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How is perception of time associated with cognitive functioning? The relationship between time perspective and executive control

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Abstract
The aim of the present studies was to examine the relationship between time perspective and executive control. In two studies, executive control was assessed with tasks that require deliberate inhibition of automatic responses (antisaccade and go/no-go) and time perspective was assessed with the Zimbardo Time Perspective Inventory. Additionally, in the first study, we controlled for intelligence and personality, whereas, in the second study, stress states were measured during task performance. Study 1 (N = 233) showed that Present Fatalism was negatively correlated with the antisaccade task. Furthermore, regression analysis indicated that the association between Present Fatalism and executive control was partly due to their shared variance with fluid intelligence. Study 2 (N = 128) explored the potential mediating role of test-related stress states in the relationship between executive control and time perspective. We found that different stress states mediated the relation between cognitive performance and time perspective. Specifically, task engagement mediated the relationship between Present Fatalism and inhibition, whereas for the connection between Past Negative and inhibition, distress

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was crucial. The results provide new insights on cognitive functioning in the context of the time perspective theory.

Keywords
Time perspective, executive control, inhibition, intelligence, stress states, personality

Introduction

Time perspective

Over the past years, there has been a widespread interest in the investigation of subjective perception of time. One of the most influential theories in this field has been proposed by Zimbardo and Boyd (1999). Time perspective (TP) theory emphasises the significance of perceiving time for human functioning in everyday life. Numerous studies have shown that TP is associated with various psychological variables including emotional, motivational and social aspects of human functioning (see Stolarski et al., 2015). TP is defined as 'often non-conscious process whereby the continual flow of personal and social experiences is assigned to temporal categories, or time frames, that help to give order, coherence, and meaning to those events' (Zimbardo and Boyd, 1999: 1271). TP can be considered as a process, a continuous way of cognitive framing of experience, and as a trait, a stable, habitual focus on a particular temporal frame, i.e., the past, the present or the future. TP includes social, cognitive and emotional components. However, it is most frequently regarded as a cognitive schema (Epel et al., 1999) or a cognitive process (Keough et al., 1999; Zimbardo and Boyd, 1999), suggesting its possible connections with other cognitive functions. Interestingly, to date, only a few attempts have been made to understand the cognitive underpinnings of TP, focusing mainly on higher order functions such as intelligence (Zajenkowski et al., 2016a, 2016b). Thus, the aim of the current studies is to examine the associations between TP dimensions and basic cognitive processes such as executive control.

Zimbardo and Boyd (1999) empirically distinguished five TPs: Past Positive (nostalgic, sentimental view of the past), Past Negative (negative, pessimistic attitude towards the past), Present Fatalism (helpless and hopeless attitude), Present Hedonism (present pleasure and immediately gratification) and Future (striving for future goals). According to many researchers (e.g. Stolarski et al., 2015; Zimbardo and Boyd, 1999), people are typically biased towards the past, present or future and this bias has a number of psychological consequences.

If the Future TP dominates, the focus is on long-term goals, which is associated with planning and a desire to achieve success (Zimbardo and Boyd, 1999). Moreover, previous studies have shown that Future orientation allows for the delaying of gratification and is associated with internal control, low impulsiveness and being patient (Shipp et al., 2009). Present Hedonistic perspective is characterised by the need to achieve instant gratification, risk taking, impulsivity and low consideration of future consequences (Zimbardo and Boyd, 1999). Prior studies show that Present Hedonism may also have a more adaptive profile because of its correlation with well-being, positive mood, energy and emotional intelligence (Stolarski et al., 2011, 2014; Zimbardo and Boyd, 1999). Past Negative and Present Fatalism are associated with similar psychological variables such as neuroticism, negative affect, tense arousal and anxiety (Stolarski et al., 2014; Zimbardo and Boyd, 1999). Past Negative perspective is characterised by a focus on the negative events of the past and also a negative interpretation of all the past events, whereas Present Fatalism is defined as an attitude of helplessness, lack of control and the belief that fate decides about life and therefore life is unpredictable and hopeless (Zimbardo and Boyd, 1999). Past Positive TP reflects positive perception of past events, sentimentality and acceptance of the past, as well as attachment to traditions and rituals. It is correlated with positive emotions and a positive mood (Stolarski et al., 2014).

TP is sometimes considered a construct similar to personality, a disposition or a part of personality (Kairys, 2010). Indeed, previous studies indicate that personality traits are substantially correlated with TPs. Specifically, conscientiousness has been found to correlate with Future TP, neuroticism with Present Fatalism and Past Negative, extraversion and openness to experience with Present Hedonism and agreeableness with Past Positive (Kairys, 2010; Kairys and Liniauskaite, 2015). However, in spite of TP's moderate convergence with personality, a considerable number of studies have demonstrated the incremental validity of TPs over and above traditional (e.g. the Big Five traits) measures of personality for health (Daugherty and Brase, 2010), autobiographical memory (Ely and Mercurio, 2011) or well-being (Zhang and Howell, 2011).

As was noted above, TP has been mainly defined in terms of cognitive processing, i.e. cognitive framing of experience (Epel et al., 1999; Zimbardo and Boyd, 1999). So far, little is known about the empirical associations between TP and basic cognitive processes. However, a careful theoretical analysis of the TP concept, as well as available empirical material, suggests that most TPs might be potentially linked to executive functions.

Executive functions and their relation to non-cognitive traits

Researchers define executive functioning (also labelled as cognitive control or executive control) as an ability allowing people to reach adopted goals and to override automatic processes (Diamond, 2013). It is widely accepted that executive functions include three basic processes, i.e. updating, inhibition and shifting (Miyake et al., 2000). Updating refers to working memory ability to search out information quickly, to keep the information in an activity state and to shield this information from distraction (Baddeley, 2007). Inhibition reflects the ability to intentionally inhibit automatic, dominant responses when necessary (Miyake et al., 2000). Shifting refers to task-switching meaning the ability to shift between tasks or mental sets (Monsell, 2003). These interrelated cognitive characteristics can be considered core executive functioning processes, and the model proposed by Miyake et al. (2000) has gained increasing support since its proposal (e.g. Latzman and Markon, 2010). Recent evidence suggests, however, that inhibition may be a general, or common, factor to all executive functions (Miyake and Friedman, 2012). Therefore, in the present studies, we focus on this function.

Numerous studies examined the link between non-cognitive characteristics, such as personality traits, and executive functions. Most studies indicate that neuroticism and anxiety are associated with poorer inhibition. Neurotics exhibit typically low inhibition ability (e.g. as measured via the Stroop task; Luu et al., 2000) as well as the general factor of executive functions (Williams et al., 2010). Likewise, anxiety has been found to impair executive functions, especially inhibition and shifting (e.g. Eysenck et al., 2007; Eysenck and Derakshan, 2011). These results are consistent with the Attentional Control Theory put forward by Eysenck et al. (2007). In line with this model, empirical evidence showed that, for instance, highly anxious individuals need more time to make a correct response in the antisaccade task (e.g. Ansari and Derakshan, 2011; Derakshan and Eysenck, 2009).

In the case of extraversion, the findings are more ambiguous. Some research has shown that extraversion is positively associated with inhibition (Matthews and Zeidner, 2012). However, other researchers have suggested that this relation may depend on situational factors, such as task difficulty (Campbell et al., 2011). Specifically, Campbell et al. (2011) found that extraverts performed better on inhibition tasks (e.g. The Tower of Hanoi, go/no-go) when their difficulty level was relatively high.

Much less is known about other personality traits. It has been shown, for instance, that agreeableness and conscientiousness tend to be positively correlated with inhibition (e.g., Avisar and Shalev, 2011; Jensen-Campbell

et al., 2002; Matthews and Zeidner, 2012). Specifically, Avisar and Shalev (2011) reported a weak positive correlation between conscientiousness and the Conjunctive Continuous Performance Test (Tsal et al., 2005). In this study, response inhibition was marginally correlated to high conscientiousness. The results of the study by Jensen-Campbell et al. (2002) indicated that agreeableness positively predicted performance on the Stroop task. They also showed the importance of agreeableness and conscientiousness for performance on the Wisconsin Card Sorting Task, which measures more general cognitive flexibility, and also, partly, inhibition ability. Furthermore, Matthews and Zeidner (2012) reported a positive link between conscientiousness and the executive control network from the Attentional Network Test.

Another trait that might be important for executive functions is impulsivity. Empirical findings indicate that a high level of this trait reduces inhibition (e.g. Logan et al., 1997; Marsh et al., 2002). The study carried out by Aichert et al. (2012) has revealed that the relationship between impulsivity and prepotent response inhibition may depend on a specific task. In particular, Aichert et al. (2012) measured inhibition with the antisaccade, Stroop, stop-signal and go/no-go tasks. The results indicated that impulsiveness was inversely correlated only with the antisaccade and go/no-go scores.

Some researchers sought psychological states, which may mediate the relationship between personality traits and performance on tasks measuring executive functions. A useful and widely studied model in this area has been proposed by Matthews et al. (2002). These authors put forward a model of stress states (motivational, cognitive and affective) influencing task performance. Matthews et al. (2002) distinguished three dimensions labelled task engagement, distress and worry. Task engagement reflects interest in a task, high energy, motivation and concentration. Distress includes tension, negative mood and lack of confidence and control. Worry refers to negative thoughts, self-focused attention, low self-esteem and cognitive interference. Stress states correlate with various cognitive tasks (Matthews et al., 2002; Matthews and Campbell, 2010), personality traits (Zajenkowski and Zajenkowska, 2015). Moreover, it has been shown that stress states mediate the relationship between personality and cognitive performance. For instance, Matthews and Zeidner (2012) found that task engagement enhances, while distress weakens, executive control. Additionally, task engagement mediated the link between conscientiousness and executive control, whereas distress mediated the extraversion – performance relation. A recent study has revealed that stress states are correlated with TPs and mediate their relationship with intelligence (Zajenkowski et al., 2016a).

Finally, it is worth mentioning that an ability to control behaviour seems to have significant consequences for adaptive functioning. For instance, Hofmann et al. (2012) suggested that executive functions might be crucial for the effectiveness of self-regulation. Indeed, the concept of self-regulation shares many important aspects with executive control, since it is defined as a complex process of control over behaviour in order to achieve goals; it requires inhibition of automatic tendencies and temptations (Baumeister and Heatherton, 1996).

TP and executive control: The current studies

Although TP has been defined in terms of cognitive processing, so far there have been only a few attempts to link these two areas (e.g. Zajenkowski et al., 2016a; 2016b). However, considering the theoretical background of TP and taking into account previous studies on executive control and non-cognitive traits, one may describe the potential associations between cognitive functioning and TP.

Many studies have shown that Future TP might be an important factor determining effective self-regulation in a number of domains such as achieving goals (Díaz-Moralez and Ferrari, 2015; Zaleski and Przepiórka, 2015), health-related behaviours (Hall et al., 2015) or consumption behaviour (Klicperová-Baker et al., 2015). Moreover, Future is associated with gratification delaying and low impulsivity, which can be understood as manifestations of self-regulation (Mischel, 2015). As mentioned above, effective self-regulation as well as low impulsivity have both been found to be associated with executive control (Aichert et al., 2012; Hofmann et al., 2012). Thus, one may expect that Future TP will be associated with more efficient executive control. Additionally, this hypothesis might be strengthened by the results from studies showing that Future TP is positively correlated with a specific type of energetic arousal associated with resource allocation through using self-regulation strategies (Stolarski et al., 2014). It is worth noting that strategic use of energy, i.e. task engagement, correlates positively with executive functions (Matthews and Zeidner, 2012). Therefore, one may expect that Future TP will be associated with more effective executive control, referring to the ability to inhibit impulses and automatic reactions (Hypothesis 1); possibly, task engagement may be a factor mediating this relationship (Hypothesis 2).

High impulsivity, low consideration of future consequences and inability to delay gratification are the characteristic features of Present Hedonism, one may expect that this TP will be negatively associated with executive functions. Moreover, based on the results of research, which indicate a positive association between mania and Present Hedonism, it may be

expected that being stuck in the present will cause difficulty with initiating actions for the future – making decisions and anticipating consequences (Gruber et al., 2012). The authors claim that the positive correlation between Present Hedonism and being prone to mania suggests difficulty with cognitive processes due to the lack of self-regulation skills. Because of above mentioned connections, one may expect that the Present Hedonistic dimension may weaken inhibition ability (Hypothesis 3). Although Present Hedonists might exhibit poor self-control and executive functions, it is worth mentioning that a number of studies show that Present Hedonism correlates with positive mood and energetic arousal (Stolarski et al., 2014; Zimbardo and Boyd, 1999). Thus, this TP dimension should not have a negative effect on the states experienced in the context of undertaking a demanding task.

Past Negative and Present Fatalistic TP may be inversely related to inhibition ability because of their strong connection with negative emotionality, especially neuroticism and anxiety (Zimbardo and Boyd, 1999). Previous findings have shown that high anxiety negatively influences intellectual functioning, especially executive functions (Derakshan and Eysenck, 2009; Eysenck and Derakshan, 2011; Eysenck et al., 2005; Matthews and Zeidner, 2012; Sarason, 1980). Although both Past Negative and Present Fatalism are linked to anxiety, their poorer cognitive functioning might be related to different mechanisms. Previous work linking TP and fluid intelligence revealed that Past Negative and Present Fatalistic TPs were negatively correlated with intelligence. However, these relationships were mediated by different state variables (Zajenkowski et al., 2016a). Specifically, in the context of taking an IQ test, Past Negative was related to negative affect (distress), whereas lack of motivation and worry were linked to Present Fatalism. Thus, one may expect that Past Negative and Present Fatalism will be negatively associated with the performance on tasks measuring inhibition (Hypothesis 4). Moreover, stress states may mediate possible relationships: Past Negative will be more related to negative affect (distress) (Hypothesis 5), whereas lack of motivation and worry will be linked to Present Fatalism (Hypothesis 6).

High positive and low negative emotionality characterise Past Positive TP. Existing literature indicates the beneficial influence of low stress for executive control (Matthews and Zeidner, 2012). Because of this evidence, one may expect that Past Positive will be positively correlated with inhibition (Hypothesis 7) and also with low worry and distress during cognitive task performance (Hypothesis 8).

Below, we report two studies verifying the aforementioned hypotheses. The aim of study 1 was to examine simple associations between TPs and

inhibition ability. Because prior work shows that intelligence and personality might be important factors for both constructs (e.g. Kairys and Liniauskaite, 2015; Matthews and Zeidner, 2012; Zajenkowski et al., 2016a), we decided to control for them in the analyses. Study 2 explored the potential mediating role of test-related states in the relationship between inhibition and TP.

Study 1

Method

Participants. A total of 233 subjects took part in the study (123 females and 110 males). Their mean age was 23.62 (standard deviation [SD] = 3.79) with a range 18–39. Each participant was individually tested in a quiet laboratory in the presence of one experimenter. The sample consists of undergraduate students from various universities in Warsaw, Poland. Volunteer participants were recruited via publicly accessible social networking websites. Each participant gave informed consent and was offered a small gift for taking part in the study. Some of the data presented below were analysed previously in the context of balanced TP (Zajenowski et al., 2016b).

Measures. *Time perspective* dimensions were measured using the Zimbardo Time Perspective Inventory (ZTPI; Zimbardo and Boyd, 1999). It contains five scales: Past Negative (10 items), Present Hedonistic (15 items), Future (13 items), Past Positive (9 items) and Present Fatalistic (9 items). Respondents rate their degree of endorsement of each statement on a five-point Likert-type response scale, from 1 (strongly disagree) to 5 (strongly agree).

Inhibition

Go/no-go task. In the task, participants were instructed to categorise presented digits (1–8) as odd or even. Initially, a training session (60 trials) was administered to form a strong stimulus response association. Subsequently, the experimental condition was introduced requiring the subjects to assign certain digits (3–8) to the aforementioned categories, as well as to inhibit the reaction to other digits (1 and 2). There were 120 trials in this part (90 for go, and 30 for no-go stimuli). For each trial, the response time was limited to 2 seconds.

Antisaccade. In this task, first, a fixation point appeared at the centre of the screen (1500–2500 ms) followed by a rapidly flashing black square on

either the right or left side of the screen (200 ms; about 16 cm away from the centre). Finally, a small arrow pointing down, right or left was presented on the side opposite to the square and after 150 ms it was replaced with a mask. In the task, subjects were asked to determine the direction of the arrow by pressing the proper key. There were 60 trials and the score was the total number of correct detections of the presented arrows.

Fluid intelligence was measured with Cattell's Culture Fair Intelligence Test (Cattell, 1973) which consists of four nonverbal subtests with strict time limits. In the first part, *Series*, there were 13 items with three abstract shapes/figures and one missing piece in each. To complete the series, one needed to select the single correct answer from six possible alternatives. In the subtest, *Classifications,* participants were given 14 sets of five patterns and were supposed to choose two significantly different ones from the remaining three. In the *Matrices* part, only one of six choices can fit the blank space in each of 13 matrices. *Conditions* subtest (including 10 sets) requires the individual to select one out of five answers in order to replicate the relationships between figures and dots in the model.

Personality traits were measured with the Polish adaptation (Strus et al., 2014) of the 50-item set of International Personality Items Pool Big Five Factor Markers questionnaire (Goldberg et al., 2006). The measure consists of five subscales: extraversion, agreeableness, conscientiousness, emotional stability and intellect and has a five-point Likert-type response format, from 1–very inaccurate to 5–very accurate.

Results

Table 1 presents correlations between TPs, cognitive control, intelligence and personality. The most important relationships for the current study are the relationships between TPs and cognitive variables. The results indicated that only one TP, i.e. Present Fatalism was negatively associated with inhibition measured with the antisaccade task. Additionally, Present Fatalism and Past Negative TPs were negatively associated with intelligence. None of the TPs was significantly correlated with the go/no go task. The significant correlations referred also to personality and cognitive variables. Intellect was positively related to antisaccade and intelligence. Moreover, the go/no go task was negatively associated with emotional stability.

Subsequently, we examined how TP predicts inhibition task after controlling for intelligence and personality (Table 2). We ran two regression models. Sex and age were controlled in the first step in both models, since previous findings show that these variables might be important for executive functions (e.g. Zelazo et al., 2004) and TP

Table 1. Correlation matrix comparing time Perspective, inhibition, intelligence and personality traits.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Past Negative	–												
2. Past Positive	−.08	–											
3. Present Hedonism	.20**	.33**	–										
4. Present Fatalism	.40**	.27**	.51**	–									
5. Future	.02	−.10	−.32**	−.27**	–								
6. Antisaccade	−.08	−.07	−.06	−.18**	.03	–							
7. Go/no Go	.05	.03	.06	−.06	.08	.16*	–						
8. Intelligence (Cattell)	−.14*	−.03	−.05	−.27**	.09	.44**	.13*	–					
9. Extraversion	−.28**	.13*	.18**	−.08	.03	−.09	.10	−.00	–				
10. Agreeableness	−.08	.07	.11	−.14*	.09	.02	−.09	.09	.39**	–			
11. Conscientiousness	−.04	−.10	−.33**	−.24**	.71**	−.02	.02	−.07	.11	.14*	–		
12. Emotional stability	−.50**	.09	−.06	−.19**	−.11	.03	−.18*	−.06	.22*	.11	.05	–	
13. Intellect/imagination	−.09	−.09	−.00	−.24**	.09	.16*	.04	.32**	.25**	.33**	.04	.85	–
α	.84	.66	.81	.78	.80	.76	.90	.82	.87	.80	.84	.87	.73
M	2.92	3.40	3.31	2.42	3.55	45.09	25.69	24.97	32.49	39.34	34.71	28.66	38.40
SD	.76	.60	.57	.68	.61	8.23	4.89	5.05	8.14	5.65	7.44	7.68	5.54

*$p < .05$. **$p < .01$ two tailed.

Table 2. Regression analyses with time perspectives, intelligence and personality as predictors and inhibition as dependent variables.

Antisaccade							
Model 1				Model 2			
		ΔR^2	β			ΔR^2	β
Step 1		.06**		Step 1		.06**	
	Sex		−.18**		Sex		−.18**
	Age		−.20**		Age		−.20**
Step 2		.03**		Step 2		.03**	
	Sex		−.17**		Sex		−.17**
	Age		−.20**		Age		−.20**
	Present Fatalism		−.18**		Present Fatalism		−.18**
Step 3		.01		Step 3		.15**	
	Sex		−.18**		Sex		−.20**
	Age		−.19**		Age		−.06
	Present Fatalism		−15*		Present Fatalism		−.07
	Intellect/Imagination		.10		Intelligence (Cattell)		.42**
Step 4		.14**		Step 4		.00	
	Sex		−.20**		Sex		−.20**
	Age		−.06		Age		−.06
	Present Fatalism		−.07		Present Fatalism		−.07
	Intellect/Imagination		.01		Intelligence (Cattell)		.42**
	Intelligence (Cattell)		.42**		Intellect/Imagination		.01

*$p < .05$. **$p < .01$.

(Sobol-Kwapińska et al., 2016; Zimbardo and Boyd, 1999). In the first model, inhibition (antisaccade task) was an outcome, whereas demographic variables (sex and age), Present Fatalism, intellect and intelligence were predictors. Present Fatalism was added in step 2, intellect in step 3 and intelligence in step 4. In the second model, the order of the last two predictors was reversed. The analyses revealed that the effect of Present Fatalism on inhibition decreased when this variable was analysed together with intelligence. In the model with intellect, Present Fatalism remained significant.

Study 2

Method

Participants. A total of 128 subjects took part in the study (74 females and 54 males). Their mean age was 26.66 (SD = 9.80) with a range 18–66. Each participant was individually tested in a quiet laboratory in the presence of

one experimenter. The sample consists of undergraduate students from various universities in Warsaw, Poland. Volunteer participants were recruited via publicly accessible social networking websites. Each participant gave informed consent and was offered a small gift for taking part in the study.

Measures. TP was measured with the same tool as in study 1.

Inhibition was measured only with the antisaccade task (see study 1).

Stress states were measured with the Dundee Stress State Questionnaire (DSSQ; Matthews et al., 2002) in the short version (see Matthews and Zeidner, 2012), translated into Polish (Zajenkowski and Zajenkowska, 2015). The DSSQ measures three factors: task engagement, distress and worry. On the instrument, there are 24 items with 5-point response scales. The internal consistency of the Polish version is high (task engagement $\alpha = 0.80$; distress $\alpha = 0.76$; worry $\alpha = 0.84$). The DSSQ was administered twice: just before and immediately after the antisaccade task.

Results

Table 3 shows correlations between TPs, executive control and three stress states before and after the completion of the antisaccade task. Most important, two TPs were negatively correlated with the inhibition task: Past Negative TP and Present Fatalism. Moreover, individuals scoring high on these scales also exhibited a higher level of task related stress. Specifically, they were less engaged in the task and more worried and distressed. Additionally, Past Negative and Present Fatalism were positively correlated with pre-task distress and worry. Past Positive dimension exhibited low worry and high-task engagement while performing the task. Present Hedonistic TP was negatively correlated with pre-task task engagement and positively associated with pre-task distress. A higher level of Future orientation was linked with higher engagement before and after the task.

Tables 4 to 7 present a series of regression analyses investigating whether TPs predict the second measurement of stress states, controlling for the pre-task (baseline) level of stress. Matthews and Zeidner (2012) claim that the post-task score is more representative of the state during task performance, whereas the pre-task score is a more typical state for an individual. In each case, we introduced sex and age in the first step, the first measurement of a given stress state in step 2, and one TP dimension in step 3. The results indicated that Past Negative was associated with lower task engagement and greater distress during task performance after controlling for the first stress assessment, whereas Past Fatalistic had negative impact on task engagement. Moreover, Past Positive and Future were positive

Table 3. Correlation matrix comparing Time Perspective, Inhibition, Stress States.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Past Negative	–											
2. Past Positive	−.22*	–										
3. Present Hedonism	.16	.16	–									
4. Present Fatalism	.52**	−.05	.37**	–								
5. Future	−.16	.30**	−.28**	−.33**	–							
6. Antisaccade	−.29**	.09	−.02	−.19*	.03	–						
7. TE1	−.02	.09	−.18*	−.09	.18*	−.06	–					
8. DIS1	.29**	−.14	−.02	.21*	−.09	−.05	−.27**	–				
9. WOR1	.30**	−.03	−.03	.25**	−.02	−.27**	−.01	.28**	–			
10. TE2	−.40**	.26**	−.05	−.23*	.24**	.32**	.20*	−.15	−.15	–		
11. DIS2	.37**	−.13	−.13	.161	−.06	−.51**	−.00	.11	.29**	−.40**	–	
12. WOR2	.23**	−.21*	−.10	.22*	−.11	−.18*	−.13	.36**	.60**	−.21*	.15	–
α	.84	.62	.83	.75	.77	.90	.80	.81	.80	.79	.82	.85
M	2.88	3.42	3.36	2.48	3.57	45.13	17.66	13.31	14.41	21.99	10.88	10.87
SD	0.75	0.55	0.56	0.63	0.54	9.09	4.43	3.91	6.08	5.23	5.52	6.58

TE1: pre-Task Engagement; TE2: post-Task Engagement; DIS1: pre-Distress; DIS2: post-Distress; WOR1: pre-Worry; WOR2: post-Worry.
*$p < .05$. **$p < .01$ two tailed.

Table 4. Regression analyses (betas) with pre-task stress states and Past Negative as predictors and post-task stress scores as dependent variables.

TE2		DIS2		WOR2	
	Δ *R2* *β*		Δ *R2* *β*		Δ *R2* *β*
Step 1	.02	Step 1	.11**	Step 1	.01
Sex	.04	Sex	.23**	Sex	.06
Age	−.14	Age	.21*	Age	.06
Step 2	.05**	Step 2	.02	Step 2	.35**
Sex	.01	Sex	.23**	Sex	−.04
Age	−.18*	Age	.24**	Age	.03
TE1	.23**	DIS1	.14	WOR1	.61**
Step 3	.16**	Step 3	.11**	Step 3	.00
Sex	.04	Sex	.20**	Sex	−.04
Age	−.17*	Age	.22**	Age	.03
TE1	.22**	DIS1	.04	WOR1	.59**
Past Negative	−.40**	Past Negative	.34**	Past Negative	.06

TE1: pre-Task Engagement; TE2: post-Task Engagement; DIS1: pre-Distress; DIS2: post-Distress; WOR1: pre-Worry; WOR2: post-Worry.
*$p < .05$. **$p < .01$.

Table 5. Regression analyses (betas) with pre-task stress states and Past Positive as predictors and post-task stress scores as dependent variables.

	TE2		WOR2	
	Δ *R2*	*β*	Δ *R2*	*β*
Step 1	.02		.01	
Sex		.04	Sex	.06
Age		−.14	Age	.06
Step 2	.05**		.35**	
Sex		.01	Sex	−.04
Age		−.18*	Age	.03
TE1		.23**	WOR1	.61**
Step 3	.05*		.04**	
Sex		−.01	Sex	−.02
Age		−.15	Age	.00
TE1		.21*	WOR1	.60**
Past Positive		.22*	Past Positive	−.20**

TE1: pre-Task Engagement; TE2: post-Task Engagement; DIS1: pre-Distress; DIS2: post-Distress; WOR1: pre-Worry; WOR2: post-Worry.
*$p < .05$. **$p < .01$.

Table 6. Regression analyses (betas) with pre-task stress states and Present Fatalism as predictors and post-task stress scores as dependent variables.

TE2		DIS2		WOR2	
	Δ *R2* *β*		Δ *R2* *β*		Δ *R2* *β*
Step 1	.02	Step 1	.11**	Step 1	.01
Sex	.04	Sex	.23**	Sex	.06
Age	−.14	Age	.21*	Age	.06
Step 2	.05**	Step 2	.02	Step 2	.35**
Sex	.01	Sex	.23**	Sex	−.04
Age	−.18*	Age	.24**	Age	.03
TE1	.23**	DIS1	.14	WOR1	.61**
Step 3	.04*	Step 3	.02	Step 3	.01
Sex	.01	Sex	.23**	Sex	−.03
Age	−.18*	Age	.23**	Age	.03
TE1	.21*	DIS1	.10	WOR1	.59**
Present Fatalism	−.20*	Present Fatalism	.14	Present Fatalism	.08

TE1: pre-Task Engagement; TE2: post-Task Engagement; DIS1: pre-Distress; DIS2: post-Distress; WOR1: pre-Worry; WOR2: post-Worry.
*$p < .05$. **$p < .01$.

predictors of task engagement. Finally, Past Positive reduced worry in the post-task situation.

In the next step, we decided to examine whether post-task stress states might be considered as mediators between Past Negative and Present Fatalistic TP and the inhibition task. We used the PROCESS macro for SPSS developed by Hayes (2015), which tests for indirect effects by calculating (bootstrapping) confidence intervals (CIs) for indirect effects. We decided to analyse all stress states as mediators and control for sex and age of the participants. The first mediation analysis indicated that only distress was a significant mediator of the link between Past Negative and inhibition. The total effect of Past Negative TP on inhibition ($\beta = -.27$; $p < .01$) was reduced upon inclusion of the mediator (distress) and the direct effect was not significant ($\beta = -.12$, $p = .16$; see Figure 1). The indirect effect was −.11, 95% CI = [−.1927; −.0495]. The mediation analysis revealed that only task engagement was a significant mediator of the link between Present Fatalism and inhibition. The total effect of Present Fatalism on inhibition ($\beta = -.18$; $p < .05$) was reduced upon inclusion of task engagement and the direct effect was not significant ($\beta = -.12$, $p = .099$; see Figure 2). The indirect effect was −.05, 95% CI = [−.1103, −0128].

Table 7. Regression analyses (betas) with pre-task stress states and Future as predictors and post-task stress scores as dependent variables.

TE2			
		Δ *R2*	*β*
Step 1		.02	
	Sex		.04
	Age		−.14
Step 2		.05**	
	Sex		.01
	Age		−.18*
	TE1		.23**
Step 3		.04*	
	Sex		−.03
	Age		−.17
	TE1		.19*
	Future		.21**

TE1: pre-Task Engagement; TE2: post-Task Engagement; DIS1: pre-Distress; DIS2: post-Distress; WOR1: pre-Worry; WOR2: post-Worry.
*$p < .05$. **$p < .01$.

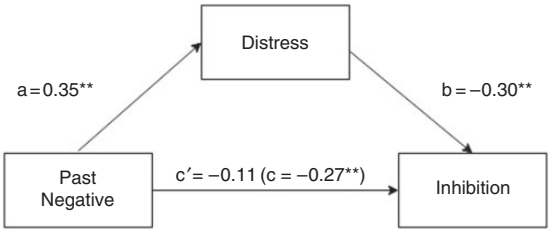

Figure 1. Relationships between Past Negative, distress and antisaccade task The paths with a's and b's are direct, c is the total effect from Past Negative to antisaccade task and c' is the direct path from Past negative to antisaccade task, controlling for distress.
*$p < 0.05$. **$p < 0.01$.

Discussion

The present studies investigated the link between TPs and executive control. Additionally, we considered factors that might account for this relationship such as intelligence and personality traits, as well as task-related psychological states. Most importantly, we found that among the

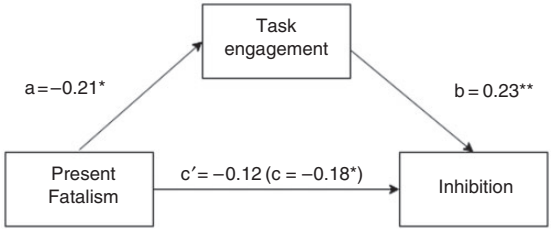

Figure 2. Relationships between Present Fatalism, task engagement and antisaccade task. The paths with a's and b's are direct, c is the total effect from Present Fatalism to antisaccade task and c' is the direct path from Present Fatalism to antisaccade task, controlling for task engagement. *$p < 0.05$. **$p < 0.01$.

five TPs, two were especially crucial for executive control. Specifically, Past Negative and Present Fatalism impaired cognitive inhibition measured with the antisaccade task. These results are congruent with our predictions and the previous findings (Zajenkowski et al., 2016a) showing that Past Negative and Present Fatalism are negatively associated with fluid intelligence. Moreover, in the work by Zajenkowski et al. 2016a, Present Fatalism exhibited a relatively high correlation with cognitive ability in comparison to other TPs. Interestingly, in the current study 1, Present Fatalism did not predict the inhibition task when fluid intelligence was controlled in the model. This may suggest that fluid ability is essential for Present Fatalism and accounts for the variance of the Fatalism – executive control relation. What is more, in the prior work (Zajenkowski et al., 2016a), it was found that individuals scoring high on Present Fatalism tend to subjectively assess their intelligence as low. According to Chamorro-Premuzic and Furnham (2006), subjectively assessed intelligence may determine the level of effort an individual is prepared to invest: low levels of subjectively assessed intelligence may have negative effects on one's confidence and thus lead to intellectual avoidance. This interpretation seems to be coherent with our other result indicating that Present Fatalism is negatively correlated with intellect. The latter reflects intellectual interest or engagement as well as perceived intelligence (e.g. 'Have a rich vocabulary'. Goldberg et al., 2006) and thus might be, to some extent, a marker of subjectively assessed intelligence.

Study 2 sheds more light on the nature of the negative impact of Present Fatalistic and Past Negative TPs on executive control. Interestingly, different task-related stress states were important for these two TPs, as found in previous studies on fluid intelligence (Zajenkowski et al., 2016a). Specifically, task engagement mediated the relationship between Present Fatalism and inhibition, whereas distress was important for the link

between Past Negative TP and inhibition. Individuals who tend to focus on Present Fatalistic TP may display low motivation (low task engagement) in the context of solving a demanding task due to a belief that they are not able to perform the task effectively (Zimbardo and Boyd, 1999). This interpretation seems to be in line with the definition of Present Fatalism, which is described mainly in terms of beliefs and motivation. Zimbardo and Boyd (1999) define this TP as an orientation of 'hopelessness and helplessness', the belief of little control over one's life and its unpredictability and that the present must be borne with resignation because humans are at the whimsical mercy of 'fate'; luck is as good a factor in success as preparation and hard work for those with Present Fatalistic orientation. Since Present Fatalism is also negatively associated with internal control (Shipp et al., 2009), individuals may think that the results of a task do not depend on their efforts, therefore, they cannot engage in a cognitive activity.

Individuals with high Past Negative TP have a general tendency toward negative emotionality including tension (Stolarski et al., 2014), anxiety, depression (Zimbardo and Boyd, 1999) and anger (Stolarski et al., 2016). Our study revealed that, indeed, an affective component of stress, i.e. distress, mediated the relationship between Past Negative TP and the inhibition task. It is possible then that individuals with high Past Negative orientation may experience a negative affect encountering difficulties in a cognitive task. As a result, this overwhelming state may hinder their performance. This result is similar to the finding reported by Zajenkowski et al. (2016), who found that distress mediated the Past Negative – fluid intelligence association. It is worth noting that individuals with negative orientation to the past not only experience bad moods but they are also biased in their perception of affect. Stolarski et al. (2014) have shown that Past Negative TP negatively influences recalled and anticipated mood. These authors have suggested that accessing negative beliefs about the past may support a self-schema that biases both immediate experiences and future projections. One may wonder, whether past experiences related to cognitive performance are projected by people with high Past Negative TP on their expectations regarding the test situation, and their higher level of distress may simply reflect a fear of failure in this particular performance.

In contrast to our expectation, Future TP was not related to executive control. We predicted that Future-oriented individuals will display a high level of executive control because they show effective self-regulation in various real-life domains. Our results indicate, however, that this is not the case and that the adaptive behaviour of Future-orientated people is probably based on other than extraordinary executive control resources.

Previous studies also show that Future TP is positively connected with self-reported self-control (Barber et al., 2009). It is worth pointing out, however, that self-report and behavioural measures of self-control are not always related (Hamilton et al., 2014). Furthermore, study 2 revealed that Future TP is positively correlated with task engagement. This result is consistent with the theoretical background of this TP (e.g. high motivation; Zimbardo and Boyd, 1999) as well as previous findings indicating that Future TP correlates positively with a specific type of energetic arousal associated with resource allocation through using self-regulation strategies (Stolarski et al., 2014). However, the increased engagement did not influence performance of Future-oriented individuals.

Similar to Future, Past Positive TP did not correlate with the inhibition task. However, it had a positive impact on the states experienced during performance. Specifically, high Past Positive increased task engagement and decreased worry. The results are in line with empirical findings showing that Past Positive perspective is beneficial for human functioning and increases positive affect and well-being. For instance, Past Positive is correlated with higher levels of life satisfaction, optimism (Shipp et al., 2009), well-being (Drake et al., 2008), self-esteem (Zimbardo and Boyd, 1999), emotional intelligence (Stolarski et al., 2011) and life engagement (Sobol-Kwapińska et al., 2016). These findings indicate that high Past Positive TP may manifest a general positive attitude regardless of the activity undertaken.

To sum up, our studies revealed that among the five TPs, two might be crucial for executive functioning: Past Negative and Present Fatalistic. Specifically, high levels of these dimensions hinder cognitive performance. However, the underlying mechanisms might be different. It needs to be acknowledged, however, that our conclusions are limited by several facts. First, the two aforementioned TPs were associated with only one inhibition task, i.e. the antisaccade, and not the go/no-go task. Moreover, in study 1, Past Negative TP was very weakly and insignificantly correlated with the antisaccade task. This may suggest that the specific measure might be relevant for the obtained results and that the effects, especially in the case of Past Negative, may not be salient. It would be valuable to include various measures of executive control to examine carefully which of its aspects are actually relevant for TP. Finally, an important theoretical proposition has been put forward by researchers. For instance, von Stumm et al. (2011) suggest that there are two theoretical models of the ability–personality associations. According to one, personality may influence cognitive processes at the measurement level, e.g. anxiety may increase among neurotics while solving a demanding task. On the other hand, there might be a

developmental dependence between personality and cognition, such that personality traits influence how and when people invest their intellectual abilities, or that some personality traits might be shaped by the level of cognitive ability (von Stumm et al., 2011). However, there are not many studies related to developmental perspective and TP. So far, researchers studied mainly TP in different age groups in cross-sectional design (Carelli et al., 2011; Rönnlund et al., 2017; Sobol-Kwapińska et al., 2016). Only one study examined TP (stability of balanced TP) in a longitudinal perspective (Wiberg et al., 2017). Thus, it is still unknown how TP is shaped during the lifespan and whether cognitive ability determines the level of particular TP dimension. More studies (e.g. longitudinal investigations) are necessary to examine the causal nature of the associations obtained in the current study, i.e. Past Negative and Present Fatalistic TPs and executive control. Another possibility, besides longitudinal studies, that may shed some light on the nature of TP–cognition association are cognitive trainings and their potential positive transfer on TP. Findings from the area of personality have shown that cognitive trainings, for instance, improve sensitivity to rewards among patients with social anhedonia (Li et al., 2016). Moreover, cognitive training is effective in decreasing worry (Course-Choi et al., 2017). These findings give a base for consideration this method in context of TP. Specifically, it would be interesting to examine transfer of such trainings on TP. Adopting both methods (longitudinal studies and cognitive trainings) may allow to understand the causal nature of the TP–cognition relationship.

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