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Abstract

Third party punishment (TPP), or altruistic punishment, is specifically human prosocial behavior. TPP denotes the administration of a sanction to a transgressor by an individual that is not affected by the transgression. In some evolutionary accounts, TPP is considered crucial for the stability of cooperation and solidarity in larger groups formed by genetically unrelated individuals. Belief in free will (BFW), on the other hand, is the idea that humans have control over their behavior. BFW is a human universal notion that, in some studies, has been found to be supportive of prosocial behavior. In our study, we examined the effect of BFW on TPP under high and low affect scenarios through optical brain imaging (fNIRS). We hypothesized that in low affect cases, there would be a positive correlation between the strength of the BFW and the severity of the punishment inflicted. Obtained results and related statistical analyses indicate that participants with higher degree of BFW have more neural activation in their right dorsolateral prefrontal cortex (DLPFC) (hbo and hbt measures) in high affect scenarios, whereas the participants with lower degree of BFW have higher levels of neural activation in the medial PFC (hbo and hbt measures) in low affect scenarios. These empirical findings are in line with the research findings in the relevant academic literature and support the hypothesis that the degree of BFW influences punishment decisions.

Keywords: free will; fNIRS; third-party punishment; frontal cortical areas; high and low affect.

Introduction

The idea that humans are in control of how they act, or the belief in free will (BFW) is a human universal notion (Sarkissian et al., 2010). The social function of BFW, especially its supposed effect on prosocial behavior has been a topic of research since the 1980s in a large body of scholarly work (for a critical review see Ewusi-Boisvert and Racine, 2018). In some highly cited studies (Vohs and Schooler, 2008; Baumeister et al., 2009), it has been shown that stronger belief in free will decreases antisocial behaviors,

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including cheating, stealing, aggression, and defection. Other studies have found that inducing disbelief in free will has not only behavioral but also neurocognitive effects, influencing brain mechanisms involved in volitional action (Rigoni et al., 2011; Rigoni et al., 2012; for an overview see Rigoni and Bass, 2014). However, recent works (Caspar et al., 2017; Crone et al., 2019; Nadelhoffer et al., 2020) could not replicate the results of earlier behavioral studies. The issue is therefore still unresolved.

Third-party punishment (TPP) or altruistic punishment, is a sanction inflicted on a transgressor by an individual who is not directly harmed by the transgression. Unlike second party punishment (SPP), where it is the victim who retaliates against the transgressor and which is common in the natural world, TPP is arguably a specifically human prosocial behavior (Riedl et al., 2012). TPP is deemed crucial for the evolutionary stability of solidarity and cooperation in large groups formed by genetically unrelated members (Buckholtz and Marois, 2012). Neural networks activated during TPP have been studied in a large body of literature that was reviewed to establish models (see Krueger and Hoffman, 2016; Bellucci et al., 2020). In this literature, which will be summarized in the following section, only one study (Krueger et al., 2014) investigated the issue from the perspective of the effect of BFW on TPP. Unlike neuroimaging studies, however, several behavioral studies investigated the supposed correlation between BFW and TPP. In early studies of this kind (Viney et al. 1982; Viney et. al. 1988; Stroessner and Green 1990; Haynes et al. 2003), researchers have found no correlation between the strength of the BFW and punitiveness. Nevertheless, more recently Sharif et al. (2014) found that reduced BFW makes people less retributive in their attitudes about punishment. A positive correlation between higher BFW and punitiveness was found also in the neuroimaging study of Krueger's et al. (2014), but only in low affective scenarios.

The present research aims to study the hypothetical correlation between BFW and TPP using fNIRS technique of neuroimaging. In this way, we aim to contribute to the existing literature by both filling a gap and replicating some results obtained via already used research methods.

Frontal Cortical Areas Activated During TPP

Studies show that TPP involves a number of neural networks rather than a specific brain region. The two cognitive functions that TPP depends on are a) determining blameworthiness and b) assigning a deserved punishment. Scholars describe distinct neural networks for each of these two cognitive functions. Krueger and Hoffman (2016), in a model largely supported by a meta-analysis (Bellucci et al., 2020), describe three large networks (salience, default mode, and central executive networks) that are active in TPP tasks. These networks are formed of cortical regions connected to subcortical ones. In this review, we emphasize frontal cortical regions activated during TPP tasks, since they are the ones that could be imaged by fNRIS technique.

Neuroimaging studies (fMRI) point out that the right DLPFC is activated during both the determination of blameworthiness (Buckholtz et al., 2008) and the prediction of the punishment magnitude (Bellucci et al., 2017). On the other hand, Buckholtz et al. (2015) showed that the repetitive transcranial magnetic stimulation of the DLPFC reduced the punishment for wrongful acts without affecting the blameworthiness ratings. This region is involved in SPP tasks as well (Buckholtz and Marois, 2012), and these two cognitive functions are considered as evolutionary related to each other (TPP may have been a selective extension of SPP: Krueger and Hoffman, 2016). Nevertheless, in their meta-analysis Bellucci et al. (2020) found higher activity in the ventrolateral prefrontal cortex during TPP tasks than during SPP tasks.

On the other hand, in their neuroimaging study on the correlation between BFW and TPP, Krueger et al. (2014) found higher activity in temporoparietal junction (TPJ) for the high-level BFW in low affect cases, a region situated outside of the frontal cortex. Nevertheless, these brain regions are connected with the frontal cortical areas whose activities were recorded during our research.

Research Question and Related Hypotheses

The main research question of this study has been to understand the neural underpinnings of the prefrontal cortex with respect to the participants' BFW when required to make third-party punishment decisions taken in high affect and low affect hypothetical crime scenarios. The most recent behavioral research on the interaction between BFW and TPP (Sharif et al., 2014) has shown a positive correlation between the level of BFW and a retributivist approach to punishment. Based on these findings, one may expect that higher BFW would lead to harsher penalties in TPP tasks. Nevertheless, the single neurobiological study on this topic (Krueger et al., 2014) has witnessed such an effect only in low affect cases. In the light of these findings, in our research we wanted to test the following hypotheses:

H_1: There will be a measurable difference in the neural activation in the prefrontal cortex between participants with a high level of BFW and those with a low level. In a previous study on moral judgment using the fNIRS method (Dashtestani et al., 2018), which confirmed the majority of previous relevant fMRI studies, it was found that the left DLPFC was more strongly activated during tasks involving emotions than during tasks involving high levels of cognitive process demand. Participants with higher levels of BFW may be expected to use more cognitive processes to assess the blameworthiness of a transgressor. Accordingly, we expect to observe higher activity in the PFC for participants with high levels of BFW.

H_2: The measured neural activation difference between the two considered groups will be different in high affect conditions versus low affect conditions. Based on findings from previous studies, which showed higher activity in TPJ during TPP tasks in low affect conditions (Krueger et al.,

2014) and that both TPJ and prefrontal cortex are important parts of the mentalizing network (Krueger and Hoffman, 2106; Ginthis et al., 2016; Monticelli et al., 2021), we expected to observe higher levels of neural activity in prefrontal cortex in low affect scenarios for participants who have a lower level of BFW.

Method

Participants

In total, 41 participants (21 males, 19 females, 1 who declined to specify) participated in this experiment (M_{age}= 28.78, *SD*= 8.17, Range= 18-45). Two individuals had a high school degree (4.9%), nine had an associate degree (22.0%), 24 had an undergraduate degree (58.5%), and six had a master's degree (14.6%). Four individuals were self-employed (9.8%), one was working in the public sector (2.4%), 11 were working in the private sector (26.8%), seven were unemployed (17.1%), 15 were students (36.6%), and the working status of the remaining three individuals did not fall into the predefined categories (7.3%).

Experimental Design/Procedure

The study consisted of two phases aimed at collecting neuroscientific and behavioral information. At the neuroscientific stage, 49 fictional crime scenarios were shown to the participants, who were tasked to select a punishment between two options given to them following the screening of scenarios. Scenarios were categorized as either high or low affect ones. Penalty options were prison terms, with a few exceptions consisting of fines. One of the options contained a considerably higher penalty compared to the other one. To eliminate order effects and to increase the reliability of the test, the scenarios were presented to each participant in a random order. Participants were recruited by an applied neuroscience lab and were given 50 TL each for their participation. In addition, a quiet environment free from external factors was provided during the experiment; no communication was established with the participant, except for situations that had the potential to disrupt the experiment, such as the participant not understanding the question. Participants were all right-handed, had no history of neurological disorders, no mental health or cognitive impairment (they had not used psychiatric medication in the last six months), and had no vision problems.

Before starting the experiment, a consent statement was read to the participants; once the participant had given their consent, they were taken to the experiment room. fNIRS neuroimaging method was used and the BOLD activity of the users was observed — information was collected over oxy, hbo, hbt, and hbr signals. 16 optodes were connected to the frontal cortex of the participants and information was collected over 4 main channels. In addition, the participant's heart rate and pulse were recorded. Biometric data was collected with Empatica E3 HD Biometrics (HR) System, electrodermal activity (EDA) and heart rate (HR). For each scenario, 8 seconds for fixation, 7 seconds for reading the scenario, and 5 seconds for deciding on the punishment were accorded. Following the data collection, the participants were directed to another room to fill in the following surveys: FAD Plus scale consisting of 27 items (Paulhus and Carey, 2011; Alper and Sümer, 2017), extraversion scale consisting of 10 items (Goldberg 1992; Tatar, 2017), system justification scale consisting of 8 items (Kay & Jost, 2003; Atabey, 2017), Rational - Experiential Inventory consisting of 24 items (Epstein et al., 1996; Çal, 2018), Social Conservatism consisting of 10 items (Hennigham, 1996; Yılmaz & Saribay, 2016), and a demographic data section consisting of 4 items. Finally, a debrief was read to each participant and the experiment was completed.

The 49 criminal vignettes used in the experiment were prepared in line with those used in previous studies (Krueger et al., 2014; Buckholtz et al., 2008). Nevertheless, since the penal law in force in the USA and in Turkey are not identical, the content of the vignettes was adapted according to the Turkish legal framework. We intended vignettes to contain as many different types of offenses as possible. Hypothetical cases for the vignettes were drawn from a textbook (Tezcan et al., 2021) and from existing case law of the Turkish Court of Appeal, and in some instances, they were created by our team. All criminal vignettes were classified as high affect and low affect according to the following criteria: 1- the relevant legally protected interests (physical integrity, sexual inviolability, and property) as objective criterion, and 2- the potential social reactions to this hypothetical offence as subjective criterion. To determine the subjective criterion, the way the offense was committed, the features of victims (whether they belong to a vulnerable group, such as children, minority etc.), and public reactions to previous similar cases were taken into account. For example, the criminal vignette where the perpetrator had an intercourse with their friend, whom they had drugged, was considered as high affect, because it was a sexual offence, the victim was in a defenseless situation, and this kind of offence always gets strong social reactions in Turkey (death penalty, castration discussions). Conversely, the criminal vignette where the perpetrator stole a luxury car at night and brought it back after a tour, was considered as low affect. Firstly, it was a petty offense against the property, secondly the car/the property was not harmed and finally, this offense generally does not get a strong social reaction.

Paradigm

In this experiment, participants took part in a third-party legal decision-making task in which they needed to determine the appropriate level of punishment for the actions of the perpetrator in the fictional vignettes. Our design continuously manipulated the crime scenario and the crime severity. In all crime scenarios, the perpetrator was a fictitious agent named Ahmet, a common male name in Turkey. Some research showed that variables like societal stereotypes may affect the perception of responsibility and blame. The type of crime has an impact on social judgments, and it has been demonstrated that crime types have an impact on the degree of responsibility projected on the perpetrator. For instance, while the victims of theft were considered to bear more responsibility than victims of rape, perpetrators were assessed as more responsible for rape than for theft (Brems & Wagner, 2010). In addition, deciding the blameworthiness of an accused criminal offender is correlated to the severity of a criminal offense (Buckholtz et. Al., 2008; Robinson, 1997; Robinson and Darley, 1995). In scenarios involving different degrees of responsibility of the perpetrator, the arousal and punishment scores in the responsibility condition (responsibility, diminished responsibility, and no-crime) showed similar results, whereas the punishment score was significantly lower than the arousal scores in the case of reduced responsibility (Buckholtz et al., 2008).

Results

To analyze the fNIRS data, we grouped certain brain regions as follows: (1) Up-down, where eight electrodes are on the upper line and the other eight are on the lower line, (2) Right-left, where eight electrodes are on the left side and the other eight are on the right side, (3) Location, where the electrodes are clustered in groups of four to form a total of four squares side-by-side. For all crime scenarios including low and high affect crimes, neural data were collected during both pre-decision (when the participant reads the scenario but the punishment options are hidden) and decision phase (when both scenarios and punishment options are present. Then a 2 (Up or down) x 2 (Right or left) x 2 (High affect or low affect) x 2 (Pre-decision or decision) x 2 (High BFW or low BFW) x 4 (Left, center left, center right, or right) repeated measures ANOVA was conducted to understand whether there were differences in neural activation for low and high affect crimes during the pre-decision and decision phase between participants with high-level of BFW and low-level of BFW. All factors apart from BFW were within-subject variables, and BFW was the only between-subject variable. The affect level of the scenario had a significant influence on oxy levels $F(1, 39) = 4.209$, $p = .047$, $\eta_p^2 = .097$. Oxy levels were significantly greater in low affect scenarios (M=.031, SE=.016) than in high affect scenarios (M=-.004, SE=.017). There was a significant two-way interaction between BFW and affect level of scenarios on hbo levels ($F(1, 39) = 7.839$, $p = .008$, $\eta_p^2 = .167$). There was a significant two-way interaction between BFW and affect level of scenarios on hbt levels ($F(1, 39) = 4.977$, $p = .032$, $\eta_p^2 = .113$). The phase (pre-decision or decision) had a significant effect on oxy levels $F(1, 39) = 8.593$, $p = .006$, $\eta_p^2 = .181$. Oxy levels were significantly greater during the pre-decision phase (M=.033, SE=.014) than in the decision phase (M=-.005, SE=.017). The location had a significant effect on hbr levels $F(2.202, 85.895) = 3.771$, $p = .023$, $\eta_p^2 = .088$. Hbr levels were significantly higher in location 4 (M=.033, SE=.010) compared to location 1 (M=.012, SE=.007). Laterality had a significant effect on oxy levels $F(1, 39) = 7.987$, $p = .007$, $\eta_p^2 = .170$. Oxy levels were significantly greater on the left side (M=.019, SE=.014) compared to the right side (M=.008, SE=.014). Laterality had a significant effect on hbr levels $F(1, 39) = 4.511$, $p = .040$, $\eta_p^2 = .104$. Hbr levels were significantly greater on the right side (M=.024, SE=.007) than on the left side (M=.018, SE=.007). t-test results between participants with high level of BFW and low level of BFW for low and high affect scenarios are presented in Table 1 and Table 2, respectively.

Table 1: t-test results for the difference between high and low levels of BFW in pre-decision phase for low affect scenarios

	High-level BFW		Low-level BFW		
	M	SD	M	SD	t-test
Hbo-8	-.006	.120	.107	.123	2.950**
Hbo-10	.003	.114	.085	.118	2.255*
Hbt-8	-.083	.232	.140	.199	3.313**
Hbt-10	-.082	.231	.122	.195	3.075**

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

Table 2: t-test results for the difference between high and low levels of BFW in decision conditions for high affect scenarios

	High-level BFW		Low-level BFW		
	M	SD	M	SD	t-test
Hbo-3	.010	.088	-.086	.136	-2.630*
Hbo-12	.062	.132	-.034	.116	-2.481*
Hbo-14	.063	.112	-.023	.120	-2.349*
Hbo-15	.043	.112	-.038	.140	-2.022†
Hbo-16	.070	.110	-.030	.126	-2.650*
Hbt-3	.055	.167	-.037	.125	-2.025†
Hbt-12	.144	.246	-.048	.151	-3.056**
Hbt-14	.145	.235	-.022	.203	-2.441*
Hbt-15	.159	.269	-.015	.189	-2.415*

Hbt-16	.190	.215	-.010	.257	-2.620*

Note. †p=.05, *p<.05, **p<.01

A discriminant function analysis was performed to understand whether all the neural data from four different voxels can successfully distinguish high and low levels of BFW in low affect scenarios in the pre-decision phase. At first, voxel 7 was a significant predictor but in the assumption check process, it did not meet the expectation of normal distribution, and was therefore excluded from the final model. Thereafter, the outliers were eliminated with respect to 5^{th} and 95^{th} percentiles (approximately two standard deviations), causing our sample to fall to 33 individuals for the discriminant function analysis. As presented in Table 3, neural data can predict the level of BFW with 81.8% accuracy, which is a considerably high classification rate.

Table 3: Results of the discriminant function analysis

	All Sample (N=33)	High Belief in Free Will (N=15)	Low Belief in Free Will (N=18)
Optode 5	-0.0018±.06	0.0291±.04	-0.0275±.06
Optode 8	-0.0224±.08	-0.0465±.07	-0.0024±.08
Optode 10	-0.0231±.10	-0.0569±.08	0.0051±.10
Wilk's Lambda	.581	-	-
Chi-Square	$\chi2(3)$ =16.00 *p*=.001	-	-
Classified Correctly	81.8%	86.7%	77.8%

Discussion & Conclusion

The empirical results indicate that during the decision stage of high affect scenarios, the participants with high-level of BFW have higher levels of neural activity in the right DLPFC than those with low levels of BFW. This might be due to the fact that high affect scenarios involved relatively sensitive content such as raping or child abuse. In this respect, the findings by Buckholtz et al. (2015) suggested a causal role for DLPFC in norm enforcement. This may explain our findings: participants with high-level of BFW probably made a more intensive use of this brain region for the neural integration during the process of punishment decisions. This idea is also supported by the findings of Spitzer et al. (2007), who claimed that the neural activation in right DLPFC tends to be higher during the punishment decision phase, influenced by the degree of norm compliance. Moreover, Buckholtz and Marois (2012) suggested that DLPFC translated "rough intuitions about deserved punishment into a precise punishment response by anchoring it to a context-specific punishment scale". Thus, the difference of DLPFC activity between two groups might have been due to the inter-subject variations with respect to the degree of BFW.

Our findings imply that the participants with a lower BFW level tended to have higher levels of neural activation among the medial PFC during the pre-decision phase in low affect scenarios. Previous research has also addressed the identification of several different brain mechanisms, in particular in the medial PFC, associated with processes related to SPP (Bellucci et al., 2020). The empirical findings by Buckholtz and Marois (2012) indicated a core brain network, comprising the medial PFC, the temporoparietal junction (TPJ) and the posterior cingulate, which is responsible for self-projective mentalizing processes. Thus, it might be argued that the participants with lower BFW have tended to mentalize more intensely than the participants with higher BFW.

The results of the discriminant function analysis indicated that three optodes (O5, O8, and O10) are influential in the final model, which works with 81.8% of classification accuracy on average with respect to the neural activations in the mentioned optodes during the presentation of low affect scenarios. The mean activation levels for the optodes in vmPFC indicate that a low degree of BFW tends to be correlated with higher levels of neural activation, which is also in line with the idea of mentalizing process (Buckholtz & Marois, 2012).

The scope of this empirical study is limited by a couple factors inherent to the method employed as well as other factors, notably cultural differences. First of all, the fNIRS method used during data collection could only serve to acquire data from the prefrontal cortex, thus leaving aside question of the potential involvement of the subcortical areas for the current analyses. This limitation is especially important because it prevents us from comparing our findings with those reported by Krueger et al. (2014). In their study, Krueger et al. (2014) found that participants with high levels of BFW (libertarians, as the researchers named them) inflicted harsher penalties in low affect scenarios and showed higher activity in the right temporoparietal junction. As they report, this difference between the two groups disappeared in high affect scenarios. In order to overcome this limitation, we aim to conduct follow-up studies in which we will use the fMRI method, thus giving us the opportunity to validate the current findings as well as understand the potential contribution of the involvement of the subcortical brain areas. Cultural differences are another potential limitation for the generalizability of this study's findings. This study has been conducted in an applied neuroscience laboratory in Turkey. Several studies (Miller & Bersoff, 1992; Kashima et al., 1995) showed that people who are raised in Western Cultures have a different understanding of the concepts of free will, such as responsibility and agency. For example, individuals of Western European Heritage or Culture considered actors more negatively when their actions are motivated by obligation, compared to actions that are agentic (Buchtel et al., 2018). In addition, belief in free will and religiosity are positively correlated in samples from individuals of Western culture (Carey & Paulhus, 2013). Needless to say, one of the main differences between ours and Western studies is that our sample consisted of participants raised in a social sphere heavily influenced by Muslim faith. Based on this idea, a recent study (Yilmaz et al., 2018) found that there is no relationship between religiosity and free will. However, fatalistic determinism is found to be the main mechanism underpinning belief systems in Turkish samples. To provide generalizable findings of the sort, new empirical studies are needed.

In conclusion, this empirical neuroscientific study aimed to understand the neural correlates of third-party punishment and the effect of BFW, which is also a specifically human prosocial behavior. In this study, we have examined the effect of BFW on third-party punishment in high and low affect scenarios through optical brain imaging method (fNIRS). The obtained results and the related statistical analyses indicate that the participants with higher degree of BFW have more neural activation in their right DLPFC regions (hbo and hbt measures) during high affect scenarios whereas the participants with lower degree of BFW have higher levels of neural activation in the medial PFC regions (hbo and hbt measures) during low affect scenarios. To sum up, the findings obtained via the empirical method throughout the current study are in line with the findings in the related academic literature.

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