06	.21**	-.08	.17*			
7. IPIP-VIA gratitude	3.66	0.69	.41**	.02	.31**	.02	.21**	.72**		
8. Age	19.21	2.02	.13	-.04	-.01	-.01	.21**	.19**	.26**	
9. DBTP	2.34	0.39	-.49**	.64**	-.13	.39**	-.42**	-.26**	-.22**	-.14*

Note. * $p < .05$, ** $p < .01$

Table 2 *Results of stepwise linear regression for the dependent variables (Gratitude GQ-6, Gratitude IPIP-VIA) on independent variables – dimensions of time perspective (N = 204)*

Model	*B*	*SE*	*β*	*t*	*p*
Gratitude GQ-6					
Past-positive	0.359	0.081	0.304	4.431	.001
Gratitude IPIP-VIA					
Past-positive	0.232	0.055	0.302	4.243	.001
Present-hedonistic	0.207	0.072	0.202	2.865	.005
Future	0.122	0.049	0.164	2.484	.014

The dependent variables in these equations were dispositional gratitude and gratitude considered as a character strength. We centered the main effects (e.g., Aiken & West, 1991) in order to reduce multicollinearity between the main effects and the interaction term. As a result of a series of analyses, it became evident that age plays a moderating role only in the case of the relationship between the present-hedonistic perspective and a grateful disposition. The interaction factor is significant in the postulated model (Table 3), and a two-percent increase in the proportion of explained variance is also statistically significant, $\Delta R^2 = .019$; $F_{(200, 1)} = 4.3, p = .039$. Although the small amount of explained variance might imply that the practical relevance of the interaction is marginal, McClelland and Judd (1993) observe that it is rather common for variance explained by interactions in field research to be small.

Table 4 presents the size of the effect of the present-hedonistic perspective in three age groups (high school students, undergraduates, and graduates). It appears that only in the groups of high school students and undergraduates is the impact of the present-hedonistic perspective on dispositional gratitude statistically significant. This influence disappears in the group of graduates, where it proves not to be statistically significant.

Age being a moderator, the strength of the relationship between present-hedonistic time perspective and dispositional gratitude differs across age groups. Figure 1 serves as an illustration of this relationship in the three age groups.

In the case of high school students and undergraduates there was a stronger relationship between the present-hedonistic perspective and dispositional gratitude than in the case of graduates (Figure 1).

Discussion

The purpose of this report is to explain whether time perspective dimensions and balanced time perspective are related to and predict gratitude understood as a disposition and

Table 3 *Results of regression analysis with two predictors and an interaction factor*

					95% CI	
	B	*SE*	*t*	*p*	LL	UL
Constant	30.52	0.42	72.17	.000	29.68	31.35
Age	0.64	0.21	3.00	.003	0.22	1.06
Present-hedonistic time perspective	2.06	0.64	3.23	.002	0.80	3.32
Age x Present-hedonistic time perspective	-0.66	0.32	-2.07	.039	-1.28	-0.03

Table 4 *The effect of the present-hedonistic perspective in three age groups*

					95% CI	
	Effect	*SE*	*t*	*p*	LL	UL
High school students	3.38	0.91	3.69	**.000**	1.57	5.18
Undergraduates	2.06	0.64	3.23	**.002**	0.80	3.32
Graduates	0.75	0.89	0.84	.401	-1.00	2.49

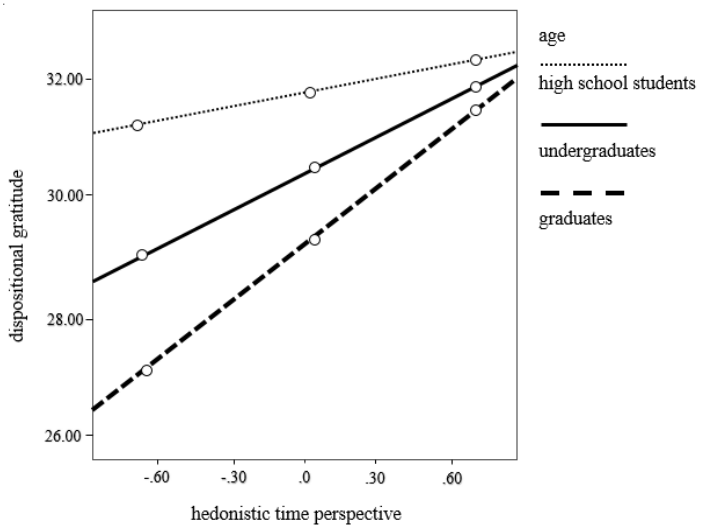

Figure 1 The effect of the present-hedonistic perspective on dispositional gratitude in three age groups.

gratitude understood as a character strength. The report is also meant to clarify the moderating role of age in the relationship between present-hedonistic perspective and gratitude as well as between future time perspective and gratitude.

The results provided above support the first hypothesis, postulating that gratitude is higher in the case of past-positive, present-hedonistic, and future time perspective dimensions. As regards the reverse correlations, the second hypothesis is only partially supported, and exclusively with respect to deviation from balanced time perspective, which was negatively associated with GQ-6 and IPIP-VIA gratitude. Additionally, our analysis has confirmed that age moderates the relationship between present-hedonistic perspective and gratitude. This pattern of outcomes is consistent with some of the previously obtained results (Zhang, Howell, & Stolarski, 2013).

First of all, the past-positive time perspective dimension was positively correlated with and a predictor of gratitude. These findings are consistent with previous studies. Gratitude consists in "counting blessings" (Emmons & McCullough, 2003) and is considered an individual's predisposition to appreciate the perceived benefits and the positive aspects of one's life (McCullough, Emmons, & Tsang, 2002). Moreover, gratitude is conceptualized as retrospective appreciation and thankful response that follows favors received in the past (Hoy, Suldo, & Mendez, 2013). In fact, other outcomes show that gratitude is related to a pervasive sense of abundance, which consists in recalling the benefits and pleasant life events that one has experienced and relished. People who believe that they are entitled to more favors than they have received are not likely to feel gratitude (Watkins, Grimm, & Kolts, 2004). Other research results demonstrate that grate-

ful individuals are likely to evoke subjective events from the past rather than objective ones to a greater extent than less grateful individuals (Watkins, Uhder, & Pichinevskiy, 2015).

Secondly, the research done in the course of the present study additionally reveals an interesting interplay between the present-hedonistic dimension of time perspective and gratitude. The interaction effect between these two variables implies that people who tend to be grateful are distinguished by a focus on experiencing enjoyment and pleasure in the present. There are a few possible explanations for this link. In earlier studies (Holman & Zimbardo, 2009), respondents who demonstrated higher present hedonism declared higher levels of social relationships and reported more assistance from friends and/or acquaintances. Therefore, a positive correlation between the present-hedonistic perspective and gratitude is understandable if one considers the latter as a social emotion (McCullough, Emmons, & Tsang, 2002). Grateful individuals perceive benefits received thanks to other people's generosity, often reciprocate gifts and favors, and thus promote developing positive social ties (Fagley, 2016). At the same time, the results of our study can be perceived from yet another point of view. Over the years, researchers have consistently demonstrated that gratitude correlates positively with satisfaction, which reflects contentment with the quality of one's life (Hoy, Suldo, & Mendez, 2013; Kong, Ding, & Zhao, 2015). People with higher levels of gratitude have a propensity to perceive greater social support from others, which may contribute to an increase in their life satisfaction. An alternative explanation of the association between present-hedonistic perspective and gratitude refers to the mechanisms that have salutary effects on everyday functioning. Kashdan and colleagues (Kashdan, Uswatte, & Julian, 2006) observed that in the Vietnam War veterans gratitude was positively related to daily hedonistic well-being, also referred to as pleasure-attainment and pain-avoidance. Finally, present-hedonistic time perspective gives people energy and helps them enjoy simply being alive (Zimbardo & Boyd, 2008), opening individuals to a sense of appreciation, which is closely related to gratitude (Watkins & Bell, 2017).

Thirdly, we found that future time perspective was positively correlated with gratitude, although this outcome may seem surprising, as gratitude is generally associated with past and present time perspectives. Our findings, however, are consistent with an earlier study by Zhang, Howell, and Stolarski (2013), who reported the same kind of association. Moreover, Macaskill and Denovan (2014) observed that both gratitude and hope agency predicted life satisfaction. In the context of time perspective, gratitude and hope may connect the past and the future (Harvey & Pauwels, 2004) and in the framework of conceptions developed by Peterson and Seligman (2004), overall well-being or psychological fulfillment can be attained by maintaining positive levels of emotions pertaining to the past (e.g., gratitude, forgiveness), present (e.g., satisfaction with life), and future (e.g., hope) (Hoy, Suldo, & Mendez, 2013).

Another outcome concerns balanced time perspective and gratitude. Regardless of the lack of predicting value of DBTP on gratitude, we found that past-positive, present-hedonistic, and future dimensions of time perspective correlated positively with GQ-6 grateful disposition and IPIP-VIA gratitude, and that they were predictors of IPIP-VIA gratitude. Furthermore, the optimal BTP profile, measured with DBTP, was associated with both types of gratitude. These results allow us to cautiously conclude that the components of an optimally balanced time perspective (PP, PH, and F) blend and engage in triggering grateful situations. In this regard, Webster and Ma (2013) observed that discovering support, strength, and personal meaning by examining one's own past, as well

as attaining a sense of happiness in the present and having a clear sense of future purpose, are associated with higher scores on well-being measures. Other studies confirm that expressing gratitude increases the sense of well-being (Boniwell & Zimbardo, 2004; Watkins, 2014; Wood et al., 2005). On the basis of our research, one can safely state that people with BTP are capable of acting gratefully within a temporal mode suitable for the condition in which they find themselves at a particular moment of life. Thus, recollecting the past, experiencing the present, and facing the future may predict a grateful disposition and gratitude as a human strength.

Finally, in accordance with our assumptions, age proved to be a moderator in the association between present-hedonistic time perspective and dispositional gratitude: this association was stronger in both younger clusters than in graduates. Although there are no similar studies presenting analogous results, our outcomes are in line with some of the previous theoretical and empirical findings. Firstly, according to the developmental approach, adolescents attribute more importance to self-oriented values (hedonism, power, achievement) than adults (Schwartz, 2012) and exhibit a more evident present perspective (Siu, Lam, Le, & Przepiórka, 2014). Focus on the "here and now" experience may help them to perceive the benefits of the present moment. In fact, Watkins (2014) maintains that grateful people, who are more focused on pleasant events, tend to be more attentive to what they currently have. This is related to research showing that a more pronounced present perspective at the expense of the future perspective is linked to lower ability to delay gratification (Wittmann, Rudolph, Linares Gutierrez, & Winkler, 2015). Furthermore, individuals with a hedonistic orientation toward the present perceive their life as more purposeful (Sobol-Kwapińska & Jankowski, 2016). Such an attitude may also indicate their appreciative approach to life. On the other hand, graduates may focus less on the present-hedonistic perspective and assume a future time perspective as they finish their studies, enter the job market, and make critical decisions about family life. Even though graduates can be considered relatively young, they are emerging adults who start to display a different future perspective than they did a few years earlier, when they mainly concentrated on finishing their high school, passing their final exams, and starting their university education. In fact, some researchers (Creten, Lens, & Simons, 2001; Siu, Lam, Le, & Przepiórka, 2014) observe that many high school students live with a rather short future time perspective and are more present-oriented than adults, which makes it challenging for them to take the future into account in the "here and now." Ferrari, Nota, and Soresi (2010) came to a similar conclusion, proving that future orientation was stronger in older adolescents than in younger ones.

Conclusions

Our study has a number of significant strengths, one of them being its innovative character, given that there are not enough studies specifically focusing on the topic of time perspective as related to grateful disposition in adolescents and emerging adults. Yet, it is not free from significant limitations that need to be acknowledged and addressed. The first one is the use of self-report instruments, which are subject to social desirability bias. Nevertheless, self-report techniques remain an acceptable method of assessing time perspectives and gratitude. Another limitation stems from the fact that our study was cross-sectional; this kind of design makes it possible to measure group differences, but it reveals neither the direction of causal relationships between the variables nor patterns of individual change over time. As a result, we believe that future studies should

examine the relationship between time perspectives, gratitude, and age using a longitudinal design tracking the determinants of growth and change on the personal level. Moreover, due to the fact that a large part of our study is correlational in nature, explaining the relationships we found in terms of cause and effect proves quite problematic. Therefore, another methodological recommendation would be to apply an experimental approach, which has the potential for investigating causation.

The results of our research may have some practical implications as well, especially as regards interventions promoting gratitude in high school students and undergraduates. It seems that being grateful at this stage of life is related to savoring pleasures in the present. Therefore, young people's capacity to appreciate and enjoy the present moment may help them to develop general thankfulness for simple events and for the things they experience daily. This kind of approach to the present has its advantages, as it supports confidence in oneself ("I am worthy of other people's attention and kindness") and others ("People around me are caring and benevolent"). The emotional cognition toward issues found good, valuable, and satisfactory may thus increase adolescents' active engagement in and responsibility for both today and tomorrow.

References

Allemand, M., & Hill, P. L. (2014). Gratitude from early adulthood to old age. *Journal of Personality*, *84*, 21–35.

Barsics, C., Rebetez, M. M. L., Rochat, L., D'Argembeau, A., & Van der Linden, M. (2017). A French version of the Balanced Time Perspective Scale: Factor structure and relation to cognitive reappraisal. *Canadian Journal of Behavioural Science / Revue Canadienne des Sciences du Comportement*, *49*, 51–57.

Bhullar, N., Surman, G., & Schutte, N. S. (2015). Dispositional gratitude mediates the relationship between past-positive temporal frame and well-being. *Personality and Individual Differences*, *76*, 52–55.

Blomgren, A. S., Svahn, K., Åström, E., & Rönnlund, M. (2016). Coping strategies in late adolescence: Relationships to parental attachment and time perspective. *The Journal of Genetic Psychology*, *177*(3), 85–96.

Boniwell, I., Osin, E., Linley, A. P., & Ivanchenko, G. V. (2010). A question of balance: Time perspective and well-being in British and Russian samples. *Journal of Positive Psychology*, *5*, 24–40.

Boniwell, I., & Zimbardo, P. G. (2004). Balancing one's time perspective in pursuit of optimal functioning. In P. A. Linley & S. Joseph (Eds.), *Positive psychology in practice* (pp. 165–180). Hoboken, NY, US: Wiley.

Brothers, A., Chui, H., & Diehl, M. (2014). Measuring future time perspective across adulthood: Development and evaluation of a brief multidimensional questionnaire. *The Gerontologist*, *54*, 1075–1988.

Buck, R. (2004). The gratitude of exchange and gratitude of caring: A developmental-interactionist perspective of moral emotion. In R. A. Emmons & M. E. McCullough (Eds.), *The psychology of gratitude* (pp. 100–122). New York, NY, US: Oxford University Press.

Carstensen, L. L. (2006). The influence of a sense of time on human development. *Science*, *312*, 1913–1915.

Chopik, W. J., Newton, N. J., Ryan, L. H., Kashdan, T. B., & Jarden, A. J. (2017). Gratitude across the life span: Age differences and links to subjective well-being. *The Journal of Positive Psychology*, DOI: 10.1080/17439760.2017.141496.

Cosentino, A. C. (2014). Character strengths: Measurement and studies in Argentina with military and general population samples. In A. Castro Solano (Ed.), *Positive psychology in Latin America: Cross-cultural advancements in positive psychology* (pp. 111–127). Dordrecht: Springer.

Creten, H., Lens, W., & Simons, J. (2001). The role of perceived instrumentality in student motivation. In A. Efklides, J. Kuhl, & R. M. Sorrentino (Eds.), *Trends and prospects in motivation research* (pp. 37–45). Dordrecht: Kluwer Academic Publishers.

Cunningham, K. F., Zhang, J. W., & Howell, R. T. (2015). Time perspectives and subjective well-being: A dual-pathway framework. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory; Review, research, and application: Essays in honor of Philip G. Zimbardo* (pp. 403–415). New York, NY, US: Springer.

Cybis, N., Rowiński, T., & Przepiórka, A. (2012). Development of the Polish version of Zimbardo Time Perspective Inventory. Poster presented at the 1st International Conference on Time Perspective, Portugal, September 5-8, 2012.

Daughtery, P. J., & Hand, E. (2009). *The unexpected gift: Inspirational stories of hope and significance*. Bloomington, IN, US: iUniverse.

Drake, L., Ducan, E., Sutherland, F., Abernethy, C., & Henry, C. (2008). Time perspective and correlates of wellbeing. *Time & Society*, *17*, 47–61.

Emmons, R. A. (2013). *Gratitude works! A 21-day program for creating emotional prosperity*. San Francisco, CA, US: Jossey-Boss.

Emmons, R. A., & McCullough, M. E. (2003). Counting blessings versus burdens: An experimental investigation of gratitude and subjective well-being in daily life. *Journal of Personality and Social Psychology*, *84*, 377–389.

Fagley, N. S. (2016). The construct of appreciation: It is so much more than gratitude. In D. Carr (Ed.), *Perspectives on gratitude: An interdisciplinary approach* (pp. 70–84). New York, NY, US: Routledge.

Ferrari, L., Nota, L., & Soresi, S. (2010). Time perspective and indecision in young and older adolescents. *British Journal of Guidance and Counselling*, *38*, 61–82.

Fox, G. R., Kaplan, J., Damasio, H., & Damasio, A. (2015). Neural correlates of gratitude. *Frontiers in Psychology*, *6*, 1–11. doi.org/10.3389/psyg.2015.01491.

Froh, J. J., Kashdan, T. B., Ozimkowski, K. M., & Miller, N. (2009). Who benefits the most from a gratitude intervention in children and adolescents? Examining positive affect as a moderator. *The Journal of Positive Psychology*, *4*, 408–422.

Froh, J. J., Miller, D. N., & Snyder, S. (2007). Gratitude in children and adolescents: Development, assessment, and school based intervention. *School Psychology Forum*, *2*, 1–13.

Gao, Y. (2011). Time perspective and life satisfaction among young adults in Taiwan. *Social Behavior and Personality: An International Journal*, *39*, 729–736.

Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. G. (2006). The international personality item pool and the future of public-domain personality measures. *Journal of Research in Personality*, *40*, 84–96.

Greenstein, M., & Holland, J. (2015). *Lighter as we go: Virtues, character strengths, and aging*. New York, NY, US: Oxford University Press.

Güell, P., Orchard, M., Yopo, M., & Jamne-Molina, A. (2015). Time perspectives and subjective wellbeing in Chile. *Social Indicators Research*, *123*, 127–141.

Harvey, J. H., & Pauwels, B. G. (2004). Modesty, humility, character strength, and positive psychology. *Journal of Social and Clinical Psychology*, *23*, 620–623.

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY, US: The Guilford Press.

Holman, E. A., & Zimbardo, P. G. (2009). The social language of time: The time perspective–social network connection. *Basic and Applied Social Psychology*, *31*, 136–147.

Hoy, B. D., Suldo, S. M., & Mendez, L. R. (2013). Links between parents' and children's levels of gratitude, life satisfaction, and hope. *Journal of Happiness Studies*, *14*, 1343–1361.

Jackson, L. (2016). Why should I be grateful? The morality of gratitude in context marked by injustice. *Journal of Moral Education*, *45*, 276–290.

Jiang, H., Sun, P., Liu, Y., & Pan, M. (2016). Gratitude and late adolescents' school well-being: The mediating role of materialism. *Social Indicators Research*, *127*, 1363–1376.

Kashdan, T. B., Uswatte, G., & Julian, T. (2006). Gratitude and hedonic and eudaimonic well-being in Vietnam war veterans. *Behaviour Research and Therapy*, *44*, 177–199.

Killen, A., & Macaskill, A. (2015). Using a gratitude intervention to enhance well-being in older adults. *Journal of Happiness Studies*, *16*, 947–964.

Kong, F., Ding, K., & Zhao, J. (2015). The relationship among gratitude, self-esteem, social support and life satisfaction among undergraduate students. *Journal of Happiness Studies*, *16*, 477–489.

König, S., & Glück, J. (2014). "Gratitude is with me all the time": How gratitude relates to wisdom. *Journals of Gerontology, Seiries B: Psychological Sciences and Social Sciences*, *69*, 655–666.

Lake, G. (2017). *Getting free: Moving beyond negativity and limiting beliefs*. Los Gatos, CA, US: Smashwords Edition.

Lang, F. R., & Carstensen, L. L. (2002). Time counts: Future time perspective, goals and social relationships. *Psychology and Aging*, *17*, 125–139.

Laureiro-Martinez, D., Trujillo, C., & Unda, J. (2017). Time perspective and age: A review of age associated differences. *Frontiers in Psychology*, *8*(101). https://doi.org/10.3389/fpsyg.2017.00101.

Lewin, K. (1942). Time perspective and morale. In G. Watson (Ed.), *Civilian morale. Second yearbook of the S.P.S.S.L.* (pp. 103–124). Boston, MA, US: Houghton Mifflin.

Lewin, K. (1946). Behavior and development as a function of total situation. In L. Carmichael (Ed.), *Manual of child psychology* (pp. 791–844). New York, NY, US: Wiley.

Macaskill, A., & Denovan, A. (2014). Assessing psychological health: The contribution of psychological strengths. *British Journal of Guidance & Counselling*, *42*, 320–337.

Martínez-Martí, M. L., & Ruch, W. (2014). Character strengths and well-being across the life span: Data from a representative sample of German-speaking adults living in Switzerland. *Frontiers in Psychology*, *5*, 1–10. doi: 10.3389/fpsyg.2014.01253.

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of defecting interactions and moderator effect. *Psychological Bulletin*, *114*, 376–390.

McCullough, M. E., Emmons, R. A., & Tsang, J. A. (2002). The grateful disposition: A conceptual and empirical topography. *Journal of Personality and Social Psychology*, *82*, 112–127.

Mehlsen, M., Platz, M., & Fromholt, P. (2003). Life satisfaction across the life course: Evaluations of the most and least satisfying decades of life. *International Journal of Aging and Human Development*, *57*, 217–236.

Mello, Z. R., & Worrell, F. C. (2006). The relationship of time perspective to age, gender, and academic achievement among academically talented adolescents. *Journal for the Education of the Gifted*, *29*, 271–289.

Mello, Z. R., & Worrell, F. C. (2015). The past, the present, and the future: A conceptual model of time perspective in adolescence. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory: Review, research and application. Essays in honor of Philip G. Zimbardo* (pp. 115–129). New York, NY, US: Springer.

Mroczek, D. K., & Kolarz, C. M. (1998). The effect of age on positive and negative affect: A developmental perspective on happiness. *Journal of Personality and Social Psychology*, *75*, 1333–1349.

Najderska, M., & Cieciuch, J. (2013). Polska adaptacja kwestionariusza do pomiaru mocnych stron charakteru International Personality Item Pool – Values in Action (IPIP-VIA): Wyniki wstępne [A Polish adaptation of the questionnaire for measuring character strengths, the International Personality Item Pool – Values in Action (IPIP-VIA): Preliminary results]. *Studia Psychologica*, *13*, 65–83.

Nielsen, L., Knutson, B., & Carstensen, L. L. (2008). Affect dynamics, affective forecasting, and aging. *Emotion*, *8*, 318–330.

Nurmi, J. E. (1991). How do adolescents see their future? A review of the development of future – orientation and planning. *Developmental Review*, *11*, 1–59.

Nuttin, J. (1985). *Future time perspective and motivation*. Leuven – Hillsdale: Leuven University Press – Erlbaum.

Olivera-Figueroa, L. A., Juster, R. P., Morin-Major, J. K., Marin, M. F., & Lupien, S. J. (2015). A time to be stressed? Time perspectives and cortisol dynamics among healthy adults. *Biological Psychology*, *111*, 90–99.

Oyanadel, C., Buela-Casal, G., Araya, T., Olivares, C., & Vega, H. (2014). Percepción del tiempo: Resultados de una intervención grupal breve para el cambio del perfil temporal. *Suma Psicológica*, *21*, 1–7.

Palgi, Y., & Shmotkin, D. (2010). The predicament of time near the end of life: Time perspective trajectories of life satisfaction among the old-old. *Aging and Mental Health*, *14*, 577–586.

Park, N., Peterson, C., & Seligman, M. E. P. (2004). Strengths of character and well-being. *Journal of Social and Clinical Psychology*, *23*, 603–619.

Peterson, C., & Seligman, M. E. P. (2004). *Character strengths and virtues: A handbook and classification*. New York, NY, US: Oxford University Press.

Polak, E., & McCullough, M. E. (2006). Is gratitude an alternative to materialism? *Journal of Happiness Studies*, *7*, 343–360.

Roberts, R. (2014). *God confidence: A practical guide for reaching the Divine zone*. Bloomington, IN, US: Balboa Press.

Robustelli, B. L., & Whisman, M. A. (2018). Gratitude and life satisfaction in the United States and Japan. *Journal of Happiness Studies*, *19*, 41–55.

Rosenbaum, M., & Ronen, T. (2013). Emotional well-being and self-control skills of children and adolescents: The Israeli perspective. In C. L. M. Keyes (Ed.), *Mental well-being* (pp. 209–229). Dordrecht: Springer.

Schwartz, S. H. (2012). Values and religion in adolescent development: Cross-national and comparative evidence. In G. Tromsdorff & X. Chen (Eds.), *Values, religion, and culture in adolescent development* (pp. 97-122). Cambridge: Cambridge University Press.

Selma, R., & Sircova, A. (2013). Mindfulness – A time perspective? Estonian study. *Baltic Journal of Psychology*, *14*, 4–21.

Simons, M., Peeters, S., Janssens, M., Lataster, J., & Jacobs, N. (2016). Does age make a difference? Age as moderator in the association between time perspective and happiness. *Journal of Happiness Studies*, *6*, 1–11.

Siu, N. Y. F., Lam, H. H. Y., Le, J. Y. Y., & Przepiórka, A. (2014). Time perception and time perspective differences between adolescents and adults. *Acta Psychologica*, *151*, 222–229.

Sobol-Kwapińska, & M., Jankowski, T. (2016). Positive time: Balanced time perspective and positive orientation. *Journal of Happiness Studies*, *17*, 1511–1528.

Sood, S., & Gupta, R. (2012). A study of gratitude and well-being among adolescents. *Journal of Humanities and Social Science*, *3*, 35–38.

Staudinger, U. M., Bluck, S., & Herzberg, P. Y. (2003). Looking back and looking ahead: Adult age differ-

ences in consistency of diachronous ratings of subjective well-being. *Psychology and Aging*, *18*, 13–24.

Stolarski, M. (2016). Not restricted by their personality: Balanced time perspective moderates well-established relationships between personality traits and well-being. *Personality and Individual Differences*, *100*, 140–144.

Stolarski, M., Bitner, J., & Zimbardo, P. G. (2011). Time perspective, emotional intelligence and discounting of delayed awards. *Time & Society*, *20*, 346–363.

Stolarski, M., Matthews, G., Postek, S., Zimbardo, P. G., & Bitner, J. (2014). How we feel is a matter of time: Relationships between time perspectives and mood. *Journal of Happiness Studies*, *15*, 809–827.

Stolarski, M., Vowinckel, J., Jankowski, K. S., & Zajenkowski, M. (2016). Mind the balance, be contented: Balanced time perspective mediates the relationship between mindfulness and life satisfaction. *Personality and Individual Differences*, *93*, 27–31.

Stolarski, M., Wiberg, B., & Osin, E. (2015). Assessing temporal harmony: The issue of a balanced time perspective. In M. Stolarski, N. Fieulaine, & W. van Beek (Eds.), *Time perspective theory: Review, research and application. Essays in honor of Philip G. Zimbardo* (pp. 57–71). New York, NY, US: Springer.

Stolarski, M., Wojtkowska, K., & Kwiecińska, M. (2016). Time for love: Partners' time perspectives predict relationship satisfaction in romantic heterosexual couples. *Time & Society*, *25*, 552–574.

Sun, P., & Kong, F. (2013). Affective mediators of the influence of gratitude on life satisfaction in late adolescence. *Social Indicators Research*, *114*, 1361–1369.

Wang, Q., Gould, T., & Hou, Y. (2015). Is the future always brighter than the past? Anticipation of changes in the personal future after recall of past experiences. *Memory*, *23*, 178–186.

Wang, D., Wang, Y. C., & Tudge, J. R. H. (2015). Expressions of gratitude in children and adolescents: Insights from China and the United States. *Journal of Cross-Cultural Psychology*, *46*, 1039–1058.

Watkins, P. C. (2014). *Gratitude and the good life: Toward a psychology of appreciation*. New York, NY, US: Springer.

Watkins, P. C., & Bell, J. (2017). Current theories and research in the psychology of gratitude. In M. A. Warren & S. I. Donaldson (Eds.), *Scientific advances in positive psychology* (pp. 103–129). Santa Barbara, CA, US: Praeger.

Watkins, P. C., Grimm, D. L., & Kolts, R. (2004). Counting your blessings: Positive memories among grateful persons. *Current Psychology*, *23*, 52–67.

Watkins, P. C., Uhder, J., & Pichinevskiy, S. (2015). Grateful recounting enhances subjective well-being: The importance of grateful processing. *Journal of Positive Psychology*, *2*, 91–98.

Webster, J. D. (2011). A new measure of time perspective: Initial psychometric findings for the Balanced Time Perspective Scale (BTPS). *Canadian Journal of Behavioural Science/Revue Canadienne des Sciences du Comportement*, *43*, 111–118.

Webster, J. D., & Ma, X. (2013). A balanced time perspective in adulthood: Well-being and developmental effects. *Canadian Journal of Aging*, *32*, 433–442.

Weiss, D., Job, V., Mathias, M., Grah, S., & Freund, A. M. (2016). The end is (not) near: Aging, essentialism, and future time perspective. *Developmental Psychology*, *52*, 996–1009.

Wittmann, M., Rudolph, T., Linares Gutierrez, D., & Winkler, I. (2015). Time perspective and emotion regulation as predictors of age-related subjective passage of time. *International Journal of Environmental Research and Public Health*, *12*, 16027–16042.

Wood, A., Froh, J., & Geraghty, A. (2010). Gratitude and well-being: A review and theoretical integration. *Clinical Psychology Review*, *30*, 890–905.

Wood, S., Busemeyer, J., Koling, A., Cox, C. R., & Davis, H. (2005). Older adults as adaptive decision makers: Evidence from Iowa gambling task. *Psychology and Aging*, *20*, 230–225.

Worrell, F. C., McKay, M. T., & Andrett, J. R. (2015). Concurrent validity of Zimbardo Time Perspective Inventory profiles: A secondary analysis of data from the United Kingdom. *Journal of Adolescence*, *42*, 128–139.

Zajenkowski, M., Stolarski, M., Maciantowicz, O., Malesza, M., & Witowska, J. (2016). Time to be smart: Uncovering a complex interplay between intelligence and time perspectives. *Intelligence*, *58*, 1–9.

Zajenkowski, M., Stolarski, M., Witowska, J., Maciantowicz, O., & Łowicki, P. (2016). Fluid intelligence as a mediator of the relationship between executive control and balanced time perspective. *Frontiers in Psychology*, *22*, 1844. doi: 10.3389/fpsyg.2016.01844.

Zajenkowski, M., Witowska, J., Maciantowicz, O., & Malesza, M. (2016). Vulnerable past, grandiose present: The relationship between vulnerable and grandiose narcissism, time perspective and personality. *Personality and Individual Differences*, *98*, 102–106.

Zhang, X., & Ho, Y. W. (2015). In the pursuit of emotionally meaningful goals: When would the older East-Asians display or not to display the positivity

effect? In S. T. Cheng, I. Chi, H. Fung, L. Li, & J. Woo (Eds.), *Successful aging* (pp. 283–300). Dordrecht: Springer.

Zhang, J. W., Howell, R. T., & Stolarski, M. (2013). Comparing three methods to measure a balanced time perspective: The relationship between a balanced time perspective and subjective well-being. *Journal of Happiness Studies*, *14*, 169–184.

Zimbardo, P. G., & Boyd, J. N. (1999). Putting time in perspective: A valid, reliable, individual-differences metric. *Journal of Personality and Social Psychology*, *77*, 1271–1288.

Zimbardo, P. G., & Boyd, J. N. (2008). *The time paradox. The new psychology of time what will change your life*. New York, NY, US: Free Press.

Zimbardo, P. G., & Sword, R. K. M. (2017). *Living and loving better with time perspective therapy: Healing from the past, embracing the present, creating an ideal future*. Jefferson, NC, US: Exposit Books.

Studia Psychologica, Vol. 60, No. 3, 2018, 167-182 doi: 10.21909/sp.2018.03.760

Academic Self-Concept and the Use of Tablet Technologies in Czech and Slovak Schools

Radomír Masaryk
Faculty of Social and Economic Sciences, Comenius University
Bratislava, Slovak Republic

Lenka Sokolová
Faculty of Education, Comenius University
Bratislava, Slovak Republic

Mária Kénesy Túnyiová
Institute of Experimental Psychology, CSPS Slovak Academy of Sciences
Bratislava, Slovak Republic

New technologies are being increasingly introduced into classrooms as new tools for learning. This is however often done regardless of any academic evidence concerning their impact. Our objective was to identify differences in Academic Self-Concept in students before and after using tablet technologies in education. A total of 490 students aged 10 to 17 from 10 schools in Slovakia and 12 schools in Czechia were enrolled in a 6-month trial, in which instruction was conducted via tablets and touchscreen boards. Our findings showed that the Academic Self-Concept scores of children, who had below-average Academic Self-Concept scores, improved over the trial. However, initial above-average scores tended to decrease throughout the trial. Incorporating technologies into the educational process does not appear to have the potential to be associated with an increase in Academic Self-Concept in students overall. We believe that those who score low on Academic Self-Concept may benefit from the overall motivating effect of the intervention, and from the chance to experience success in novel educational situations.

Key words: education, self-concept, academic self-concept, tablets

Introduction

Academic research on the effect of using new classroom technologies on student outcomes is still far from comprehensive.

On one hand, there is some evidence to suggest that digital technologies have desirable effects on student outcomes. For example, Jackson, von Eye, Fitzgerald, Zhao, and Witt (2010) studied the effect of Internet, cellular-phone, and computer-game use on academic

Acknowledgements
The authors wish to thank the members of data collection teams: the Slovak data team consisted of Radomír Masaryk, Lenka Sokolová, Slavomíra Vaňová, Zuzana Púčeková, and Simona Kralovičová; Czech data were collected by Radomír Masaryk, Aleš Neusar, Lucie Viktorová, Simona Kralovičová, Tereza Janásová, and Jana Nemcová. The authors would also like to thank EDULAB in the Slovak Republic, especially Ján Trubač, Ján Machaj, and Miloš Bielik; and EDUkační LABoratoř, z.s. in the Czech Republic, especially Michal Orság and Richard Valenta, for their support. We also acknowledge the patience and dedication of teachers, administrators and pupils from the 22 schools involved in the entire project.

Correspondence concerning this article schould be addressed to Radomír Masaryk, Institute of Applied Psychology, Faculty of Social and Economic Sciences, Comenius University in Bratislava, Mlynské Luhy 4, 821 05 Bratislava, Slovak Republic. E-mail: radomir.masaryk@fses.uniba.sk

Received January 3, 2018

performance and social and overall self-esteem, and found that Internet use leads to higher scores on standardized reading skills tests and higher overall self-esteem. Kucirkova, Messer, and Sheehy (2014; see also Kucirkova & Littleton, 2017) found that reading personalized books with preschool children enhances vocabulary acquisition. Others have explored the use of digital technologies in specific domains, such as mathematics (Sinclair & Baccaglini-Frank, 2016) or the use of digital technologies for autism (Parsons, Yuill, Brosnan, & Good, 2017). Finnish researchers (Salmela-Aro, Muotka, Alho, Hakkarainen, & Lonka, 2016) found that almost half (46%) of the elementary students in their sample felt some degree of cynicism toward school; those students reported that they would be more engaged if socio-digital technologies were used at school.

On the other hand, other experts, parents, and educators have expressed reservations regarding the use of technologies in schools, and suggested that technologies are of no significant benefit to education. A study by Clements (2002) claims the computer has no single effect on mathematics achievement. Others point to the negative impact technology has on children's health (e.g., the lack of physical activity, or its detrimental effect on eyesight), the risk that technology may be overused or misused (e.g., technology addiction or cyber bullying), and potential deterioration in cognitive skills due to excessive technology use from early childhood. Spitzer's Digital Dementia is a notable example of this kind of critique (Spitzer, 2012). A study by Uhls et al. (2014) suggests that screen time may compromise social skills in sixth graders. More recently Ravizza, Uitvlugt, and Fenn (2016) have warned that nonacademic Internet use among students who bring laptops to class was inversely related to class performance; they concluded that class-related Internet use did not benefit classroom performance.

Building on the existing research, this article presents the findings of a research project on the use of tablets in 22 classrooms across the Slovak Republic and the Czech Republic, and their effect on student self-concept.

The outcome measure we opted for is Academic Self-Concept. The rationale behind this was that digital technologies that enable individualized and incremental learning may benefit students by enhancing their perceptions of their own success and motivating them to study. The main objective of the present paper is to explore possible associations between the use of digital technologies (in our case tablets) and Academic Self-Concept in pupils.

Self-concept is defined as 'a person's perceptions of him- or herself formed through experience with and interpretations of one's environment' (Marsh & Shavelson, 1985, p. 107). It is viewed as a dynamic multifaceted and hierarchically organized construct with descriptive as well as evaluative aspects (Zeidner & Schleyer, 1998; Marsh & Shavelson, 1985). Children develop their self-concepts through interaction within their social settings and responding to feedback from others (Zeidner & Schleyer, 1998). As individuals move from childhood to adolescence and adulthood, their self-concept becomes increasingly multifaceted (Marsh & Shavelson, 1985; Guay, Marsh, & Boivin, 2003).

Educational researchers such as Marsh and Shavelson (1985), Bong and Skaalvik (2003) and Chapman (1989) hold the view that there is a separate dimension of self-concept that relates to school performance, known as Academic Self-Concept. This is different from academic performance. Boersma and Chapman (1979, in Chapman, 1989) describe Academic Self-Concept as a relatively stable set of attitudes and affective variables, which reflect one's perception of oneself, self-evaluation, and attitudes related to school-task achievement. Academic Self-Concept relates to the individual's knowl-

edge and perceptions of him/herself in academic achievement situations (Ferla, Valcke, & Cai, 2009); it refers to a person's interest, enjoyment, and perceptions of his or her own competency in a given academic domain (Zhan & Mei, 2013). Academic Self-Concept develops through the individual experiencing success or failure in school tasks, reflecting on the school performance of peers, and being assessed by authority figures (e.g., teachers) and peers (Vágnerová, 2001).

Muijs (1997) analyzed studies on the relationship between school achievement and Academic Self-Concept from various countries and concluded that there is a positive relation between these two phenomena. The positive correlations between Academic Self-Concept and academic achievement (school grades or test scores) indicate that a higher Academic Self-Concept may lead to higher academic achievement (Zhan & Mei, 2013; Chapman, 1989). Other researchers assume there is a reciprocal relation between the two constructs: Academic Self-Concept may both be a result of and affect the individual's academic achievement (Guay et al., 2003; Marsh, Trautwein, Lüdtke, Köller, & Baumert, 2005; Ju, Zhang, & Katsiyannis, 2012).

The relationship between academic achievement and Academic Self-Concept has mostly been studied in the general school population. However, Ju et al. (2012) studied this relationship among school students with various types of disabilities and special educational needs. Their findings confirmed that in this group of students, similarly to the general school population, positive self-concept had a significant effect on academic success. When students experience positive feelings of mastery in school, their academic achievement may improve.

Academic Self-Concept positively correlates with external factors in young children (Guay et al., 2003) such as accomplishments, achievement, self-concepts inferred by significant others (Guay et al., 2003), socio-economic background, the number of books at home, time parents spend reading to children, and methods of instruction adopted in schools (Stringer & Heath, 2008).

The most discussed factor relating to Academic Self-Concept is gender differences. Classic studies from the United States of America (Chapman, 1989) consistently confirmed gender differences in global Academic Self-Concept: girls reported higher self-perceptions than boys. More recent studies (Marsh et al., 2015) have not found significant differences in global Academic Self-Concept but have identified differences in specific domains. Cross-sectional and longitudinal studies have revealed that boys report higher self-perceptions of physical ability, physical appearance, and mathematics self-perceptions, while girls report higher verbal self-perceptions (Marsh et al., 2005). Sullivan (2009) analyzed complex data on the Academic Self-Concept of a 1958 cohort and reported gender-stereotyped differences between boys and girls. Sáinz and Eccles (2012) studied gender differences in self-concept in mathematics and computer studies and found a higher Academic Self-Concept in boys than in girls. Similar results were obtained by Jansen, Schroeders, and Lüdtke (2014) for science-related (physics, biology, and chemistry) Academic Self-Concept.

Marsh et al. (2005) described stereotyped gender differences between the verbal and mathematics domains. A Czech study by Skopal, Dolejš, and Suchá (2014) found that there was a slight tendency for mathematics self-concept to decrease in cross-sectional comparison, while verbal and general ability self-concept seemed to be more stable. Academic Self-concept scores were compared among 11, 12, 13, 14, and 15-year-old students ($N = 4117$): the highest mathematics self-concept was recorded in the 11-year-old students, while older students had a lower one. According to Skaalvik and Skaalvik (2004), older students had a higher verbal than

mathematics self-concept, regardless of gender. Marsh (in Marsh et al., 2015) later added the internal/external frame of reference model. Based on this theory, achievement in each domain has a positive effect on self-concept in the matching domain (e.g., achievement in mathematics has a positive effect on mathematics self-concept) but a negative effect on self-concept in the non-matching domain (e.g., achievement in mathematics has a negative effect on verbal self-concept).

Could an intervention change Academic Self-Concept scores? Boersma, Chapman, and Battle (1979) compared Academic Self-Concept among children with developmental learning disorders ($N = 50$) and intellectual disabilities ($N = 18$). Following a change in educational setting (full-time remedial placement), these children reported significant improvement in Academic Self-Concept. The introduction of a new method of instruction or an intervention in the school environment had mixed results among the general population, while students with special educational needs or of low socioeconomic status may profit more (Page, 2002). Despite the relative stability of general self-concept, intervention in the educational setting may lead to a significant improvement in Academic Self-Concept, especially in students with special educational needs (see also research by Chiang and Jacobs, 2009, in which academic self-concept was found to improve in students who received software-specific computer-based instruction).

Research Objectives

Our main research objective was to assess the difference in Academic Self-Concept before implementing the tablet project and after several months of using tablets in classrooms. We also intended to measure gender differences in all dimensions of Academic Self-Concept in pre-test measurements, to see whether girls and boys differed in Academic Self-Concept. We were also interested in the comparison of the differences between pre-test and post-test, independently in these two groups. Finally, we wanted to see if Academic Self-Concept would change less or more in those students who had lower initial Academic Self-Concept scores before the program, compared to students with higher initial Academic Self-Concept. Once we had established our objectives, we formulated three research questions:

1) Would the Academic Self-Concept change in students over the duration of our trial?

2a) Would there be a difference in Academic Self-Concept between girls and boys?

2b) Would Academic Self-Concept change after using tablets in school differently in girls and boys?

3) Would changes in academic self-concept and its components differ according to the initial pre-test scores?

Method

Project Description and Protocol

Ten schools from the Slovak Republic (2013/2014) and twelve schools from the Czech Republic (2014/2015) were enrolled in an experimental project, where teaching was conducted using tablets and touchscreen boards. The schools were selected by the two non-profit organizations running the project – EDULAB in Slovakia and its partner organization EDUkační LABOratoř in Czechia. Project managers selected the schools in such a way as to ensure regional representation: the schools were asked to submit a project on how they would use these technologies, and the school with the most feasible project for each region was selected. In each school there was a project class using the technologies. The schools had very diverse academic performances, rural/urban settings, and student economic status. The selection was representative of the most com-

mon kinds of schools in the two countries – none of them were elite schools, none were in severely deprived areas, and all were public schools.

Students and teachers enrolled in the project were equipped with Samsung Galaxy Note 10.1 tablets. The tablets have special touchscreens enabling the use of an integrated stylus. They communicate with a 65-inch (165 cm) touchscreen board via Samsung School. In addition, the classrooms were equipped with desktop computers with 24-inch monitors. The projects were launched in the fall of the academic year (2013 for the Slovak project, 2014 for the Czech project).

The project was run by EduLab project managers. Each student had a tablet of their own, and used them in class. The tablets were used every day at school for several school subjects, including the language of instruction (Czech or Slovak), foreign language, and mathematics. The project did not provide specific digital curricula, but encouraged the general use of digital technologies in the classroom and provided participating teachers with resources in the form of educational software, training sessions, on-call support, peer tutoring, and regular tips on subject-relevant applications. Project managers asked teachers to provide regular reports to make sure that the teachers were making a continual effort to integrate the digital technologies into everyday use. Additionally, project managers provided all-round support to classes enrolled in the project: on-site training visits, tips for useful digital content, online support groups, on-call support to fix technical problems, and provided ideas and suggestions.

To ensure impartiality, the research team differed from the project management team. Prior to project commencement we collected initial (pre-test) data via questionnaires administered to students by project coordinators. Our research team member contacted the project coordinators in each school, described the research objectives, explained the procedure, answered any questions, and provided support throughout the administration of the questionnaire. Before the end of the school term (spring) we contacted all the schools again (post-test), collected the second round of data, and then visited all the schools to observe the classes and conduct interviews with the teachers, students, and administrators. The mean time of the tablet trial run (exposure to the tablet) was 6 months.

Participants

The data were collected on students from 10 schools in Slovakia and 12 schools in Czechia. The classes originally contained 726 students in total, in both experimental (tablet use in class) and control (no-tablet use in class) groups. Some students did not take part in the first or second rounds of data collection (due to illness, absence, withdrawal, etc.) or noted down a different identification code making it impossible to match their data; these students were excluded from the data analysis. Our original idea was to recruit a parallel class in the same grade in each school to create a control group that did not use the digital technologies. However, this proved extremely difficult. Firstly, in the smaller schools, there was often only one class in each grade. Where there was more than one class they often failed to meet the condition that tablets should not be used regularly during lessons. This was because the teachers tried to extend the experience to other students and made arrangements for these other classes to use the tablets regularly, despite our attempts to ensure stricter experimental conditions. All students in the control group were thus excluded from our analysis because they ended up using digital classrooms only marginally less than the project class (based on the data from the questionnaires on the frequency of digital technology use given to the students).

Adjusted for excluded students, the final sample for the only group in our test-retest comparison contained 490 students. Gender distribution was as follows: 255 girls aged 10 to 17 (mean age 12.82, *SD* = 1.86) and 235 boys aged 10 to 17 (mean age 12.83, *SD* = 1.77).

Research Ethics

We asked the project coordinators to obtain written informed consent from the parents of all the participating students. All the parents gave their informed consent. The data were collected by their teachers under specific instructions from our team member; we made sure the teachers explained to the students that the questionnaires did not constitute testing of any kind and that the results would be kept completely anonymous. We did not collect names or any other personal information except for age. The teachers were asked to create a code table of student names and to assign a code to each student for the pre-test and then to ensure the students used the same code in the post-test so the pre-test and post-test data could be matched. These tables were retained by the teachers; the research team did not have access to the code tables, and the teachers did not have access to the data tables.

In all our dealings with the teachers and students, we made a special effort to reassure them that our role was not to evaluate the schools or the teachers but to gain insights into how the technologies were used.

Measures

Academic Self-Concept. Participants' Academic Self-Concept was measured before and after completion of the tablet project using the Slovak and Czech versions of the Perception of Ability Scale for Students – PASS (Chapman, 1989; Chapman & Boersma, 1986), published as the Student's Perception of Ability Scale (SPAS; Matějček & Vágnerová, 1992). This self-report instrument is used to measure students' perception of their own abilities, achievements in school subjects, and academic status compared to their classmates (Matějček & Vágnerová, 1992). The items were derived from a pool of 200 items relating to self-perceptions of school performance and attitudes toward school, which were then consulted with teachers, school psychologists, and compared with other self-concept measures. The original instrument had satisfactory structural, reliability, and validity characteristics as well as good discriminant validity between the subscales and cross-cultural stability (Chapman, 1989). The scale was adopted and standardized for the Czechoslovak population in the 1980s (Vágnerová & Matějček, 1992). Czech and Slovak researchers have used SPAS extensively to analyze Academic Self-Concept and school achievement (Žilinčík & Novotný, 2014; Čornák & Popelková, 2008; Skopal, Dolejš, & Suchá, 2014).

The standardized version of the instrument consists of 48 items divided into six subscales, which were originally derived by factor analysis (general abilities, perception of mathematical ability, perception of reading ability, perception of writing ability, perception of spelling ability, and self-confidence in academic ability). The scale is dichotomously structured, making it less sensitive but more suitable for younger participants with lower reading abilities and/or lower reflective and metacognitive skills. In clinical administration, the instrument is aimed at children aged 9 to 14 (Matějček & Vágnerová, 1992); however, for research purposes, it may be used for junior high and older students (Chapman, 1989). Its advantages are that it is easily administered and understood, and has satisfactory validity and reliability (Svoboda, Krejčířová, & Vágnerová, 2009).

Validity and reliability. The construct validity of the instrument was tested by correlating SPAS with personality inventories, school

achievement, and teachers' reports using both the US and Czechoslovak versions, and found to be satisfactory. Discriminant validity was obtained by testing the differences between the individual subscales. In the US normative sample (N = 831) the internal consistency of the original instrument was α = .93 (Chapman, 1989). In the Czechoslovak normative sample (N = 300) the internal consistency was between α = .89 and α = .95 depending on age and gender (Matějček & Vágnerová, 1992).

The test-retest method was applied using the original and adapted versions. In the original study (Chapman, 1989), the retest was conducted after four to six weeks (the overall stability coefficient was .83), while in the Czechoslovak sample, the retest was done after two weeks with an overall stability coefficient of between .87 and .93 among the different age groups (Matějček & Vágnerová, 1992). Scales 1 (general abilities) and 6 (self-confidence) had the lowest dependability. These subscales have the highest level of intercorrelation and seem to be most sensitive to changes in external conditions.

The reliability of the instrument is also supported by more recent studies (Orel, Obereignerů, & Mentel, 2016; Obereignerů, Orel, Mentel, & Vohradská, 2017). The reliability test for our sample (N = 490) revealed satisfactory reliability with a Cronbach's α for the individual subscales of between .653 and .905 (Table 1).

The tests were administered online by teachers. Although the measure was originally intended for pen-and-paper data collection, Žilinčík and Novotný (2014), who have extensive experience with it, have stated that it makes no difference to the results if SPAS is administered online or offline. We therefore chose to administer it online in a classroom setting both before and after the tablet project.

Results

As the first step we assessed the normality of data distribution. We used the Shapiro-Wilk test, which showed that the data distribution was different than the normal distribution. On the other hand, skewness and kurtosis suggest that data distribution may be in line with normality criteria. The difference may be related to a relatively large sample (please see Table 2). Based on the results of the Shapiro-Wilk test, we decided to use non-parametric test for further analysis.

Table 1 *Reliability test of SPAS questionnaire*

	pre-test *Cronbach α*	post-test *Cronbach α*
General Ability	.653	.730
Perception of Math Ability	.808	.826
Perception of Reading Ability	.791	.818
Perception of Spelling Ability	.835	.850
Perception of Writing Ability	.807	.826
Self-confidence in Academic Ability	.702	.732
Factor - general abilities	.854	.884
Factor - verbal abilities	.866	.873
SPAS Total Score	.887	.905

Table 2 *Shapiro-Wilk test of normality, skewness and kurtosis of data distribution of SPAS scores*

	pre-test				post-test			
	W	*Sig.*	*Skew.*	*Kurt.*	*W*	*Sig.*	*Skew.*	*Kurt.*
General Ability	.963	.000	.029	-.799	.957	.000	-.027	-.863
Perception of Math Ability	.913	.000	-.473	-.840	.918	.000	-.383	-.979
Perception of Reading Ability	.888	.000	-.763	-.477	.859	.000	-.903	-.287
Perception of Spelling Ability	.911	.000	-.028	-1.400	.904	.000	.008	-1.422
Perception of Writing Ability	.927	.000	-.174	-1.209	.921	.000	-.065	-1.259
Self-confidence in Academic Ability	.959	.000	-.086	-.885	.952	.000	-.149	-.912
Factor - general abilities	.977	.000	-.223	-.753	.976	.000	-.255	-.730
Factor - verbal abilities	.977	.000	-.242	-.700	.977	.000	-.230	-.698
SPAS Total Score	.989	.001	-.240	-.427	.991	.004	-.195	-.383

Table 3 shows the descriptive statistics for the self-concept domains and overall self-concept measures obtained in the pre-test and post-test, and the Wilcoxon test for comparison of the two measurements. The Academic Self-Concept score attainable for the individual dimensions ranged from 0 to 8 points.

Perception of Math Ability slightly decreased across the entire sample throughout the intervention, $z = -2.09$, $p = .036$. However, the effect size was negligible, $r = -.094$. We identified a small change in Perception of Reading Ability, $z = -2.50$, $p = .012$, and found small effect size, $r = -.113$, but the value of the pre-test and post-test medians remained the same. Other changes in self-concept were not significant.

We also looked into potential gender-related links in Perception of Math Ability. Firstly, we wanted to see if these gender differences could be seen under regular classroom conditions (before the tablet project). We compared the data on self-concept domains and overall self-concept measures in the boys and girls obtained before implementation of the tablet project. For comparison we used the Mann-Whitney U test (Table 4).

Gender differences were mainly found in Verbal Abilities. The difference in the Factor Verbal Abilities was significant but with a small effect size, $U = 24704.50$, $z = -3.36$, $p = .001$, $r = -.152$. The girls perceived their Verbal Abilities to be higher ($Mdn = 15$) than the boys did ($Mdn = 13$). This difference was also clear when the different components of Verbal Abilities were compared. The girls had higher perceptions of their Reading Ability ($Mdn = 7$) than the boys did ($Mdn = 6$), and this difference was significant, $U = 25495.50$, $z = -2.89$, $p = .004$, however the effect size was still small, $r = -.131$. The girls also rated themselves better at Writing Ability ($Mdn = 5$) than the boys did ($Mdn = 4$) and this difference was significant and with a small effect size, $U = 24856.00$, $z = -3.29$, $p = .001$, $r = -.148$. The students did not differ significantly

Table 3 *Descriptive statistics for self-concept domains and overall self-concept in pre-test and post-test (N = 490) and in comparison (Wilcoxon test, effect size r)*

	pre-test		post-test		*Z*	*Sig. (2-tailed)*	*r*
	Mdn	*IQR*	*Mdn*	*IQR*			
General Ability	4	3	4	4	-1.79	.073	-.081
Perception of Math Ability	6	3	5	4	-2.09	.036	-.094
Perception of Reading Ability	6	3	6	4	-2.50	.012	-.113
Perception of Spelling Ability	4	6	4	6	-0.60	.546	-.027
Perception of Writing Ability	5	5	4	5	-0.40	.687	-.018
Self-confidence in Academic Ability	4	3	4	3	-0.25	.800	-.011
Factor - general abilities	14	9	14	9	-0.21	.832	-.009
Factor - verbal abilities	14	8	15	9	-0.70	.486	-.031
SPAS Total Score	28	13	28	14	-0.41	.684	-.019

Table 4 *Comparison of Academic Self-Concept (pre-test) between girls (n = 255) and boys (n = 235) (Mann-Whitney U, effect size r)*

	Gender	*Mdn*	*IQR*	*U*	*Z*	*Sig. (2-tailed)*	*r*
General Ability	girls	4	3	28841.00	-0.72	.470	-.033
	boys	4	4				
Perception of Math Ability	girls	5	3	29455.50	-0.33	.743	-.015
	boys	6	3				
Perception of Reading Ability	girls	7	4	25495.50	-2.89	.004	-.131
	boys	6	3				
Perception of Spelling Ability	girls	5	6	27114.00	-1.83	.067	-.083
	boys	3	5				
Perception of Writing Ability	girls	5	4	24856.00	-3.29	.001	-.148
	boys	4	4				
Self-confidence in Academic Ability	girls	4	4	29214.50	-0.48	.630	-.022
	boys	4	3				
Factor - general abilities	girls	13	9	29080.50	-0.56	.573	-.025
	boys	14	8				
Factor - verbal abilities	girls	15	8	24704.50	-3.36	.001	-.152
	boys	13	8				
SPAS Total Score	girls	29	13	27169.00	-1.79	.074	-.081
	boys	27	13				

in General Abilities; although the boys had a somewhat higher self-perception than girls in every dimension. The boys and girls achieved similar results in Perception of Math Ability and other domains.

We were also interested in whether self-concept differed in the boys and girls before and after tablet use. To compare the pre-test and post-test score for each group separately, we performed a Wilcoxon test (Table 5).

We found a very small difference in group of girls in General Ability, which was not significant, but on the borderline of small and negligible effect size, $z = -1.75$, $p = .080$, $r = -.110$. For that reason, we do not consider this difference as significant. Perception of Math Ability changed significantly, but with a small effect size and no difference between pre-test and post-test medians, only in the group of girls, $z = -2.82$, $p = .005$, $r = -.177$. The boys evaluated

Table 5 *Pre- and post-test comparison of each dimension of Academic Self-Concept, factors and total SPAS score in the group of girls and the group of boys separately (Wilcoxon test, effect size r)*

		Girls (n = 255)					Boys (n = 235)				
		Mdn	*IQR*	*Z*	*Sig. (2-tailed)*	*r*	*Mdn*	*IQR*	*Z*	*Sig. (2-tailed)*	*r*
General Ability	pre-test	4	3	-1.75	.080	-.110	4	4	-0.82	.414	-.053
	post-test	4	4				4	4			
Perception of Math Ability	pre-test	5	3	-2.82	.005	-.177	6	3	-0.15	.878	-.010
	post-test	5	4				6	3			
Perception of Reading Ability	pre-test	7	4	-1.33	.183	-.083	6	3	-2.17	.030	-.142
	post-test	7	4				6	3			
Perception of Spelling Ability	pre-test	5	6	-0.93	.355	-.058	3	5	-0.03	.976	-.002
	post-test	5	5				4	5			
Perception of Writing Ability	pre-test	5	4	-0.69	.490	-.043	4	4	-1.33	.182	-.087
	post-test	5	4				4	4			
Self-confidence in Academic Ability	pre-test	4	4	-0.23	.821	-.014	4	3	-0.50	.618	-.033
	post-test	4	4				4	3			
Factor - general abilities	pre-test	13	9	-0.01	.994	-.000	14	8	-0.37	.712	-.024
	post-test	13	10				14	8			
Factor - verbal abilities	pre-test	15	8	-0.98	.329	-.061	13	8	-0.02	.981	-.002
	post-test	16	9				13	8			
SPAS Total Score	pre-test	29	13	-0.54	.587	-.034	27	13	-0.04	.966	-.003
	post-test	28	15				27	14			

their Math Ability to be almost at the same level before and after the experiment. The Perception of Reading Ability slightly changed in the group of boys only. The difference was however only significant, but with a small effect size and no difference between pre-test and post-test medians, $z = -2.17$, $p = .030$, $r = -.142$. In the other domains relating to perception of ability there was no significant change in the girls or the boys before and after the project.

To answer the third research question (Will there be a specific group that seemed to have profited most from using tablets in classroom learning?), we labeled all those who achieved scores of 0 – 3 (under average) on the pre-test in Academic Self-Concept as low scorers, and

Table 6 *Comparison of pre-test and post-test for Academic Self-Concept domains showing students (N = 490) with low and high scores in Academic Self-Concept separately (Wilcoxon test, effect size r)*

		Students with low scores in Acad. Self-Concept					Students with high scores in Acad. Self-Concept				
		n	*Mdn*	*IQR*	*Z*	*r*	*n*	*Mdn*	*IQR*	*Z*	*r*
General Ability	pre-test	212	2	2	-7.23***	-.497	203	6	2	-5.77***	-.405
	post-test		3	3.75				5	3		
Perception of Math Ability	pre-test	118	2	2	-5.23***	-.482	315	7	2	-6.55***	-.370
	post-test		3	3				6	3		
Perception of Reading Ability	pre-test	104	2	2	-5.97***	-.585	345	7	2	-2.50*	-.135
	post-test		3	3.75				7	2		
Perception of Spelling Ability	pre-test	223	1	2	-7.26***	-.486	226	7	1	-6.72***	-.447
	post-test		2	3				6	3		
Perception of Writing Ability	pre-test	173	2	1	-6.95***	-.528	263	7	3	-6.44***	-.397
	post-test		3	3				6	4		
Self-confidence in Academic Ability	pre-test	182	2	2	-6.10***	-.452	232	5	3	-6.78***	-.445
	post-test		3	3				5	4		
SPAS Total Score	pre-test	85	15	6	-4.46***	-.484	214	35	6	-5.26***	-.360
	post-test		18	12				33	10		

*** Wilcoxon test is significant at .001 (2-tailed).
** Wilcoxon test is significant at .01 (2-tailed).
* Wilcoxon test is significant at .05 (2-tailed).

those who scored 5 – 8 (above average) as high scorers. We did this separately for each dimension, so the number of participants differs for each dimension in Table 6. The total score represents the mean score for all dimensions. Table 6 compares the pre-test and post-test scores for each self-concept dimension and the total score (the Wilcoxon test).

Children with a low Academic Self-Concept improved over time in each dimension. The above-average Academic Self-Concept was lower in the post-test measurement compared to the pre-test measurement. This was the case in each domain. The change in self-concept from the pre-test to the post-test indicated that self-concept scores tended to shift toward the mean.

Discussion

The aim of our research was to find out whether Academic Self-Concept changed following the implementation of the tablet project. We did not observe significant changes in self-concept in most of the SPAS domains before and after the tablet project. The only significant, yet very small difference was in the Perception of Math Ability and Reading Ability. Changes in Academic Self-Concept were small; some results may have showed some significance but our interpretation suggests this could have been coincidental. Such interpretations should, however, be further supported by further data that would include a control group.

Similarly to Chapman (1989) and Marsh et al. (2005), we also observed gender differences in specific domains. Girls tended to have a higher self-concept in reading and writing – in verbal skills – than did boys. Higher verbal skill self-perception scores among girls may reflect traditional gender stereotypes in western cultures (Skaalvik & Skaalvik, 2004).

When we divided the children into low-scorer and high-scorer groups and analyzed the data based on this criterion, we observed additional changes in self-concept during the intervention. One interpretation could be that they had misjudged their self-efficacy at the beginning of the academic year, perhaps by being overly optimistic after the summer break. Continuous feedback from teachers (including grades) may alter their perceived self-efficacy during the semester, which would impact their self-concept. This thesis would, however, require further testing.

Let us try to interpret this in the context of introducing technologies into education. Hypothetically, high-scoring students who have a high Academic Self-Concept and good grades do not necessarily require the intervention, and some may be conservative types with low ambiguity tolerance (a change in teaching style may unsettle them despite their positive attitude towards technologies generally). On the other hand, low scorers may benefit more from the overall motivating effect of the change, and from the chance to experience success in novel educational situations. One possible way of interpreting this could also be 'the big fish in a little pond effect (BFLPE)' hypothesis: students who are the most confident technology users (although not necessarily high academic performers) may benefit from an educational change and thus may improve their Academic Self-Concepts (Zeidner & Schleyer, 1998; Huguet et al., 2009). The idea of the stabilizing effect of the intervention would however require data from a control group.

Several researchers (e.g., Chapman & McAlpine, 1987) claim that self-concept is stable. We believe that stability can only be observed within a group in which the distribution of the values measured follows normality criteria. When we focused on students with above-average or under-average values, we found that their self-concept tended to move toward the mean. This means that self-concept does not change at the group level, but its variance tends to decrease with time.

Boersma et al. (1979) observed an improvement in self-concept in children with learning disorders and intellectual disabilities following a change of educational setting. Page (2002) presumes there is a higher probability that change in self-concept will occur among students with specific educational characteristics and needs. Our observations suggest that the academic self-concept among students did not change after the tablet project, either positively or negatively. In this context and based on our observations during data collection it would be worth assessing the impact of tablet technologies on Academic Self-Concept in children with special educational needs.

As for the limitations of the present study, the main instrument contains norms that are not entirely up-to-date. Some items are also formulated in a way that some students may find outdated (cf. Žilinčík & Novotný, 2014). Nonetheless, we still consider it to be the most appropriate measure of Academic Self-Concept available.

It must be said at this point that the researchers did not have complete control over the educational design and the content in each school. Better results could be achieved where there is an opportunity to control the selection of schools, especially if it included schools in which it was possible to guarantee a case/control scenario. This has proven to be extremely difficult to achieve in our case because such setting would interfere with academic arrangements in schools.

Although we originally wanted to collect data in parallel classes that would not be using digital technologies (control groups), this idea failed in practice. Teachers were eager to bring the benefits of innovative technologies to all of their students so they generally used the most interesting applications and digital material in all of the classes they taught, regardless of being assigned to the experimental or control group. For instance we found out that they brought other classes into the experimental class when the original tablet project class was not using them (e.g., during physical education classes), and they let other students work with their tablets. The project seemed to "spill-over" across the entire school. After long discussions we decided not to interfere with this practice; although it tampered with our experimental design it seemed in the best interest of educational objectives.

Our research design allowed us to identify small or no changes in Academic Self-Concept in the whole group, and at the same time we found significant changes in children, who initially had under-average and above-average scores in Academic Self-concept. Because of the absence of a control group, it does not allow us to confirm expressly that using tablets in education would have a specific impact on Academic Self-Concept. Without the control group to our whole sample we cannot compare our results to the following scenarios: 1) a substantial positive change in the control group might imply that our intervention had a negative effect; 2) a substantial negative change in the control group might imply that the intervention had a positive effect (it protected pupils from a substantial decline); 3) comparable effects in both groups might imply that the intervention had no effect.

To address these concerns, in the future it would be advisable to have more control over the selection of schools to ensure full cooperation. It would also be recommended to focus on students with special educational needs (over-achievers as well as under-achievers), and observe the specific benefits of using digital technologies for these target groups.

As pointed out by an anonymous reviewer, it would also be interesting to consider if an increase in Academic Self-Concept is always a desirable outcome since it does not necessarily correspond to actual academic performance.

Conclusion

The objective of the paper was to explore differences in Academic Self-Concept before and after the use of tablets in schools, that is, increase student perceptions of being successful. Introducing technologies into the educational process does not seem to have the general potential to improve Academic Self-Concept in students. The main lesson learned is that applying such technology-rich projects does not seem to have the potential to affect the overall Academic Self-Concept. However, our findings suggest that it may have the potential to bridge the divide between children with low self-concept and those who are average to high scorers. Introducing new educational practices may enable low scorers to experience success in domains where they have not experienced success before.

Our previous work (e.g., Masaryk & Sokolová, 2012) showed that introduction of projects using digital technologies into schools can be a positive impulse for pupils and teachers. Yet, in the long run it does not seem to be associated with positive academic effects on the general level. Using such technologies may, however, be a point that lets some students experience success. Projects using digital technologies have thus the potential to be a significant source of motivation and improvement in self-concept in children with special educational needs – for example those with physical or learning disabilities or from economically and socially disadvantaged backgrounds (Lemešová, 2013; Andreánska & Andreánsky, 1981).

References

Andreánska, V., & Andreánsky, M. (1981). Specifities of motivation in handicapped children. *Studia Psychologica, 23*(4), 289–296.

Boersma, F. H., Chapman, J. W., & Battle, J. (1979). Academic self-concept change in special education students: Some suggestions for interpreting self-concept scores. *Journal of Special Education, 13*, 433–442. doi: 10.1177/002246697901300410

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy how different are they really? *Educational Psychology Review, 15*(1), 1–40. doi: 10.1023/A:1021302408382

Chapman, J. W. (1989). *The Perception of Ability Scale for Students: Results from accumulated research.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, March 1989 (available via Eric Database).

Chapman, J. W., & Boersma, F. J. (1986). Student's Perception of Ability Scale: Comparison of scores for gifted, average, and learning disabled students. *Perceptual and Motor Skills, 68*, 57–58. doi: 10.2466/pms.1986.63.1.57

Chapman, J. W., & McAlpine, D. D. (1987). *Academic self-concept of gifted and average achieving students: A two year study.* Paper presented at the Annual Meeting of the American Educational Research Association. San Francisco, April 1987 (available via Eric Database).

Chiang, H., & Jacobs, K. (2009). Effect of computer-based instruction on students' self-perception and functional task performance. *Disability and Rehabilitation: Assistive Technology, 4*, 106–118. doi: 10.1080/17483100802613693

Clements, D. H. (2002). Computers in early childhood mathematics. *Contemporary Issues in Early Childhood, 3*, 160–181. doi: 10.2304/ciec.2002.3.2.2.

Ferla, J., Valcke, M., & Cai, J. (2009). Academic self-efficacy and academic self-concept: Reconsidering structural relationships. *Learning and Individual Differences, 19*, 499–505. doi: 10.1037/10197-005

Guay, F., Marsh, H. W., & Boivin, M. (2003). Academic self-concept and academic achievement: Developmental perspectives on their causal ordering. *Journal of Educational Psychology, 95*(1), 124–136. doi: 10.1037/0022-0663.95.1.124

Huguet, P., Dumas, F., Marsh, H., Regner, I., Wheeler, L., Suls, J., Seaton, M., & Nezlek, J. (2009). Clarifying the role of social comparison in the big-fish–little-pond effect (BFLPE): An integrative study. *Journal of Personality and Social Psychology, 97*(1), 156–170. doi: 10.1037/a0015558

Jackson, L. A., Von Eye, A., Fitzgerald, H. E., Zhao, Y., & Witt, E. A. (2010). Self-concept, self-esteem, gender, race and information technology use. *Computers in Human Behavior, 26*, 323–328. doi: 10.1016/j.chb.2009.11.001

Jansen, M., Schroeders, U., & Lüdtke, O. (2014). Academic self-concept in science: Multidimensionality, relations to achievement measures, and gender dif-

ferences. *Learning and Individual Differences, 30*, 11–21. doi: 10.1016/j.lindif.2013.12.003

Ju, S., Zhang, D., & Katsiyannis, A. (2012). The causal relationship between academic self-concept and academic achievement for students with disabilities: An analysis of SEELS data. *Journal of Disability Policy Studies, 24*(1), 4–14. doi: 10.1177/1044207311427727

Kucirkova, N., & Littleton, K. (2017). Developing personalised education for personal mobile technologies with the pluralisation agenda. *Oxford Review of Education*.

Kucirkova, N., Messer, D., & Sheehy, K. (2014). Reading personalized books with preschool children enhances their word acquisition. *First Language, 34*(3), 227–243. doi: 10.1177/0142723714534221

Lemešová, M. (2013). Význam prostredia v procesoch učenia u detí pochádzajúcich zo sociálne znevýhodňujúceho prostredia [The importance of environment in educating socially disadvantaged children]. In *Sociálnopedagogické štúdie 2013*. Bratislava: Univerzita Komenského v Bratislave, 74–82.

Marsh, H. W., & O'Mara, A. (2008). Reciprocal effects between academic self-concept, self-esteem, achievement, and attainment over seven adolescent years: Unidimensional and multidimensional perspectives of self-concept. *Personality and Social Psychology Bulletin, 34*(4), 542–552. doi: 10.1177/0146167207312313

Marsh, H. W., & Shavelson, R. (1985). Self-concept: Its multifaceted, hierarchical structure. *Educational Psychologist, 20*(3), 107–123.

Marsh, H. W., Lüdtke, O., Nagengast, B., Trautwein, U., Abduljabbar, A. S., Abdelfattah, F., & Jansen, M. (2015). Dimensional comparison theory: Paradoxical relations between self-beliefs and achievements in multiple domains. *Learning and Instruction, 35*, 16–32. doi: 10.1016/j.learninstruc.2014.08.005

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*(2), 397–416. doi: 10.1111/j.1467-8624.2005.00853.x

Masaryk, R. & Sokolová. L. (2012). Making a difference by doing applied qualitative research in education: Three case studies. *Human Affairs*, *22*, 492–509. doi: 10.2478/s13374-012-0040-1

Matějček, Z., & Vágnerová, M. (1992). *Dotazník sebepojetí školní úspěšnosti dětí. Príručka.* [Academic Self-Concept Questionnaire for Children. The Manual] Bratislava: Psychodiagnostika.

Muijs, R. D. (1997). Symposium: Self perception and performance. Predictors of academic achievement and academic self-concept: A longitudinal perspective. *British Journal of Educational Psychology, 67*, 263–277.

Obereignerů, R., Orel, M., Mentel, A., & Vohradská, R. (2017). *Sebepojetí dětí a adolescentů*. Olomouc: Univerzita Palackého.

Orel, M., Obereignerů, R., & Mentel, A. (2016). *Vybrané aspekty sebepojetí dětí a adolescentů*. Univerzita Palackého v Olomouci.

Page, M. S. (2002). Technology-enriched classrooms: effects on students of low socioeconomic status. *Journal of Research on Technology in Education, 34*(4), 389–409. doi: 10.1080/15391523.2002.10782358

Parsons, P., Yuill, N., Brosnan, M., & Good, J. (2017). Interdisciplinary perspectives on designing, understanding and evaluating digital technologies for autism. *Journal of Enabling Technologies, 11*(1), 13–18. doi: 10.1108/JET-01-2017-0001

Ravizza, S. M., Uitvlugt, M. G., & Fenn, K. (2016). Logged in and zoned out. How laptop internet use relates to classroom learning. *Psychological Science, 28*(2), 171–180. doi: 10.1177/0956797616677314

Sáinz, M., & Eccles, J. (2012). Self-concept of computer and math ability: Gender implications across time and within ICT studies. *Journal of Vocational Behavior, 80*, 486–499. doi:10.1016/j.jvb.2011.08.005

Salmela-Aro, L., Muotka, J., Alho, K., Hakkarainen, K., & Lonka, K. (2016). School burnout and engagement profiles among digital natives in Finland: A person-oriented approach. *European Journal of Developmental Psychology, 13*(6), 704–718. doi: 10.1080/17405629.2015.1107542

Sinclair, N., & Baccaglini-Frank, A. E. (2016). Digital technologies in the early primary school classroom. In L. D. English, & D. Kirshner (Eds.), *Handbook of International Research in Mathematics Education* (pp. 662–686). London: Routledge.

Skaalvik, S., & Skaalvik, E. M. (2004). Gender differences in math and verbal self-concept, performance expectations, and motivation. *Sex Roles, 50*(3/4), 241–252. doi: 10.1023/B:SERS.0000015555.40976.e6

Skopal, O., Dolejš, M., & Suchá, J. (2014). *Vybrané osobnostní rysy a rizikové formy chování u českých žáků a žákyň*. [Selected personality characteristics and forms of risk behavior among Czech pupils] Olomouc: Univerzita Palackého v Olomouci.

Spitzer, M. (2012). *Digitale Demenz* [Digital Dementia]. München: Droemer.

Stringer, R. W., & Heath, N. (2008). Academic self-perception and its relationship to academic performance. *Canadian Journal of Education, 31*(2), 327–345.

Sullivan, A. (2009). Academic self-concept, gender and single-sex schooling. *British Educational Research Journal, 35*(2), 259–288. doi: 10.1080/01411920802042960

Svoboda, M., Krejčířová, D., & Vágnerová, M. (2009). *Psychodiagnostika dětí a dospívajících*. [Psychodiagnostics of children and adolescents] Praha: Portál.

Uhls, Y. T., Michikyan, M., Morris, J., Garcia, D., Small, G. W., Zgourou, E., & Greenfield, P. M. (2014). Five days at outdoor education camp without screens improves preteen skills with nonverbal emotion cues. *Computers in Human Behavior, 39*, 387–392. doi: 10.1016/j.chb.2014.05.036

Vágnerová, M. (2001). *Kognitivní a sociální psychologie žáka základní školy*. [Cognitive and social psychology of elementary school pupils] Praha: Karolinum.

Zeidner, M., & Schleyer, E. J. (1998). The big-fish–little-pond effect for academic self-concept, test anxiety, and school grades in gifted children. *Contemporary Educational Psychology, 24*, 305–329.

Zhan, Z., & Mei, H. (2013). Academic self-concept and social presence in face-to-face and online learning: Perceptions and effects on students' learning achievement and satisfaction across environments. *Computers & Education, 69*, 131–138. doi: 10.1016/j.compedu.2013.07.002

Žilinčík, T., & Novotný, M. (2014). CMAS/SPAS – Počítačové škálovanie a ich možné využitie u detskej populácie [CMAS/SPAS – Computer scales and their potential use among the child population]. *Cognitive Remediation Journal, 3*(3), 3–10.

Studia Psychologica, Vol. 60, No. 3, 2018, 183-194 doi: 10.21909/sp.2018.03.761

Loneliness, Friendship, and Facebook Intrusion. A Study in Poland, Slovakia, Syria, Malaysia, and Ecuador

Agata Błachnio, Aneta Przepiórka, Mariusz Wołończiej
Institute of Psychology, The John Paul II Catholic University of Lublin, Poland

Ali Bassam Mahmoud
University of Liverpool, United Kingdom

Juraj Holdoš
Department of Psychology, Catholic University in Ružomberok, Slovak Republic

Eiad Yafi
Universiti Kuala Lumpur, Malaysia

With the increasing popularity of Facebook, a new social phenomenon connected with its extensive use has appeared: namely, Facebook intrusion. The main aim of the study was to examine the mediating role of loneliness in the relation between friendships and Facebook intrusion. We analyzed data from five countries: Poland ($N = 399$), Slovakia ($N = 266$), Syria ($N = 475$), Ecuador ($N = 327$), and Malaysia ($N = 241$). The total sample consisted of 1731 participants who had Facebook accounts; 61% of the participants were women. We administered the Facebook Intrusion Scale, the Loneliness Scale, and the Friendship Scale. The results indicated differences in the role of loneliness and friendship in Facebook intrusion, depending on the country. Among young Polish people, friendship decreases loneliness and loneliness decreases Facebook intrusion. Whereas among Ecuadorians friendship decreases loneliness, while loneliness increases Facebook intrusion.

Key words: Facebook intrusion, loneliness, friendship, culture

Facebook is one of the most popular social networking sites. As shown in research conducted by the Pew Research Center (2014), time spent on Facebook becomes longer every year. In a sample of 1597 users, 70% used Facebook several times a day. The site is extremely popular, especially with the young generation, whose members use e-mail or text messages less and less often and increasingly often use a Facebook account. The terms interchangeably used in the literature in reference to Facebook dependency are "Facebook intrusion" (Elphinston & Noller, 2011) and "Facebook addiction" (Andreassen & Pallesen, 2014); the phenomenon they refer to can be defined as excessive involvement in Facebook, disrupting day-to-day activities and interpersonal relationships (Elphinston & Noller, 2011). The authors mention three aspects of this phenomenon, namely: 1) withdrawal, 2) relapse and reinstatement, and 3) euphoria. People who are strongly involved in Facebook

Acknowledgement
This research was supported by a grant from the National Science Centre (NCN) No. 2014/15/B/HS6/03129

Correspondence concerning this article should be addressed to Agata Błachnio, Institute of Psychology, The John Paul II Catholic University of Lublin, Poland, Al. Racławickie 14, 20-950 Lublin, Poland. E-mail: gatta@kul.pl

Received January 15, 2018

feel distress when they cannot stop using it. What is more, they have unsuccessfully attempted to reduce Facebook use. They also feel a connection with other people who use Facebook (Elphinston & Noller, 2011).

On the basis of the literature, it can be said that there are certain psychological characteristics and resources that predispose individuals to excessive use both of the Internet and Facebook. A number of studies mention loneliness as one of these characteristics. Loneliness occurs when a difference is perceived between the desired and actual levels of social involvement (Russell, Cutrona, McRae, & Gomez, 2012). For instance, a high level of social loneliness increases the risk of pathological Internet use (Wegmann & Brand, 2016). Others suggest that loneliness can predict Internet addiction (Özdemir, Kuzucu, & Ak, 2014). Still another study showed that the link between technology use and physical and psychological health was mediated by reduced loneliness (Chopik, 2016). Loneliness has also been found to correlate positively with passive engagement on Facebook (e.g., groups or fan pages; Ryan & Xenos, 2011).

Some results suggest the role of loneliness in using Facebook excessively. The more time people spend on Facebook, the more lonely they feel; however, if they use both Facebook and Twitter rather than only Facebook, they feel less lonely (Petrocchi, Asnaani, Martinez, Nadkarni, & Hofmann, 2015). Some authors assumed that loneliness would turn out to be an important determinant of social media use (Ye & Lin, 2015; Song et al., 2014);. Loneliness has been found to be a positive predictor of Facebook addiction, standard Facebook use, and Facebook entertainment (Błachnio et al., 2016b). Scholars also found that the relationship between the need for privacy and excessive Facebook use was negative and significant when loneliness was introduced as a mediator. It is therefore possible to speak of a paradoxical effect of the need for privacy. On the one hand, the need for privacy can protect a person from excessive Facebook use, but on the other hand, a high level of the need for privacy is associated with loneliness, and lonely people are more prone to excessive Facebook use (Błachnio, Przepiorka, Bałakier, & Boruch, 2016). Friendship and loneliness are only partially the same concept. A person can be socially isolated (i.e., he or she may not have relationships with others) without feeling lonely (Hawthorne & Griffith, 2000). Some results indicate that Facebook dependency is related to relationship dissatisfaction (Elphinston & Noller, 2011). Biolcati and Cani (2015) explored friendship and loneliness in relation to Facebook use. They found that those who felt lonely were more dissatisfied with their online and offline relationships: these people met friends in person less frequently and considered their online contacts less satisfactory. In addition, Morahan-Martin and Schumacher (2003) found that lonely people may search for online contacts, as Internet facilitates social behaviors, and that they may make friendships online, as anonymity and the lack of physical presence may be attractive.

Some evidence suggests that there are cultural factors involved in the Facebook intrusion phenomenon (Błachnio et al., 2016). The authors showed that variables differentiating cultures, such as uniqueness, were negatively and low context positively related to Facebook intrusion (Błachnio, Przepiorka, Benvenuti et al., 2016). A great body of studies highlighted different patterns in Internet use (Gong Li & Stump, 2007; Singh, Fassot, Chao, & Hoffmann, 2006) and Facebook use (Brailovskaia & Bierhoff, 2016; Peters, Winschiers-Theophilus, & Mennecke, 2015; Vasalou et al., 2010) across various countries. Some differences have also been found in the relations between loneliness, the sense of social capital, and SNS use among three countries: South Korea, China, and the

USA (Ji et al., 2010). US users mostly were focused on exchanging and sharing opinions and information, while Korean and Chinese users tended to focus on the emotional climate of communication.

Our study was conducted in five countries: Poland, Slovakia, Syria, Ecuador, and Malaysia. These countries were selected because they differ in terms of political, industrial, economic, societal, and technological development. First of all, Internet penetration rates differ across these countries (statistics from 2017)[1, 2], the figures being 78.1 in Poland, 85.0 in Slovakia, 33.0 in Syria, 79.9 in Ecuador, and 78.3 in Malaysia. These discrepancies in access to the Internet and Facebook result in different backgrounds for their users. Internet penetration expresses the relationship between the number of Internet users in each country and its demographic data (Calderaro, 2010). The relationship between Facebook intrusion and Internet penetration was demonstrated in the previous studies (Błachnio, Przepiorka, Benvenuti, Cannata, Ciobanu, Senol-Durak et al., 2016a). More differences between the countries included in our study are shown in the Inglehart–Welzel cultural map of the world[3], where countries are arranged according to two dimensions: traditional vs. secular-rational values and survival vs. self-expression values. Apart from that, they differ in terms of the World Happiness Index that ranks countries by their happiness level[4]: 6.123 for Poland, 5.747 for Slovakia, 3.516 for Syria, 6.322 for Malaysia, and 5.973 for Ecuador. The plethora of research showed the importance of happiness in the context of Facebook use (e.g., Satici & Uysal, 2015).

The general aim of our study was to determine the role of psychological factors, such as loneliness and friendship in the relation to Facebook intrusion across five countries previously. More specifically, we wanted to test the mediating role of loneliness in the relation between friendships and Facebook intrusion in five countries. Loneliness and friendship as they both belong to the social functioning (for a review Bukowski, Laursen, & Rubin, 2009) seem to be the important variables in Facebook intrusion. Although the issue of loneliness and friendship has been addressed in previous studies (e.g., Petrocchi, Asnaani, Martinez, Nadkarni, & Hofmann, 2015; Biolcati & Cani, 2015), the cross-cultural aspect of these relations in the context of Facebook intrusion is rather new and to the best of our knowledge it was not examined previously. We would also like to compare the level of Facebook usage: log hours on weekdays and weekends within countries, as these variables were important in previous studies (e.g. Błachnio, Przepiorka, & Hawi, 2016). The following main hypothesis was formulated: Loneliness is a mediator of the relation between friendship and Facebook intrusion. The age variable was controlled for. We also examined the differences in the number of Facebook log hours on weekdays and weekends between these countries.

Method

Participants

The participants were 1,731 individuals (61% were women) possessing Facebook accounts, aged between 16 and 67, with a mean age of $M = 23.04$ years. This included 399 Polish participants aged 16 to 67 ($M = 21.85$, $SD = 4.81$, 76% were female), 266 Slovakians aged 16-59 ($M = 24.64$, $SD = 7.19$, 75% were female), 475 Syrians aged 16 to 55 ($M = 23.86$, $SD = 5.63$, 36% were female), 241 Malaysians aged 19 to 41 ($M = 21.79$, $SD = 2.38$, 43% were female), and 327 Ecuadorians aged 17 to 66 ($M = 23.04$, $SD = 6.78$, 81% were female).

[1] https://www.internetworldstats.com
[2] http://www.internetlivestats.com/
[3] http://www.worldvaluessurvey.org/
[4] http://worldhappiness.report/

Procedure

In each country we applied a snowball sampling procedure to recruit the participants. We prepared electronic versions of the questionnaires translated into the local languages and sent the link to the study website to undergraduate students, requesting them to post it on their Facebook walls and thus spread the message about the study among their Facebook friends. The participants received no remuneration for their participation.

Measures

The investigators administered the Facebook Intrusion Scale, the Loneliness Scale, and the Friendship Scale to the participants. All the instruments had been adapted in each country by means of the back-translation procedure, with great care taken to ensure grammatical and semantic correctness as well as readability. The questions about log hours on weekdays and weekends were also taken into consideration.

Facebook Intrusion Questionnaire, developed by Elphinston and Noller (Elphinston & Noller, 2011), is based on behavioral addiction components and on a scale measuring phone involvement. It consists of eight items (e.g., *I have been unable to reduce my Facebook use*) measuring the relations between Facebook involvement tendency and eight aspects of behavioral addiction, namely: cognitive salience, behavioral salience, interpersonal conflict, conflict with other activities, euphoria, loss of control, withdrawal, as well as relapse and reinstatement. The items are rated on a 7-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Cronbach's α was .82 for the total sample, .85 for Poland, .77 for Slovakia, .80 for Syria, .97 for Malaysia, and .83 for Ecuador.

The De Jong Gierveld Loneliness Scale measures the sense of loneliness. The scale consists of 11 items (e.g., *I miss having really close friends*), six of them negatively and five positively formulated. The items are rated on a 5-point Likert scale (1 = *completely disagree*; 5 = *completely agree*). Cronbach's α for the total sample was .84, and its values for specific countries were as follows: .91 for Poland, .87 for Slovakia, .83 for Syria, .69 for Malaysia, and .75 for Ecuador.

The Friendship Scale by Hawthorne and Griffith (2000), measuring level of social isolation (which means loss of relationships), consists of 5 items, (e.g., *I found it easy to get on with other people*). The items are rated on a 5-point scale, with answers ranging from 1 = *not at all* to 5 = *almost always*. Cronbach's α was .71 for the total sample, .79 for Poland, .73 for Slovakia, .63 for Syria, .57 for Malaysia, and .55 for Ecuador. In the case of the original version of the Friendship Scale, Cronbach's α was .76.

Results

The Measurement Invariance

We tested measurement invariance across the five countries. Five models were fitted with increasingly more constraints: Model 1: configural invariance – the same factor structure across groups. Model 2: weak invariance (metric) – the same factor structure and factor loadings across groups. Model 3: strong invariance (scalar) – the same factor structure, factor loadings, and intercepts across groups. Model 4: strict invariance – the same factor structure, factor loadings, intercepts, and residual variances across groups. Model 5: the same factor structure, factor loadings, intercepts, residual variances, and means across groups. The analyses were performed by means of the lavaan package (Rosseel, 2012), running in the R environment (R Core Team, 2016).

In the next step, we tested the invariance of Friendship Scale. Models with gradually more

constraints imposed were gradually significantly worse (i.e., Model 2 was worse than Model 1, Model 3 was worse than Model 2, etc.). The basic configural model also had a poor fit. In sum, we found no measurement invariance (Table 1). Next, we tested the invariance of the Loneliness Scale and did not find it significant (Table 2).

In the next step, the measurement invariance of the Facebook Intrusion scale was tested. The model imposing strong (scalar) invariance was barely significantly worse than the one assuming weak (metric) invariance (Table 3).

We did not obtain invariance for any of the scales, which means the investigated variables do not represent the same phenomenon in each

Table 1 *Measurement invariance statistics for the Friendship Scale: A comparison across five countries*

	Model fit				Differences between models			
Model	*df*	chi^2	CFI	RMSEA	Δchi^2	Δdf	ΔCFI	*p* for difference
1. Configural	25	325.67	.82	.19	155.34	16		
2. Weak	41	481.01	.74	.18	426.55	16	.08	<.001
3. Strong	57	907.56	.50	.21	421.76	20	.24	<.001
4. Strict	77	1329.32	.27	.22	317.07	4	.24	<.001
5. Means	81	1646.39	.09	.24	155.34	16	.18	<.001

Table 2 *Measurement invariance statistics for the Loneliness Scale: A comparison across five countries*

	Model fit				Differences between models			
Model	*df*	chi^2	CFI	RMSEA	Δchi^2	Δdf	ΔCFI	*p* for difference
1. Configural	175	1753.30	.72	.16	113.77	36		
2. Weak	211	1867.10	.70	.15	1141.92	36	.01	<.001
3. Strong	247	3009.00	.51	.18	705.21	40	.20	<.001
4. Strict	287	3714.20	.39	.19	214.41	4	.12	<.001
5. Means	291	3928.60	.35	.19	113.77	36	.04	<.001

Table 3 *Measurement invariance statistics for the Facebook Scale: A comparison across five countries*

	Model fit				Differences between models			
Model	*df*	chi^2	CFI	RMSEA	Δchi^2	Δdf	ΔCFI	*p* for difference
1. Configural	100	363.11	.93	.09				
2. Weak	128	468.40	.91	.09	105.28	28	.02	<.001
3. Strong	156	1229.19	.73	.14	760.8	28	.19	.054
4. Strict	188	1694.19	.62	.15	464.99	32	.11	.011
5. Means	192	1816.48	.59	.16	122.29	4	.03	.004

country. This justifies analyzing them in different cultures.

The Descriptive Statistics

The descriptive statistics for each scale (means and standard deviations for all variables) are presented in Table 4.

Pearson's *r* correlations between the variables in each of the five countries are presented in Table 5. Friendship was strongly negatively correlated with loneliness in all of the countries. Loneliness was positively correlated with Facebook intrusion in Slovakia and in Ecuador. Friendship was positively correlated with Facebook intrusion in Malaysia. Only in Malaysia we obtained a weak correlation between friendship and Facebook intrusion; in the remaining included countries there was no correlation between these variables (see Table 5).

Additionally, the means and standard deviations for log hours on weekdays and weekends and the correlations between these variables and Facebook intrusion are presented in Table 6.

Table 4 *Means and standard deviations for Facebook intrusion, loneliness, and friendship variables*

		Facebook intrusion		Loneliness		Friendship	
	N	*M*	*SD*	*M*	*SD*	*M*	*SD*
Ecuador	327	2.54	1.14	2.73	0.54	18.61	3.64
Malaysia	252	2.91	1.06	3.01	0.53	13.94	3.38
Poland	399	2.65	1.15	2.24	0.85	19.38	3.97
Slovakia	261	2.81	1.03	2.44	0.70	19.70	3.81
Syria	475	3.37	1.19	2.58	0.81	17.49	4.09

Note. *$p < .05$; **$p < .01$; ***$p < .001$

Table 5 *Correlations between variables*

		1	2
Ecuador	1. Facebook intrusion		
	2. Friendship	.001	
	3. Loneliness	.15**	-.50***
Malaysia	1. Facebook intrusion		
	2. Friendship	.16*	
	3. Loneliness	-.09	-.46***
Poland	1. Facebook intrusion		
	2. Friendship	-.08	
	3. Loneliness	.01	-.79***
Slovakia	1. Facebook intrusion		
	2. Friendship	-.11	
	3. Loneliness	.16*	-.68***
Syria	1. Facebook intrusion		
	2. Friendship	-.04	
	3. Loneliness	.08	-.65***

Note. *$p < .05$; **$p < .01$; ***$p < .001$

Table 6 *Means and standard deviations for log hours on weekdays and on weekends and their correlations with Facebook intrusion*

		log hours on weekdays		correlations with Facebook intrusion	log hours on weekends		correlations with Facebook intrusion
	N	*M*	*SD*	Pearson's *r*	*M*	*SD*	Pearson's *r*
Ecuador	327	6.57	3.76	.066	5.26	3.30	.143*
Malaysia	252	9.08	6.24	.104	11.09	6.84	.110
Poland	399	3.15	2.66	.231***	3.43	2.81	.217***
Slovakia	261	5.37	3.97	.204***	5.28	3.80	.283***
Syria	475	4.98	2.70	.256***	6.24	3.18	.287***

Note. *$p < .05$; **$p < .01$; ***$p < .001$

Mediation Analyses

The analyses explored whether or not age was a moderator of the relationship between friendship as a predictor and Facebook intrusion as the dependent variable, mediated by loneliness (Figure 1). We applied a moderated mediation model. The analyses were performed by means of the program PROCESS by Hayes (2013); Model no. 59 was applied. We performed the analyses for the total sample as well as for each of the five countries separately.

To answer the question about the role of loneliness in the relation between friendship and Facebook intrusion, we performed a mediation analyses with friendship as the predictor, loneliness as the mediator, and Facebook intrusion as the dependent variable. The analyses were performed for the total sample as well as for each of the countries. In Table 7, the mediation for total sample is presented. We used the bootstrapping method with bias-corrected confidence estimates (Preacher & Hayes, 2004).

In the next step, we performed detailed analyses of significant interactions (Table 8). First, we analyzed the relations between friendship and loneliness at three levels of age.

As can be seen in Table 8, in the total sample and in Syria the relationships between friend-

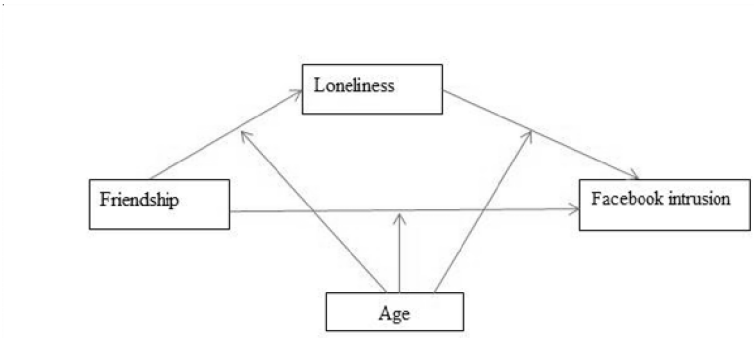

Figure 1 Conceptual model

Table 7 *Mediation analyses moderated by age (Predictor: friendship; Mediator: loneliness; Dependent Variable: Facebook intrusion)*

	friendship loneliness		loneliness > Fbintrusion		friendship> Fbintrusion	
Sample	Coeff	*p*	Coeff	*p*	Coeff	*p*
Total sample	**.007**	**.027**	.005	.582	-.009	.244
Ecuador	.001	.911	-.003	.887	.006	.670
Malaysia	-.025	.201	**-.208**	**.006**	-.074	.153
Poland	.003	.665	.025	.350	.025	.380
Slovakia	-.007	.288	.012	.582	.002	.931
Syria	**.018**	**.005**	.004	.762	-.009	.550

Note. The coefficients (Coeff) and their *p* values refer to the interactions of a given path with age.

Table 8 *Detailed analyses for significant interactions: Relations between friendship and loneliness at three levels of age in total and Syrian samples*

Age	Effect	*t*	*p*	LLCI	ULCI
Total sample					
1 *SD* below mean	-.13	-27.65	< .001	-.14	-.12
Mean	-.12	-37.29	< .001	-.13	-.12
1 *SD* above mean	-.11	-23.66	< .001	-.12	-.10
Syria					
Age	Effect	*t*	*p*	LLCI	ULCI
1 *SD* below mean	-.15	-15.06	< .001	-.17	-.13
Mean	-.13	-18.44	< .001	-.14	-.11
1 *SD* above mean	-.11	-10.57	< .001	-.13	-.09

ship and loneliness were significant (and negative) at all age levels. Given the significant interaction, we can state that the negative relationship between friendship and loneliness was the strongest in the group of young people, somewhat less strong in medium-aged people, and the weakest (though still significant) in the oldest participants. However, the differences between age groups as regards the effect size of the relationships between the investigated variables were rather small.

Next, we analyzed the relationships between loneliness and Facebook intrusion at three age levels in Malaysia (Table 9). The relationship between loneliness and Facebook intrusion was negatively significant only in the oldest group of participants.

In Poland, the indirect effect was statistically significant (bootstrap CIs not including zero) in the sample of young people, but not medium-aged or older. In contrast, in Malaysia the indirect effect was only significant in the oldest group. Loneliness mediated the relation between friendship and Facebook intrusion in two cases: in young people in Poland and among the oldest participants in Malaysia (see Table 10).

In the next step we repeated the mediation analyses with friendship as the predictor, loneliness as the mediator, and Facebook intrusion as the dependent variable – without age in the model and with the sample consisting only of participants under the age of 30 (Table 11).

As we can see in Table 11, among young people in the Polish sample, friendship de-

Table 9 *Detailed analyses for significant interactions: Relationships between loneliness and Facebook intrusion at three levels of age in the Malaysian sample*

Age	Effect	*t*	*p*	LLCI	ULCI
1 *SD* below mean	.16	0.75	.452	-.26	.59
Mean	-.23	-1.70	.090	-.49	.04
1 *SD* above mean	-.61	-3.17	.002	-.99	-.23

Table 10 *Mediation analyses moderated by age: Conditional indirect effects of friendship on Facebook intrusion at three values of age: 1 SD below mean, mean, 1 SD above mean*

			95% CI	
	Mediation at levels of age	Effect for mediation	Lower	Higher
Total sample	1 *SD* below mean	-.023	-.111	.067
	Mean	-.038	-.104	.025
	1 *SD* above mean	-.05	-.135	.029
Ecuador	1 *SD* below mean	-.163	-.306	-.045
	Mean	-.156	-.255	-.061
	1 *SD* above mean	-.148	-.292	-.024
Malaysia	1 *SD* below mean	-.118	-.335	.021
	Mean	.042	-.071	.162
	1 *SD* above mean	**.261**	**.008**	**.483**
Poland	1 *SD* below mean	**.282**	**.036**	**.574**
	Mean	.175	-.031	.372
	1 *SD* above mean	.072	-.233	.41
Slovakia	1 *SD* below mean	.002	-.311	.315
	Mean	.014	-.222	.249
	1 *SD* above mean	.025	-.358	.409
Syria	1 *SD* below mean	-.092	-.291	.106
	Mean	-.095	-.218	.02
	1 *SD* above mean	-.093	-.224	.027

Table 11 *Mediation in the group below the age of 30*

Sample (*N*)	X > M		M > Y		Direct X > Y		Total		Indirect X > Y		
	bMX	pMX	bYM	pYM	bYX	pYX	bT	pT	b'YX	p'YX	95% CI
Total (1539)	-.124	<.001	.040	.461	-.012	.202	-.017	.014	-.005	.461	-.019; .008
Ecuador (295)	**-.075**	**<.001**	**.462**	**.001**	.026	.211	-.008	.652	**-.035**	**.002**	**-.057; -.015**
Malaysia (236)	-.074	<.001	-.124	.409	.043	.064	.052	.011	.009	.414	-.015; .035
Poland (385)	**-.170**	**<.001**	**-.242**	**.033**	-.061	.012	-.020	.178	**.041**	**.033**	**.003; .082**
Slovakia (214)	-.124	<.001	.187	.161	-.002	.924	-.026	.170	-.023	.163	-.059; .013
Syria (409)	-.139	<.001	.125	.220	.004	.842	-.013	.361	-.017	.221	-.049; .013

creases loneliness and loneliness decreases Facebook intrusion, whereas in Ecuador friendship decreases loneliness and loneliness increases Facebook intrusion.

Discussion

The main aim of our study was to examine the mediating role of loneliness in the relation between friendship and Facebook intrusion among five countries that differ in terms of industrial, economic, societal, and technological development: Poland, Slovakia, Syria, Ecuador, and Malaysia. Moreover, we asked questions about Facebook use, such as log hours on weekdays and weekends.

In Syria and in Poland, the relationship between friendship and loneliness is negative in each of the age groups. This relationship is the strongest among young people and the weakest in the oldest group. It seems quite logical that people who have more friends feel less lonely. As the body of studies showed, friendships provides individuals with a sense of safety, security, and support (e.g., Lyubomirsky, King, & Diener, 2005; Hawthorne & Griffith, 2000). It has also been shown that friendship quality is a negative predictor of school loneliness (Zhang et al., 2015). In Malaysia, the relationship between loneliness and Facebook intrusion is negative only in the oldest group of people. Older people who feel lonely rarely use Facebook in an excessive way. They do not look for friends on Facebook. However, other studies indicate that Facebook may be a platform for social contacts at all ages (Grieve & Kemp, 2015; Sinclair & Grieve, 2017).

Furthermore, the results of our study show that loneliness mediates the relation between friendship and Facebook intrusion among older people in Malaysia: the higher the level of friendship, the lower level of loneliness, and the higher level loneliness, the lower level of Facebook intrusion. In this country, the people who have more friends feel less lonely and the people who feel lonely score lower on the Facebook Intrusion scale. The people who feel lonely probably do not look for friends on Facebook. In limited analyses, performed only for young people under the age of 30, we found that in the Polish sample friendship decreased loneliness and loneliness decreased Facebook intrusion. Polish young people who feel lonely do not look for friends on Facebook. By contrast, in Ecuador friendship decreases loneliness and loneliness increases Facebook intrusion, which might be related with the various internet access/penetration in these countries. Ecuadorians, as the typical collective society, probably compensate for the lack of friends with Facebook activity, due to more emotional than information based use of internet communicators (Ji et al., 2010).

Our findings show a similar tendency as the study examining the relationship between Internet use and loneliness conducted by Moody (2001), who applied Weiss's (1973) bimodal theory of loneliness. The study revealed that those who scored low on both dimensions of loneliness – emotional and social – had a wide network of face-to-face friends. Internet use was negatively related to social loneliness and positively to emotional loneliness. Another study in which types of loneliness were differentiated showed that Facebook users scored higher on family loneliness, whereas Facebook nonusers scored higher on social loneliness (Ryan & Xenos, 2011). Frison and Eggermont (2015) found that lonely people used Facebook in a more passive way.

In Poland, Slovakia, and Syria there are strong positive correlations between Facebook intrusion and log hours during weekdays and weekends. In those countries, people who have problems using Facebook in an excessive way use it every day on both working and nonworking days. It is in line with previous studies showing that Facebook Intensity was a positive predictor of Facebook addiction (Błachnio,

Przepiorka, & Hawi, 2016). Conversely, in Malaysia Facebook intrusion is not linked with log hours during weekdays. Malaysia has high smartphones penetration (65%), whereas this indicator for Poland is 41% (Pew Research Center, 2015). Probably, in Malaysia a large number of people – not only those showing symptoms of Facebook intrusion but also normal users – have access to Facebook not only via their computers but also via mobile devices. In Ecuador (with a relatively high rate of 60.3% of Facebook users in June 2016)[5], Facebook intrusion is related to log hours only during weekends. This is quite different in comparison to the other four countries, where Facebook is used more on weekends than weekdays. As far as the regular working time is concerned, in Ecuador Facebook use is much higher than it is during weekend leisure time. The explanation can be twofold. Firstly, this might stem from the work culture customs in Ecuador, where it is quite common to use Facebook at work. Secondly, Ecuador as a highly collectivistic country, it scored only 7 on the individualism-collectivism dimension, while Poland scored 60, Slovakia 52, and Syria 35[6]. The collective family culture is so strong there that during the weekend time is mainly devoted to "off-line" relations with family members, not to Facebook interactions (Liddy, Hunter, Mihan, & Keely, 2017). On the other hand, the increased Facebook use during the week might be a compensation strategy for the private contacts missing at work.

Limitations and Future Research

A limitation of the present study may be the use of self-report methods and correlational or cross-sectional designs, which have been addressed by some scholars to have limited inferential ability to prove causality. Thus, it is recommended to conduct further investigations for the present model using a longitudinal design (Bassam Mahmoud & Reisel, 2014). The next possible limitation is the low reliability of the Friendship Scale in Malaysia and Ecuador and the Loneliness Scale in Ecuador. In future studies, these reliability indices should be increased. Another limitation was the unequal number of participants from different countries and their unequal distribution in terms of age and gender. More research is also needed to provide a better understanding of the cultural aspects of Facebook intrusion. In future research, it would be a good idea to differentiate types of loneliness, or to distinguish its social and emotional levels in accordance with the theory of loneliness proposed by Weiss (1973). The pattern of Facebook use should also be controlled, as different patterns may have different impact on mental health (Frison & Eggermont, 2016; Hanna, Ward, Seabrook, Jerald, Reed, Giaccardi, & Lippman, 2017), which is particularly important for friendship and the quality of relationships. The study offers some insight, which may help Facebook users improve their usage habits. The results may be useful in therapy for people with problems stemming from the excessive use of social media.

Conclusion

To conclude, the presented studies help to better understand the cultural nature of Facebook intrusion. Our results extend the knowledge about the role of friendship and loneliness in Facebook intrusion and their different degrees of dependence on culture and age. The differences between countries suggest we cannot generalize the results, and that in exploring the Facebook intrusion phenomenon culture should always be taken into consideration.

---

[5] Ecuador – Telecoms, Mobile, Broadband and Digital Media – Statistics and Analyses available at: http://www.researchandmarkets.com/reports/838317/, retrieved June 2, 2017.

[6] https://www.hofstede-insights.com

References

Andreassen, C. S., & Pallesen, S. (2014). Social network site addiction – an overview. *Current Pharmaceutical Design*, *20*(25), 4053–4061.

Bassam Mahmoud, A., & Reisel, W. D. (2014). Relating patient satisfaction to nurses' job satisfaction, job security, and obedience OCBs. *International Journal of Pharmaceutical and Healthcare Marketing*, *8*(1), 47–61.

Błachnio, A., Przepiorka, A., Bałakier, E., & Boruch, W. (2016). Who discloses the most on Facebook? *Computers in Human Behavior*, *55*, 664–667. http://doi.org/10.1016/j.chb.2015.10.007

Błachnio, A., Przepiorka, A., Benvenuti, M., Cannata, D., Ciobanu, A. M., Senol-Durak, E., … Ben-Ezra, M. (2016a). An international perspective on Facebook intrusion. *Psychiatry Research*, *242*, 385–387. http://doi.org/10.1016/j.psychres.2016.06.015

Błachnio, A., Przepiorka, A., Benvenuti, M., Cannata, D., Ciobanu, A. M., Senol-Durak, E., … Ben-Ezra, M. (2016b). Cultural and personality predictors of Facebook intrusion: A cross-cultural study. *Frontiers in Psychology*, *7*(February 2004), 1895. http://doi.org/10.3389/fpsyg.2016.01895

Błachnio, A., Przepiorka, A., Boruch, W., & Bałakier, E. (2016). Self-presentation styles, privacy, and loneliness as predictors of Facebook use in young people. *Personality and Individual Differences*, *94*, 26–31. http://doi.org/10.1016/j.paid.2015.12.051

Chopik, W. J. (2016). The benefits of social technology use among older adults are mediated by reduced loneliness. *Cyberpsychology, Behavior, and Social Networking*, *19*(9), 551–556. http://doi.org/10.1089/cyber.2016.0151

Elphinston, R. A., & Noller, P. (2011). Time to face it! Facebook intrusion and the implications for romantic jealousy and relationship satisfaction. *Cyberpsychology, Behavior and Social Networking*, *14*(11), 631–635. http://doi.org/10.1089/cyber.2010.0318

Hawthorne, G., & Griffith, P. (2000). *The Friendship Scale: Development and properties*. Centre for Health Program Evaluation Melbourne.

Liddy, C., Hunter, Z., Mihan, A., & Keely, E. (2017). Use of Facebook as part of a social media strategy for patient engagement. *Canadian Family Physician*, *63*(3), 251–252.

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin*, *131*(6), 803–855. http://doi.org/10.1037/0033-2909.131.6.803

Özdemir, Y., Kuzucu, Y., & Ak, Ş. (2014). Depression, loneliness and Internet addiction: How important is low self-control? *Computers in Human Behavior*, *34*, 284–290. http://doi.org/10.1016/j.chb.2014.02.009

Petrocchi, N., Asnaani, A., Martinez, A. P., Nadkarni, A., & Hofmann, S. G. (2015). Differences between people who use only Facebook and those who use Facebook plus Twitter. *International Journal of Human-Computer Interaction*, *31*(2), 157–165. http://doi.org/10.1080/10447318.2014.986640

Rosseel, Y. (2012). lavaan: An R Package for Structural Equation. *Journal of Statistical Software*, *48*(2).

Song, H., Zmyslinski-Seelig, A., Kim, J., Drent, A., Victor, A., Omori, K., & Allen, M. (2014). Does Facebook make you lonely?: A meta analysis. *Computers in Human Behavior*, *36*, 446–452. http://doi.org/10.1016/j.chb.2014.04.011

Wegmann, E., & Brand, M. (2016). Internet-Communication Disorder: It's a matter of social aspects, coping, and internet-use expectancies. *Frontiers in Psychology*, *7*(November), 1–13. http://doi.org/10.3389/fpsyg.2016.01747

Weiss, R. S. (1973). *Loneliness: The experience of emotional and social isolation*. Cambridge, MA, US: The MIT Press.

Zhang, X., Chen, F., Wu, Y., Yuan, C., & Wang, Y. (2015). Examining relations between locus of control, loneliness, subjective well-being, and preference for online social interaction. *Chinese Journal of Clinical Psychology*, *23*(1), 147–149.

Studia Psychologica, Vol. 60, No. 3, 2018, 195-208 doi: 10.21909/sp.2018.03.762

These Problems Sound Familiar to Me: Previous Exposure, Cognitive Reflection Test, and the Moderating Role of Analytic Thinking

Jakub Šrol
Institute of Experimental Psychology, Center of Social and Psychological Sciences
Slovak Academy of Sciences

One of the current topics in research on the Cognitive Reflection Test (CRT) is its growing familiarity among the general public. Surprisingly, Bialek and Pennycook (2017) showed that previous exposure does not diminish the CRT's predictive power in Heuristics and Biases (H&B) tasks, but proposed that the relationship is moderated by analytic thinking, a conjecture tested in the present study. Participants (N = 365) filled in the CRT, Need for Cognition (NFC) scale, and a battery of H&B problems. While the CRT did retain its predictive power in the H&B performance, regardless of participants' self-reported thinking dispositions and exposure, both of these factors moderated the relationship, such that exposure increased CRT's predictive power in H&B tasks, albeit only among high-NFC individuals. Present results converge with studies showing that prior exposure does not invalidate the use of CRT, while offering some novel evidence for the metacognitive disadvantage account proposed by Bialek and Pennycook (2017).

Key words: Cognitive Reflection Test, familiarity issue, cognitive bias, analytic thinking, metacognitive disadvantage

Introduction

Over the past decade, Frederick's (2005) Cognitive Reflection Test (CRT), which consists of three tricky problems that give rise to compelling but wrong intuitive responses, became one of the most widely used methods in the research on individual differences in rational reasoning and decision making. As such, items of the CRT gradually came to be familiar to general public through research, popular books, or college psychology courses (e.g., Thomson & Oppenheimer, 2016). The familiarity issue is one of the current topics of the CRT research, with studies showing that people previously exposed to the test achieve better scores on it (Haigh, 2016; Pennycook, Cheyne, Koehler, & Fugelsang, 2015b), and that they might share different demographic characteristics from people unfamiliar with it (Stieger & Reips, 2016). Basedon such results, researchers quickly started to believe that prior exposure invalidates the use of CRT as a predictor of various outcomes and several came up with alternative versions of the test to tackle the familiarity issue (Thomson &

Acknowledgement
This study was funded by the Slovak Research and Development Agency and is part of research project APVV-16-0153 "Cognitive failures – individual predictors and intervention possibilities". The author is indebted to Michal Bialek and one anonymous reviewer for their invaluable comments on the earlier draft of this paper.

Correspondence concerning this article should be addressed to Jakub Šrol, Institute of Experimental Psychology, Center of Social and Psychological Sciences, Slovak Academy of Sciences, Dúbravská cesta 9, Bratislava, 841 04, Slovak Republic. E-mail: jakub.srol@savba.sk

Received April 12, 2018

Oppenheimer, 2016; Toplak, West, & Stanovich, 2014).

However, noting that the conjecture that previous exposure invalidates the CRT was not empirically tested, Bialek and Pennycook (2017) recently reanalyzed the data from six of their studies, where participants completed CRT as well as several outcome measures potentially related to analytic thinking. They have found that substantial proportion of participants in their research (22% – 60% of the samples) reported being familiar with the CRT and they scored higher on the test than the rest of the samples. More importantly, based on comparisons of correlations between CRT and outcomes among participants familiar and unfamiliar with the test, the authors found that the predictive validity of CRT never diminished as a result of prior exposure. Rather, it stayed similar or even became stronger among exposed participants, the latter option mostly occurring in the case of correlations between CRT and the composite of various heuristics and biases (H&B) tasks (Toplak, West, & Stanovich, 2011), such as ratio bias, conjunction fallacy, and base-rate neglect problems.

Further indication for the surprising non-effects of prior exposure to the CRT comes from Stagnaro, Pennycook, and Rand (2018), who have provided evidence that while scores on the CRT increased somewhat with the number of times participants were exposed to the test, the relationships between CRT and two measures related to analytical thinking – religious belief and political affiliation – remained surprisingly stable from the first time participants encountered CRT in their studies to the subsequent times they took the test. Moreover, in a comprehensive study by Meyer, Zhou, and Frederick (2018) it was shown not only that the CRT does not loose its predictive validity in one of the most notorious H&B problems (Linda task) and Raven's test of progressive matrices, but also that participants' real exposure to the CRT, as opposed to the self-reported familiarity with the test, has only a very small effect on the CRT performance. Finally, the authors also conclude that people who improve their performance on the CRT with exposure are only those who continue to reflect upon the test, even with multiple exposures, and those who have performed well on the CRT the first time they took it.

Bialek and Pennycook (2017) offered several accounts to explain why CRT might not be negatively affected by participants' previous exposure to it. Firstly, *participants familiar with the CRT may also be familiar with the H&B composite,* as this exact battery of tasks has, for several years now, been frequently employed in other studies (e.g., Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2015a; Toplak, West, & Stanovich, 2011). Secondly, exposed participants may have scored higher on the CRT because of the *self selection effect*, i.e. highly reflective individuals may simply complete more studies and are therefore more likely to be familiar with CRT and have higher scores on the test, even if the prior exposure does not necessarily help them actually solve the problems. However, the self selection effect cannot really explain the differences in correlations between the CRT and other outcomes.

Finally, to explain why the CRT's predictive power does not diminish as a result of prior exposure, Bialek and Pennycook (2017) argue that people with low scores on the CRT may have a *metacognitive disadvantage*. That is, intuitive people may not realize the problems are tricky and therefore continue to do poorly even upon repeated exposure to the test. This conjecture stems from studies showing that intuitive individuals are worse at detecting the conflict in tasks which require suppressing misleading intuitions (Pennycook, Fugelsang, & Koehler, 2015b). It is also supported by recent study of Pennycook, Ross, Koehler, and Fugelsang (2017), who have shown that people who do poorly on the CRT strongly overesti-

mate their performance, suggesting they do not realize that the intuitive response they provided is incorrect. Note that this does not mean intuitive reasoners cannot improve their performance at all under repeated exposure to the test. If they encounter the problems in a context where they are presented along with the correct solution, their performance might subsequently increase even if they do not understand why the solution is correct. On the other hand, relatively analytic individuals will realize that the compelling intuitive response is incorrect and the problems require additional reflection, and therefore are more likely to increase their performance upon repeated exposure to the test. Although being already analytic, they might score high on the CRT as it is, and therefore would also not benefit much from their prior exposure, they are still expected to gain more from it than intuitive reasoners. Based on these propositions, Bialek and Pennycook (2017) concluded that familiarity may not be such a devastating problem for CRT's predictive validity as previously thought, as the test remains to distinguish well between intuitive and analytical reasoners even after multiple exposures. Of the accounts offered by Bialek and Pennycook (2017), the metacognitive disadvantage seems to fit the best with the results of Meyer et al. (2018), who have observed that the effect of familiarity is driven mostly by people, who continue to reflect upon the CRT even with multiple exposures.

The aim of the present study was to examine whether CRT retains its predictive validity in H&B problems among participants who are already familiar with the test, and to conduct a test of the metacognitive disadvantage account proposed by Bialek and Pennycook (2017). Participants were asked to answer the original CRT, indicate whether they were familiar with the test prior to taking a part in the study, solve a battery of H&B tasks, and fill in a separate measure of analytic thinking disposition, the Need for Cognition scale (NFC; Cacioppo, Petty, Feinstein, & Jarvis, 1996). The NFC represents a widely used self-report instrument designed to study predisposition toward effortful and analytic thought (e.g., Pennycook, Cheyne et al., 2015b; Toplak et al., 2014). However, as was shown by Pennycook et al. (2017), both genuinely reflective individuals and some intuitive reasoners, who lack insight into their true reflectivity, score highly on it. Therefore, the NFC should be distinguished from direct measures of analytic thinking disposition, such as the Cognitive Reflection Test, and rather thought of as an index of how strongly participants believe they are reflective. Concerning the reasoning and decision-making problems used in the present study, rather than using a composite H&B battery from previous research (Pennycook, Cheyne, Barr et al., 2015a; Toplak et al., 2011), new problems pertaining to several cognitive biases were created in order to reduce the possibility that participants were previously exposed to them.

Following the procedure of Bialek and Pennycook (2017), I have compared the correlations between CRT and outcome measures employed in the present research among unexposed and exposed participants, in order to determine whether the predictive power of CRT changes with previous exposure. Next, per the metacognitive disadvantage account, it was hypothesized that in analytic reasoners, as identified by their NFC scores, previous exposure would lead to a higher increase in the CRT performance than among relatively more intuitive participants. Finally, as Bialek and Pennycook (2017) observed that the relationships between CRT and H&B tasks were in some cases stronger among exposed participants, it was tested whether the predictive power of CRT in the performance on the H&B tasks would increase as a function of prior familiarity with the test, as well as participants' self-reported analytic thinking disposition.

Method

Participants

The study was presented in the form of an online survey and participants were students and alumni recruited through websites of several major Slovak universities and colleges. In total, 395 people participated in the study. However, based on attention check questions[1], 16 (4%) participants failed to follow instructions or their answers indicated random responding and their data were removed from subsequent analyses. Additionally, 14 (4%) participants failed to provide answers to one or more of the CRT items and were also dropped from further analyses. The final sample consisted of 365 participants of whom 92 (25%) were male and 273 (75%) female with the mean age of 23.39 (SD = 4.103). Most of the participants were university students, who reported having a high school diploma (45% of the sample), some had already finished their bachelor's (30%) or master's (23%) degree. Concerning the study fields, the participants were students of various universities and colleges with different majors, mostly economics and management (16%), pedagogy (14%), humanities (12%) and engineering (10%).

Sensitivity analysis was carried out in G*Power 3.1.9 software in order to determine effect sizes under the current sample size with 5% error probability and at least 80% statistical power. The results showed that the study should be powered enough to detect correlation coefficients of r = .146, differences between two independent correlations of q = .296, and differences between two independent means of d = 0.294 and higher[2].

Participants always first filled out the demographic information and the NFC, answered the original CRT and indicated their familiarity with the task, and then completed several blocks of H&B tasks and other measures not reported here. The order of the items within each block of problems was randomized. The materials and data for the present study are publicly accessible at OSF: https://osf.io/xfnsw.

Materials

Cognitive Reflection Test. The original three-item test developed by Frederick (2005) was used. After answering the three problems, participants were asked if they had ever encountered any of them before taking part in the present study.

Heuristics and Biases tasks. Four types of heuristics and biases tasks were used in the present study: 12 syllogistic reasoning tasks, 8 ratio bias items, 8 conjunction fallacy problems, and 6 base-rate neglect tasks. All of the items were constructed to evoke compelling but misleading intuitive response, which had to be suppressed in order to solve the problem in line with formal logic. Brief descriptions and example items for every type of H&B task can be found in the supplementary material. These four sorts of problems were selected because of their frequent use in the research on cognitive biases, and because they all have been shown in previous research to correlate with the CRT (e.g.,

[1] Two attention check questions were created. These items were randomly intermixed with the H&B problems and were constructed to resemble these tasks, but unlike the actual items they did not involve any catch and were actually very simple math problems. Participants who got any of the two attention check items wrong were automatically excluded from further analyses. Both attention check questions are available in the Supplementary materials for the study.

[2] The sensitivity analyses were calculated under the assumption that the two independent correlations or means come from groups of equal sample sizes, i.e. each group consists of 182 observations.

Oechssler, Roider, & Schmitz, 2009; Pennycook, Cheyne, Barr, Koehler, & Fugelsang, 2014; Toplak et al., 2014). For the purpose of all analyses, correct answers on the 34 problems were summed to form a single H&B composite score.

Need for Cognition scale (Cacioppo et al., 1996). Participants rated their agreement with 18 items such as *"I would prefer complex to simple problems"* on a 7-point scale ranging from 1 (not at all like me) to 7 (completely like me). After the data collection it was found that two of the NFC items did show unsatisfactory psychometric properties, they had negative correlations with some of the remaining items and their inclusion led to the decrease in the reliability of the scale. Therefore, these items were excluded from the analysis and NFC score was calculated as an average score reported on the remaining 16 items.

Results

Correlations between Measures

Descriptive statistics and correlation coefficients between all measures reported in the study are presented in Table 1. The results pertaining to the predictors and their relationships with H&B tasks are consistent with previous research on individual differences in cognitive biases. CRT and the NFC significantly correlated with the H&B composite, however, the correlations tended to be somewhat stronger in the case of the former than the latter.

Differences between Exposed and Unexposed Participants

Table 1 also shows the correlations between participants' previous exposure to the original CRT and other measures in the study. Of the whole sample, 157 participants (43%) reported being familiar with one or more of the CRT tasks. As in other studies that asked for participants' prior exposure (Bialek & Pennycook, 2017; Haigh, 2016; Stieger & Reips, 2016), people already familiar with the CRT had higher scores on the test ($r = .408$). To facilitate the comparison with the results of previous studies, mean scores on the CRT were also compared, and this resulted in a large difference between exposed ($M = 2.36$, $SD = 0.99$) and unexposed ($M = 1.35$, $SD = 1.21$) participants, $t(360.4) = -8.75$, $p < .001$, $d = 0.91$. Furthermore, exposed participants also showed higher scores on the composite of H&B tasks presented in the study, although the relationships with exposure were lower than in the case of the CRT. The only non-significant correlation was observed between exposure and scores on the NFC, which shows that participants familiar and unfamiliar with the CRT did not differ significantly in their

Table 1 *Descriptive statistics and correlations between all methods in the present study*

	M	*SD*	*α*	1	2	3
1. Exposure	43%	–	–	1		
2. CRT	1.78	1.23	.78	**.408**	1	
3. NFC	4.17	0.82	.87	.090	**.193**	1
4. H&B composite	20.12	6.87	.89	**.240**	**.522**	**.303**

Note. $N = 365$. Table presents mean scores, standard deviations, and internal consistency of the measures employed in the study. Previous exposure to the CRT was coded as 0 = unexposed, 1 = exposed. Correlations that appear in bold are significant. Correlations of $r > .103$ are significant at $p = .05$, $r > .135$ are significant at $p = .01$, and $r > .172$ are significant at $p = .001$.

self-reported disposition toward analytic thinking. This seems to run counter to the notion of Bialek and Pennycook (2017) that increased scores on CRT among exposed participants might be the result of the self-selection effect. If more reflective people completed more studies, and therefore were more familiar with CRT, it could be expected that prior exposure would be correlated with the scores on the NFC scale. However, the lack of correlation could also reflect the fact that NFC captures only self-perception of participants as being analytic or not, and therefore, the potential relationship between number of studies completed and genuine analytic thinking disposition may have been attenuated by employing this measure.

Moreover, in order to examine whether prior exposure to CRT influenced the predictive validity of the test, Fisher's z test was used to compare the correlations between CRT and other measures among exposed and unexposed participants. There were no significant differences in the correlation between CRT and NFC among unexposed (r = .189) and exposed (r = .143) participants, z = 0.444, p = .660. Similarly, there was no significant difference in correlations observed among unexposed (r = .509) and exposed (r = .452) participants between CRT and the H&B battery, z = 0.696, p = .484. The observed differences were both very small in size and not significant, however, the correlations were never higher in exposed participants than unexposed participants, contrary to what was observed in the study of Bialek and Pennycook (2017).

Does Exposure to the CRT Predict Responses on the CRT?

Next, to test the hypothesis that prior exposure would benefit only analytic but not intuitive individuals when solving the CRT, a simple moderation analysis was conducted, where exposure was used as a predictor (X) of the scores on CRT (Y) with self-reported analytic thinking style as a moderator (M). All moderation analyses in the present paper were conducted with Hayes' (2013) macro implemented in the IBM SPSS v.20 software. The variables were always mean centered prior to the analyses. The results of this moderation (Table 2) show that both exposure and NFC are predictors of the responses on the CRT, but there is no moderation present. Thus, people with high and low self-reported analytic cognitive styles did not benefit to different extent from prior exposure, when

Table 2 *Simple moderation analysis of the CRT exposure as a predictor of scores on the CRT and the NFC as a moderator*

	b [95% *CI*]	*SE*	*t*	*p*
Scores on the CRT				
Constant	1.784 [1.670; 1.899]	0.058	30.639	$p < .001$
NFC	0.232 [0.092; 0.371]	0.071	3.268	$p = .001$
CRT exposure	0.978 [0.746; 1.209]	0.118	8.308	$p < .001$
Interaction	-0.094 [-0.378; 0.190]	0.144	-0.649	$p = .517$

Model: $R^2 = .19$, $F(3,361) = 28.605$, $p < .001$; Change: $\Delta R^2 = .0009$, $F(1,361) = 1.130$, $p = .517$

Note. N = 365. Table contains unstandardized regression coefficients (b's) with their corresponding 95% confidence intervals, standard errors, t-values and levels of significance. ΔR^2 denotes R-squared change due to interaction (adding the moderator to the regression). Variables were mean centered before the analysis.

solving the problems of the original CRT. Such possibility seems to run counter to the metacognitive disadvantage account of Bialek and Pennycook (2017), however, it should be noted that the result is based on participants' self-reported reflectivity, rather than the genuine one. Therefore, the failure of high-NFC scorers to benefit more from their previous exposure when solving the CRT than their counterparts with lower self-report reflectiveness may be due to the fact that the former group consists of both genuinely analytic individuals and intuitive participants, who only believe themselves to be analytic. This point is further explicated in the discussion.

Does Exposure and NFC Moderate the Role of CRT as a Predictor of H&B Tasks?

To address the possibility that previous exposure and self-reported analytic thinking disposition will amplify the relationship between

Table 3 *Moderated moderation analysis of the CRT as a predictor of scores on the H&B tasks with the CRT exposure and NFC as moderators*

	b [95% *CI*]	*SE*	*t*	*p*
Scores on the H&B composite				
Constant	19.925 [19.276; 20.574]	0.330	60.398	$p < .001$
CRT exposure	0.023 [-1.304; 1.345]	0.674	0.033	$p = .973$
CRT	2.702 [2.164; 3.240]	0.274	9.881	$p < .001$
CRT*CRT exposure	0.492 [-0.623; 1.607]	0.567	0.868	$p = .386$
NFC	1.375 [0.541; 2.209]	0.424	3.242	$p = .001$
CRT*NFC	0.214 [-0.469; 0.896]	0.347	0.616	$p = .538$
CRT exposure*NFC	1.449 [-0.283; 3.181]	0.881	1.645	$p = .101$
Interaction	1.466 [0.024; 2.907]	0.733	2.000	$p = .046$
Model: $R^2 = .34$, $F(7,357) = 26.145$, $p < .001$; Change: $\Delta R^2 = .0074$, $F(1,357) = 3.999$, $p = .046$				
Conditional effects of CRT on H&B composite at values of moderators:				
Low NFC – unexp	2.834 [1.966; 3.702]	0.441	6.424	$p < .001$
Low NFC – exp	2.119 [0.813; 3.425]	0.664	3.190	$p = .002$
Mean NFC – unexp	2.491 [1.840; 3.142]	0.331	7.525	$p < .001$
Mean NFC – exp	2.983 [2.077; 3.888]	0.460	6.478	$p < .001$
High NFC – unexp	2.147 [1.209; 3.085]	0.477	4.502	$p < .001$
High NFC – exp	3.847 [2.444; 5.249]	0.713	5.393	$p < .001$
Conditional effects of CRT*CRT exposure interaction at values of NFC:				
Low NFC	-0.715 [-2.283; 0.853]	0.797	-0.897	$p = .370$
Mean NFC	0.492 [-0.623; 1.607]	0.567	0.868	$p = .386$
High NFC	1.699 [0.012; 3.387]	0.858	1.980	$p = .048$

Note. $N = 365$. Table contains unstandardized regression coefficients (*b*'s) with their corresponding 95% confidence intervals, standard errors, *t*-values and levels of significance. ΔR^2 denotes R-squared change due to three-way interaction (adding the moderators to the regression). Low NFC and High NFC reflect one standard deviation below and above the mean of NFC scores in the present sample. Variables were mean centered before the analysis.

CRT and the H&B performance, a moderated moderation analysis[3] was employed, where the CRT (X) was entered as a predictor of H&B tasks (Y) with both previous exposure to the CRT (M) and NFC (W) as moderators. The results are presented in Table 3.

Both CRT and NFC were significant predictors of the performance on the composite of H&B tasks. Importantly, there was a three-way interaction present, indicating the moderated moderation effect, although it was just below the conventional threshold for significance. The middle part of the table shows that CRT was a significant predictor of H&B tasks among unexposed and exposed participants of both intuitive and analytic self-reported cognitive style. However, as the results in the bottom part suggest, the presence of interaction between prior exposure and CRT in predicting H&B tasks was only significant in participants who believed themselves to be analytic, specifically, as the Johnson-Neyman technique (Hayes, 2013) shows, among people who scored above 4.964 on the NFC scale (16% of the present sample). The interaction is depicted in Figure 1. When looking at the high-NFC individuals, CRT predicted H&B scores both among unexposed and exposed participants, but the relationship was stronger among the latter. The same was not observed among people with moderate scores on NFC, who think of themselves as not especially analytic, nor intuitive. In them, as can be seen from the middle panel of Figure 1, CRT predicted H&B tasks to similar extent, regardless of the previous exposure. Interestingly, when looking at the participants with intuitive self-reported cognitive style, the interaction observed among high-NFC individuals seems to reverse (upper panel in Figure 1), and the conditional effect indeed is in the opposite direction, although it does not reach significance among participants, who scored one standard deviation below the mean NFC.

Does Exposure to the CRT Predict Responses on the H&B Tasks?: An Exploratory Analysis

As shown in the correlation analysis, not only did participants exposed to the CRT achieve higher accuracy on the test itself, but they also scored significantly higher on the H&B composite. To examine this surprising result, I have decided to carry out one additional exploratory moderation analysis, where composite of H&B tasks (Y) was predicted by the CRT exposure (X) and this relationship was moderated by the NFC (M). The results of this analysis are presented in Table 4.

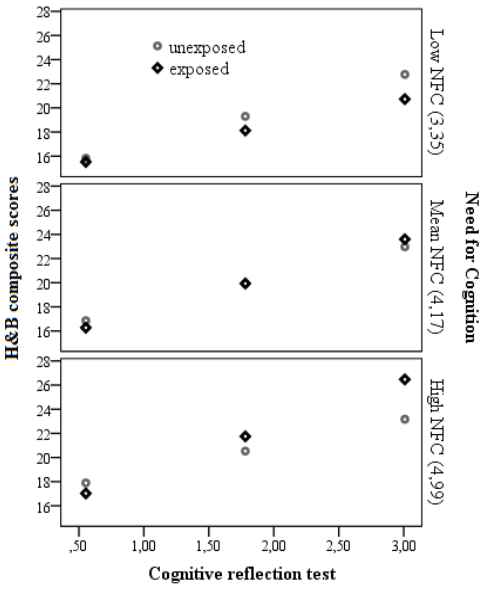

Figure 1 Cognitive reflection test as a predictor of scores on the H&B composite at low, mean, and high levels of NFC among participants exposed and unexposed to the CRT

[3] As a template for this analysis, model 3 in Hayes (2013) was used. A visual representation of the analysis is included in the Supplementary material (see Figure S1).

Table 4 *Simple moderation analysis of the CRT exposure as a predictor of scores on the H&B composite and the NFC as a moderator*

	b [95% *CI*]	*SE*	*t*	*p*
Scores on the H&B composite				
Constant	20.054 [19.396; 20.712]	0.335	59.922	$p < .001$
NFC	2.416 [1.615; 3.218]	0.408	5.929	$p < .001$
CRT exposure	2.919 [1.589; 4.249]	0.676	4.317	$p < .001$
Interaction	1.815 [0.183; 3.447]	0.830	2.187	$p = .029$
Model: $R^2 = .15$, $F(3,361) = 20.970$, $p < .001$; Change: $\Delta R^2 = .0113$, $F(1,361) = 4.783$, $p = .029$				
Conditional effects of CRT exposure on H&B composite at values of NFC:				
Low NFC	1.424 [-0.496; 3.344]	0.976	1.459	$p = .146$
Mean NFC	2.919 [1.589; 4.249]	0.676	4.317	$p < .001$
High NFC	4.414 [2.553; 6.275]	0.947	4.664	$p < .001$

Note. $N = 365$. Table contains unstandardized regression coefficients (*b*´s) with their corresponding 95% confidence intervals, standard errors, *t*-values and levels of significance. ΔR^2 denotes R-squared change due to interaction (adding the moderator to the regression). Low NFC and High NFC reflect one standard deviation below and above the mean of NFC scores in the present sample. Variables were mean centered before the analysis.

As can be seen from the table, while CRT exposure was in itself a significant predictor of the H&B composite, a significant interaction between exposure and the NFC emerged, indicating the presence of the moderation effect. Conditional effects analysis showed that among participants with low NFC previous exposure to the CRT did not help increase the accuracy on various H&B tasks, but in the people with higher self-reported analytic cognitive style, it did. Johnson-Neyman technique showed that prior CRT exposure did not significantly predict scores on the H&B composite among people, who scored less than 3.516 on the NFC (22% of the present sample). If the participants who were familiar with the CRT also already knew some of the H&B tasks, then it might be the case that those who perceive themselves as reflective did gain some insight into the tasks and thus scored higher on them in the present study. On the other hand, participants who believed themselves to be of little reflectivity did not benefit from this potential familiarity with the H&B problems, which could be regarded as an evidence for their metacognitive disadvantage. However, due to the exploratory nature of this analysis, such interpretation should remain cautious.

Discussion

In this study I examined the relationships between prior exposure to CRT, self-reported analytic thinking disposition, and H&B performance. Similarly to the previous research (Haigh, 2016; Stieger & Reips, 2016), 43% of the participants in the present sample indicated they were familiar with the items of CRT before their participation, and these people achieved substantially higher scores on the test than the rest of the sample ($d = 0.91$). As was shown in the first moderation analysis (Table 2), previous

exposure predicted participants' CRT responses independently of their self-reported thinking dispositions. This result might be seen as running counter to the metacognitive disadvantage conjecture of Bialek and Pennycook (2017), who suggested that intuitive participants, unlike their more analytically disposed counterparts, would not realize the tricky nature of the CRT problems even upon repeated exposure and thus would not benefit much from prior exposure when solving the CRT. Yet, as was shown in the study by Pennycook et al. (2017), high self-reported NFC is not only representative of genuinely reflective participants, but also of some intuitive reasoners, who misestimate their true reflectivity. Then high-NFC scorers in the present study may not have benefitted more from their exposure when solving the CRT than participants with low NFC, precisely because the effect of presumed metacognitive advantage of the former may have been attenuated by the subset of genuinely intuitive individuals, who self-identified themselves as analytic. However, before reaching any conclusions on this matter, I shall review other findings of the present study that are also relevant to the metacognitive disadvantage account.

The account of Bialek and Pennycook (2017) was further explored in the model where CRT predicted scores on the H&B composite with both exposure to the CRT and NFC included as possible moderators of this relationship (Table 3). While both CRT and self-reported analytic thinking disposition predicted H&B scores, as in the previous research (Toplak et al., 2011), CRT exposure did not emerge as significant independent predictor of the susceptibility to cognitive biases. Yet, there was a three-way interaction between the predictors indicating the presence of moderated moderation. Conditional effects showed that while CRT was a predictor of H&B tasks regardless of participant's exposure and NFC score, prior familiarity with the CRT increased its predictive value, albeit only individuals, who perceived themselves as analytic. Moreover, as was shown in an additional exploratory moderation analysis (Table 4), exposure to the CRT in itself predicted H&B performance, and this relationship was further amplified by the self-reported analytic thinking disposition.

Thus, even if the results of the simple moderation might be seen as not in line with the metacognitive disadvantage proposition (Bialek & Pennycook, 2017), subsequent analyses showed that self-reported analytic thinking disposition did play a role in the predictive power of CRT on the H&B tasks among exposed participants, and even moderated the link between exposure to the CRT and the ability to solve various H&B problems, which is quite consistent with the aforementioned account. Furthermore, there are two things that one has to consider when looking at the results of the first moderation reported in this paper. First, a possible explanation for why high-NFC scorers did not show predicted higher performance increase on CRT upon exposure, in comparison with participants who self-identified as intuitive, is that their scores might have been already almost at the ceiling and therefore could not improve much more. The average CRT performance in the present study was quite high even among participants unfamiliar with the test ($M = 1.35$), but among those who were familiar, it was not too far from perfect ($M = 2.36$). As a sidenote, these values are in line with some other studies on the CRT exposure (e.g., Haigh, 2016; Stieger & Reips, 2016). It is plausible then that participants who scored highly on NFC in the present research could not benefit much from previous exposure because the performance of a substantial amount of them was already at the ceiling. If this was the case, then since participants with low self-reported analytic thinking disposition had far more space for improvement on the CRT upon exposure, the fact that they only improved as much as the more analytic

reasoners, who could only perform a little better to begin with, could actually be taken as evidence for their presumed metacognitive disadvantage (Bialek & Pennycook, 2017; Mata, Ferreira, & Sherman, 2013).

The second consideration regarding the first moderation analysis comes from the surprising link between previous exposure to the CRT and increased performance on H&B composite. It might be that people, who were familiar with the CRT also knew the H&B problems, as these methods are often employed together in psychological studies on cognitive biases (Bialek & Pennycook, 2017), and therefore achieved better performance on the latter. While this possibility cannot be ruled out, it would have been more plausible if the present sample came from a participant pool, which is known to be especially likely to be familiar with the CRT, such as Mechanical Turk service or undergraduate psychology students (Haigh, 2016; Thomson & Oppenheimer, 2016). In this study, no recruitment service was used and most of the participants were majoring in various subjects, with only small proportion coming from social sciences (4%). Also, instead of the H&B battery, which is most frequently employed in studies along with the CRT (Bialek & Pennycook, 2017; Toplak et al., 2011), in the present research different sets of problems were used, some of which were constructed specifically for this study and should not have been previously seen by the participants. Importantly, even if some of the participants exposed to the CRT may have seen several of the H&B problems before, although not exactly the ones used here, this would not explain why only those who identified themselves as analytic ended up benefiting from the exposure when solving the H&B battery. However, it could be that only high-NFC scorers benefited from exposure to the CRT when solving H&B problems because they actually understood the logic of the tasks, while more intuitive participants may have encountered H&B problems already, but they either did not recognize them, or were unable to gain insight into the logic of these tasks and therefore did not improve their performance. Such explanation would then again speak in favor of metacognitive disadvantage of intuitively disposed reasoners (Bialek & Pennycook, 2017; Mata et al., 2013).

Alternative interpretation of the link between exposure to the CRT and H&B performance comes from the suggestion of Meyer et al. (2018) that the ability to recall previous exposure may be related to general intelligence. Thus, people better at recalling their familiarity with the CRT may have had higher cognitive abilities, which have been linked to superior performance on various H&B problems (Pennycook, Cheyne et al., 2015a; Toplak et al., 2014). Exploratory moderation also showed that this relationship was further amplified by the NFC, which would likewise be consistent with the fact that avoidance of cognitive biases requires both intelligence and analytic thinking disposition (e.g., Toplak et al., 2011). Such account would also explain why exposure did not predict H&B performance after the CRT score itself was included in the analysis (Table 3). As the ability to solve the test has been known in part to reflect general cognitive abilities (Frederick, 2005), its inclusion in the regression model may have explained away any difference in intelligence among participants who were able to recall CRT exposure and those who were not.

Putting the differences between analytically disposed reasoners and their intuitive counterparts aside, one additional result of the moderated moderation (Table 3) deserving further notice is that the CRT does not lose its predictive validity in the H&B performance upon previous exposure. While several researchers in the past assumed that familiarity with the CRT automatically invalidates its use (e.g., Haigh, 2016; Stieger & Reips, 2016), the results of the present study converge with recent investiga-

tions, which show that while exposure may lead to an improvement in the CRT performance, it does not seem to affect the test's predictive power in various outcomes related to analytic thinking (Meyer et al., 2018; Stagnaro et al., 2018). Similarly to the observation by Bialek and Pennycook (2017), if anything, exposure to the CRT seemed to increase the predictive power of the test in H&B performance, although this was true only among individuals with high self-reported reflectivity, presumably because of their metacognitive advantage. As the CRT is known to be an important predictor of H&B performance over and above the measures of cognitive ability and thinking dispositions (Toplak et al., 2011), it is important to reiterate that as far as the results of this study go, the test retains its predictive power in the performance on H&B tasks among all participants who claim they have seen or taken it previously, regardless of their self-reported thinking dispositions.

Limitations

The metacognitive disadvantage account (Bialek & Pennycook, 2017) tested in the present study relies on the prediction that intuitive reasoners will not benefit from previous exposure when solving CRT as much as their analytic counterparts because they fail to gain insight into the tricky nature of the problems. However, the performance of intuitive participants might improve if they were exposed to the CRT in a context in which it was presented along with a correct response. As I did not ask participants where they have encountered the CRT before, I cannot rule out the possibility that they saw the test during some academic course or in an internet video, where they were able to learn correct responses without actually having to understand the logic behind the tricky problems. If this was the case with substantial number of intuitive participants, it might explain why intuitive people also benefitted from their exposure when solving the CRT. To circumvent this possibility, researchers in the future might want to ask their participants not only whether they know the CRT but also whether they know the correct answers to the problems.

Other caveat of the present research stems from the use of self-report NFC scale to study participants' thinking dispositions. While it has been used for this purpose in a great number of studies, recently Pennycook et al. (2017) showed that people who score highly on NFC are actually a mix of genuinely analytical reasoners and intuitive participants, who overestimate their true reflectivity. Based on this, the authors recommend relying on performance measures of thinking style instead of the self-report ones. However, while the CRT or H&B composite score are often employed as performance measures of analytic thinking disposition (Pennycook, Fugelsang et al., 2015a), the ability to solve both of them is also dependent on other factors, such as numeracy or cognitive ability, which may confound the intended effect of the cognitive style. For this reason, a self-report NFC scale was used here to specifically reflect participants' propensity to engage in analytic thinking, without tapping into other related constructs. Still, based on the conclusions of Pennycook et al. (2017), it is important to realize that NFC may be an imperfect indicator of a participant's disposition for analytical thinking. Some of the participants, who scored highly on NFC in the present study, may actually have been intuitively disposed, and this might explain why the expected effect of analytic individuals benefitting more from exposure while solving the CRT did not emerge.

One last limitation that I would like to mention is that while this study presents evidence that the exposure to the CRT increases its predictive power in the H&B tasks among high-NFC individuals, the three-way interaction this finding was based upon was just below the

conventional threshold for significance (p = .046). Therefore, it would be wise to wait for other researchers to independently replicate this finding before drawing any strong conclusions from it. Most likely this effect reached only marginal significance because the increase of predictive power of CRT in H&B tasks among exposed analytic participants was not particularly strong. This again might be seen as a consequence of the possibility that the high-NFC group may have been contaminated with some intuitive individuals, who lacked insight into their true reflectivity.

Conclusion

While the CRT remains a popular individual difference measure in the research on cognitive biases, as well as other areas related to analytic thinking (Pennycook, Fugelsang et al., 2015a), many researchers now realize that there are problems with this method stemming from unsatisfactory psychometric properties (Bialek & Pennycook, 2017), questionable nature of the construct that is being measured by it (Pennycook & Ross, 2016), and its increasing familiarity to the general public (Haigh, 2016; Stieger & Reips, 2016). Other issues notwithstanding, the present research converges with the results of several recent studies, which suggest that mere familiarity with the CRT may not actually present such a problem as was previously thought (Bialek & Pennycook, 2017; Meyer et al., 2018; Stagnaro et al., 2018). While participants familiar with the test do achieve higher scores on it, regardless of their self-reported thinking dispositions, the predictive power of CRT on the H&B performance is not lost among exposed participants. If anything, it grows stronger although only among high-NFC individuals, who due to their presumed metacognitive advantage (Mata et al., 2013; Pennycook et al., 2017) gain insight into the tricky nature of the problems and therefore subsequently improve their performance with multiple encounters of the CRT, unlike their intuitive counterparts. While this conjecture remains to be examined in more detail by future research, the results of the present study point out some discrepancies in reasoning processes among participants with analytic and intuitive self-reported thinking disposition, and thus highlight the need to change the focus of research in this area to the individual differences among subgroups of reasoners (Mata et al., 2013; Svedholm-Häkkinen, 2015).

References

Bialek, M., & Pennycook, G. (2017). The cognitive reflection test is robust to multiple exposures. *Behavior Research Methods*, 1–7.

Cacioppo, J. T., Petty, R. E., Feinstein, J. A., & Jarvis, W. B. G. (1996). Dispositional differences in cognitive motivation: The life and times of individuals varying in need for cognition. *Psychological Bulletin*, *119*(2), 197–253.

Frederick, S. (2005). Cognitive reflection and decision making. *Journal of Economic Perspectives*, *19*(4), 25–42.

Haigh, M. (2016). Has the standard Cognitive Reflection Test become a victim of its own success? *Advances in Cognitive Psychology*, *12*(3), 145–149.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis*. London: The Guilford Press.

Mata, A., Ferreira, M. B., & Sherman, S. J. (2013). The metacognitive advantage of deliberative thinkers: A dual-process perspective on overconfidence. *Journal of Personality and Social Psychology*, *105*(3), 353–373.

Meyer, A., Zhou, E., & Frederick, S. (2018). The non-effects of repeated exposure to the Cognitive Reflection Test. *Judgment and Decision Making*, *13*(3), 246–259.

Oechssler, J., Roider, A., & Schmitz, P. W. (2009). Cognitive abilities and behavioral biases. *Journal of Economic Behavior and Organization*, *72*(1), 147–152.

Pennycook, G., Fugelsang, J. A., & Koehler, D. J. (2015a). Everyday consequences of analytic thinking. *Current Directions in Psychological Science*, *24*(6), 425–432.

Pennycook, G., Fugelsang, J. A., & Koehler, D. J. (2015b). What makes us think? A three-stage dual-

process model of analytic engagement. *Cognitive Psychology*, *80*, 34–72.

Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., & Fugelsang, J. A. (2014). Cognitive style and religiosity: The role of conflict detection. *Memory & Cognition*, *42*(1), 1–10.

Pennycook, G., Cheyne, J. A., Barr, N., Koehler, D. J., & Fugelsang, J. A. (2015a). On the reception and detection of pseudo-profound bullshit. *Judgment and Decision Making*, *10*(6), 549–563.

Pennycook, G., Cheyne, J. A., Koehler, D. J., & Fugelsang, J. A. (2015b). Is the cognitive reflection test a measure of both reflection and intuition? *Behavior Research Methods*, (MARCH), 341–348.

Pennycook, G., & Ross, R. M. (2016). Commentary: Cognitive reflection vs. calculation in decision making. *Frontiers in Psychology*, *7*(9).

Pennycook, G., Ross, R. M., Koehler, D. J., & Fugelsang, J. A. (2017). Dunning–Kruger effects in reasoning: Theoretical implications of the failure to recognize incompetence. *Psychonomic Bulletin & Review*, *24*(6), 1774–1784.

Stieger, S., & Reips, U.-D. (2016). A limitation of the Cognitive Reflection Test: familiarity. *PeerJ*, *4*(2014), e2395.

Svedholm-Häkkinen, A. M. (2015). Highly reflective reasoners show no signs of belief inhibition. *Acta Psychologica*, *154*, 69–76.

Stagnaro, M. N., Pennycook, G., & Rand, D. G. (2018). Performance on the Cognitive Reflection Test is stable across time. *Judgment and Decision Making*, *13*(3), 260–267.

Thomson, K. S., & Oppenheimer, D. M. (2016). Investigating an alternate form of the cognitive reflection test. *Judgment and Decision Making*, *11*(1), 99–113.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2011). The Cognitive Reflection Test as a predictor of performance on heuristics-and-biases tasks. *Memory & Cognition*, *39*(7), 1275–1289.

Toplak, M. E., West, R. F., & Stanovich, K. E. (2014). Assessing miserly information processing: An expansion of the Cognitive Reflection Test. *Thinking & Reasoning*, *20*(2), 147–168.