



Error processing deficits in academic procrastinators anticipating monetary punishment in a go/no-go study



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ABSTRACT

Procrastination is a failure of self-regulation in which people delay some actions despite knowing that their behavior will lead to discomfort. Although some previous studies have revealed a significant relationship between procrastination, impulsivity and poorer executive control, and indicated that encountering negative emotions escalates procrastination, this evidence has mainly come from questionnaire-based research. This study aimed at investigating executive control in individuals with high and low academic procrastination tendencies using monetary go/no-go task that was performed in three following contexts: punishing for errors, rewarding correct responses, and a neutral condition. Results revealed executive dysfunction in academic procrastinators in the context of aversive motivation. Specifically, in the punishment condition this group showed reduced post-error-slowing and longer reaction times than low procrastinating controls. However, the two groups did not differ with regard to various indicators of executive control in the neutral and reward conditions. Questionnaires revealed greater susceptibility to punishment in high than low procrastinating students but there were no group differences in the sensitivity to reward. This study suggests that error-processing deficits occurring in emotionally negative contexts may hinder adjustments of faulty behaviors in procrastinators and reduce their level of performance and intensify negative emotions by means of a vicious cycle.

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1. Introduction

Meeting high requirements regarding effective realization of responsibilities and on-time task completion often determines educational or professional success in modern society. However, some people do not seem to be capable of meeting these requirements and often fail when they are required to complete a task on time. Such failure is often associated with one's tendency to delay important time-limited tasks and to engage in some other activities, despite knowing this will lead to further discomfort. This tendency, estimated to affect 15–20% (e.g. Harriot & Ferrari, 1996) of the total population and 80–95% of students (e.g. Ellis and Knaus, 1977; for review see Steel, 2007), is called procrastination. Postponing tasks not only leads to a significant decrease in performance level (e.g. Ariely and Wertenbroch, 2002) but also affects the satisfaction with achievements and the quality of life (see Steel, 2007). Negative effects of procrastination are also noticed in the field of economics (e.g. Kasper, 2004) and health care (e.g. due to delayed seeking of treatment) (e.g. Sirois, 2007; Sirois, Melia-Gordon,

and Pychyl, 2003). For these reasons, the problem of procrastination is gaining more and more attention among researchers representing different fields of science.

Despite numerous studies regarding procrastination that have been conducted in the recent years, detailed mechanisms underlying this complex phenomenon are still unknown. However, procrastinators are characterized by high stress intolerance (Harrington, 2005) and ineffective emotion regulation (Pychyl and Sirois, 2016; Sirois and Pychyl, 2013). Further, procrastination is associated with an increased fear of failure (Solomon and Rothblum, 1984) that tends to be more pronounced in situations bearing a risk of being assessed for task performance (Senécal, Lavoie, and Koestner, 1997). This pattern of traits suggests that the success orientation of the modern society may put procrastinators at a greater risk of experiencing negative emotions that they cannot easily cope with. By means a vicious cycle, ineffective emotion regulation may escalate procrastination, as the tendency to put things off was shown to increase with increasing anxiety and negative emotions (e.g. Albiński and Siemiot, 2015; review in Sirois and Pychyl, 2013). What is more, procrastination was found to be strongly associated with impulsivity (e.g. Schouwenburg and Lay, 1995; for meta-analysis see Steel, 2007), a trait that is typically conceptualized as a tendency to think and act according to one's desires (Whiteside

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and Lynam, 2001). Thus, it could be posited that procrastination may be a by-product of impulsivity that was useful throughout almost the whole human history, when basic survival needs had to be satisfied quickly and at the cost of longer-term plans (Steel, 2007, 2010). Recent studies conducted in a paradigm of behavior genetics confirmed this hypothesis: procrastination and impulsiveness are strongly correlated at the genetic and phenotypic levels (Gustavson, Miyake, Hewitt, and Friedman, 2014, 2015; Loehlin and Martin, 2014). Strong connection of procrastination and impulsivity suggests that procrastination may be related to executive dysfunctions that make it difficult to control and regulate goal-related behaviors (Miyake and Friedman, 2012; Miyake et al., 2000). Indeed, procrastination was observed to be related to various self-reported executive problems, such as initiation, planning/organizing, inhibition, self/task monitoring, and working memory (Rabin, Fogel, and Nutter-Upham, 2011). Moreover, recent studies showed worse executive performance of procrastinators, especially in tasks requiring inhibition (Gustavson et al., 2015; Rebetz, Rochat, Barsics, and Van der Linden, 2016).

In order to characterize specific cognitive functions contributing to executive control, usually reaction time tasks requiring differentiation between execution and inhibition trials, such as go/no-go or stop-signal tasks, are used (Donders, 1869; Logan and Cowan, 1984). In the go/no-go task participants are presented with a series of different stimuli and instructed to respond as quickly as possible to one, occurring more frequently, stimulus type while withholding (inhibiting) the reaction to the other, less frequent, type of stimulus. This task allows assessing the attention-related response latency (reaction time) as well as the effectiveness of prepotent response inhibition that is a critical component of the response selection processes contributing to accurate performance, as measured with the number of errors. The go/no-go task is also suitable to measure the process of error-monitoring, as indexed by post-error slowing (PES), that is, an increase in reaction time (RT) in trials following an error (Rabbitt, 1979). Although there are several competing explanations of this effect, it has been most frequently proposed to reflect increased cautiousness in responding that helps to monitor and adjust further errors (e.g. Dutilh et al., 2012). Investigating the relationship between procrastination and the above-mentioned deficits specified with a go/no-go task may bring us closer to answering the question whether procrastination-related deficiencies in goal-related behaviors result from deficits in using feedback for better behavioral adaptation and/or in inhibiting dominant response, both required to accomplish long-term goals.

In a recent go/no-go study, a reduced post-error slowing was found in highly impulsive antisocial individuals, indicating error-adjustment deficits in this group (Michałowski, Drożdżel, and Harciarek, 2015). Previous EEG monetary gain/loss reaction time studies revealed that impulsivity-related error processing deficits are especially strong under the condition activating aversive motivation and diminish under the condition activating appetitive motivation. Potts, George, Martin, and Barratt (2006) showed that individuals scoring high on self-reported impulsivity scale responded with lower error-related brain activity than those with low impulsivity scores in a punishment but not reward condition. Similar effects were observed for high and low socialized subjects in a study performed by Dikman & Allen, (2000). As was suggested by Potts et al. (2006) and Potts (2011), this pattern of results indicates that impulsive individuals may be less able to modify their behaviors after making mistakes in the aversive (i.e. punishing) context.

Considering the above-mentioned error-adjustment deficits observed in highly impulsive individuals and the positive relationship between procrastination and impulsivity, fear of failure as well as stress intolerance, one might expect there is also an error-processing deficit in procrastinators. Thus, the main aim of the present study was to test if high procrastinators, in comparison to low procrastinators, show defective executive control while performing monetary visual go/no-go tasks. We expected that executive dysfunctions would mainly emerge with regard to error-adjustment (PES and number of errors) and these

dysfunctions would depend on the value of choice outcomes. In particular, we have formulated the following hypotheses:

- 1) Based on previous findings for procrastination-related emotion regulation problems (Harrington, 2005; Pychyl and Sirois, 2016; Sirois and Pychyl, 2013) and impulsivity-related error processing deficits observed in a punishment condition (Dikman & Allen, 2000; Potts et al., 2006), we hypothesized that procrastinators will show executive control deficits while performing a task under the context of increased risk of losing.
- 2) Considering the fact that impulsivity was shown not to affect executive functions in a rewarding-motivation condition (Dikman & Allen, 2000; Potts et al., 2006), we expected that low and high procrastinators will not differ with regard to their executive functioning in a context when they are motivated to win.
- 3) Based on the findings from impulsive individuals (Michałowski et al., 2015), error-processing deficits are hypothesized to emerge in high when compared to low procrastinators also in a neutral condition, i.e. without specific win/lose instruction.
- 4) We hypothesized that procrastinators would score higher than controls on Sensitivity to Punishment but not Sensitivity to Reward scales of the SPSRQ-SF (Cooper and Gomez, 2008; Wytykowska, Białaszek, and Ostaszewski, 2014).

2. Materials and methods

2.1. Participants

Students of 5 different Xxxxx universities were invited via official university emails or facebook students' groups to complete an online Polish version of the Study Problems Questionnaire (SPQ; Schouwenburg, 1995; Wichrowski, 2008), and the total SPQ score was used as a measure of procrastination in academic context. Out of 586 students (470 females) who completed the questionnaire, on the basis of the total SPQ scores, 64 students were randomly recruited to take part in the present study (mean age = 22.18, SD = 2.39, range: 18–30 years). Based on descriptive statistics (Wichrowski, 2008), subjects with scores higher than 1 SD above the mean (>77.41) were assigned to procrastination group (PRO, $N = 31$, 25 females), and subjects with scores lower than 1 SD below the mean (<54.81) to the low procrastinating control group (CON, $N = 33$, 25 females). Additionally, the PRO and CON groups were divided into two subgroups, each performing standard (STA) and reward (REW) or punishment (PUN) condition (see below). Before the actual testing, all participants signed the informed consent. The study was approved by local Ethics Committee of Psychology Faculty of University of Xxxxx and was conducted in accordance with the provisions of the Declaration of Helsinki.

2.2. Measures

Polish versions of the Study Problems Questionnaire (SPQ; Schouwenburg, 1995; Wichrowski, 2008) and the Sensitivity to Punishment and Sensitivity to Reward Questionnaire – Short form (SPSRQ-SF; Cooper and Gomez, 2008; Wytykowska et al., 2014) have been used in the present study. The SPQ is a self-report questionnaire used to assess motivation-related study problems in higher education students. It consists of 23 statements (e.g. "I read non-obligatory readings connected to my studies" or "I often have crises associated with my studies") to which participants are requested to record their agreement using a 5-point scale (1 strongly disagree/it does not apply to me (1), I strongly agree/it applies to me to a high degree (5)). A study performed by (Wichrowski, 2008) showed that the Polish version that was used in our research is characterized by satisfactory internal consistency (Cronbach alpha = 0.74) and content validity. The SPSRQ-SF (Cooper and Gomez, 2008; Wytykowska et al., 2014) is a self-assessment questionnaire consisting of 21 questions related to tendencies for reward

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