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The Effect of Social Value Orientation on Theta to Alpha Ratio in Resource Allocation Games

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Abstract: The social value orientation (SVO) has a profound effect on the strategic decision making in economic choices and the ability to succeed in coordination games. With that in mind, in this study we wanted to examine an electrophysiological measure elicited in different resource allocation problems that affect the preferences of the player. We recorded EEG from participants while they were engaged in different allocation problems varying in the magnitude of reward and the difference size between alternative choices. We found that the theta to alpha ratio (TAR) can differentiate between individualistic and prosocial players. Specifically, individualistic players were more sensitive to the magnitude of the overall payoff (reflected by the radius size) as well as to the difference between two reward alternatives in the resource allocation task. These two variables, reward magnitude, and the difference between payoff alternatives, have significantly differentiated between the TAR levels of prosocials and proselfs ($p < 0.001$). For extreme differences (small or large), TAR was higher in comparison to medium sized differences. Our results demonstrated that in resource allocation games the TAR can be predicted based on the parameters of the task and the SVO category of the player (prosocial or individualistic). Specifically, an interaction was found between the attractiveness of the reward (radius) as well as the conflict between alternatives ($\Delta\varnothing$) and the SVO of the player at a significance level of $p < 0.0001$. These results highlight the importance of the SVO construct in economic decision choices varying in both reward magnitude and the proximity between alternative choices. Suggestions for future studies are discussed.

Keywords: resource allocation tasks; social value orientation; EEG; statistical modeling

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1. Introduction

A measure which reflects the magnitude of a person's concern for different others is known in the literature as the Social Value Orientation (SVO) [1,2]. The SVO of a player is not an absolute value; it describes a spectrum of possible behaviors, in which one end of the spectrum denotes proself behavior, and the other end denotes prosocial behavior [3,4]. In organization science, there is evidence showing that the composition of individuals SVOs affects the collective group outcomes [5,6] since it determines the players' strategies during the game. Moreover, it has been recently shown [7] that SVO improves team productivity over and above other organizational variables that link between inputs and outputs of group processes such as group potency, job design, group heterogeneity, and team productivity [8,9].

Existing literature has shown that the SVO [10] has a profound impact on the decision bias of the player regarding the divisions of resources [11]. While the SVO value is continuous in nature, it can be categorized into two main classes: people who are more individualistic in nature are more oriented towards reward maximization, and people who are more prosocial oriented are more focused on maximizing some function of the joint outcome. In contrast to the rationality assumption of game theory, there are significant individual differences in SVO, and players are not always oriented to earn higher individual payoffs [2,12]. Until now, the SVO has been only measured behaviorally by using questionnaires. However, it has been shown that SVO is susceptible to behavioral priming effects and therefore the validity of this construct is often questioned. More specifically, previous research did not try to distinguish between strategic profiles of prosocials and individuals by electrophysiological indices. Previous electrophysiological studies have found major differences in electrophysiological responses in the context of tacit coordination games (e.g., [13,14]) but not in the context of research allocation task. Here, for the first time, we have managed to electrophysiologically separate different SVO categories through research allocation and by measuring the responses to conflict and uncertainty on the one hand and the attractiveness of the reward on the other.

In our previous work, we have demonstrated that the cultural background has a profound effect on the strategic profile and the ability to succeed in pure tacit coordination games without considering the construct of SVO [15]. However, since in our previous studies, the SVO was only studied behaviorally, here we wanted to extract an electrophysiological measure elicited in different resource allocation problems that affect the preferences of the player [11,16]. Thus, in this study, we have taken the first step towards measuring the SVO objectively by finding electrophysiological correlates of SVO in the context of a resource allocation task.

The goal of this study was to investigate the effect of SVO on the perception of conflict and attractiveness of reward in resource allocation problems using an electrophysiological measure, namely the theta to alpha Ratio (TAR), which is considered to be a measure of cognitive load. The TAR as a measure of cognitive load is based on the hypothesis that an increase in load is associated with an increase in theta power with a simultaneous decrease in alpha power (e.g., [17,18]). We have assumed that as the magnitude of conflict and attractiveness increases, TAR, as a measure of cognitive load, will be affected by the SVO category of the player (prosocial or individualistic). This assumption is based on previous findings. Specifically, economic paradigms were related to goal conflict and to approach-avoidance conflict which was found to be associated with changes in the theta and alpha band [19]. Furthermore, theta has also been implicated in conflict resolution outside the economic domain [20]. As an example of decision bias, it was previously found that when presented with a two-choice reward task, reward payoff maximization was associated with diminished prefrontal theta.

To measure the SVO in this study, we have designed an SVO questionnaire based on parameters of the "slider method" [10,21], in which the player had to allocate resources between herself and an unknown partner. In each question there were two alternatives of allocation. Each pair of alternatives could be characterized by $\varnothing$, the angle between a pair of alternatives, and by the magnitude of the radius (R) which reflects the magnitude of the available payoff of each of the alternatives.

Since there is a different attitude of individualistic and prosocial players towards allocation of resources, the individualistic player mainly considers her own payoff whereas the prosocial player takes the joint outcome into consideration, it is expected that the two parameters, namely, the magnitude of the angle difference between alternatives and the magnitude of the radius of each pair of alternatives, will have a differential effect on the players' decision-making. Decision-making in resource allocation problems, as in other economic problems, is affected by cognitive biases which often result in framing effects.

In view of the above, we hypothesized that the players with an individualistic social orientation will be driven by the goal of payoff maximization and therefore TAR will be modulated to a greater degree as a function of the magnitude of the reward or conflict. In the current study, we found that TAR can differentiate between individualistic and prosocial players. Specifically, individualistic players were more sensitive to the magnitude of the overall payoff (reflected by the radius size) as well as to the difference between two reward alternatives in the resource allocation task. For extreme differences (small or large), TAR was higher in comparison to medium sized differences. These results may indicate that there is an interaction between the attractiveness of the reward (radius) as well as the conflict between alternatives ($\Delta\varnothing$) and the SVO of the player.

In the next sections of the paper, we will detail the methods used including information regarding the participants, the experimental design and the EEG analysis stages. Subsequently, the results will be described regarding the effect of SVO on reward attractiveness and conflict. Next, we will present a regression model that predicts TAR. Finally, we will discuss the results in view of previous studies, and address limitations and possible future work.

2. Materials and Methods

2.1. Participants

To collect the electrophysiological data, we gathered data from 10 university undergraduates' students in the Faculty of Engineering at Ariel University that were enrolled in one of the courses on campus (3 female participants; mean age = ~25, standard deviation = 4). The participants received a verbal explanation regarding the experiment including the stages pertaining to the EEG recording, and signed an informed consent detailing the course of the study and the EEG recording stages. The study was approved by the IRB committee of the university.

2.2. Experimental Design

This study comprised several stages. First, we have measured the SVO of the player using the "slider" method [10] and categorized it as "prosocial" or "individualistic". The SVO slider method describes the player's preferences about how to allocate resources (e.g., money) between herself and another person [12,22]; a "prosocial" player aims to maximize the total profits of both players while an "individualistic" player aims to maximize only his own profit (see Figure 1 for a basic description of the "slider method"). Figure 1 displays the effect of the two main parameters of the slider method: radius and angle size. It can be seen that as the radius increases, the magnitude of the total resource to be allocated between the two players increases as well. The angle size determines the difference between the payoff to oneself and the payoff to the other player. The difference between angles ($\Delta\varnothing$) affects the difference between two allocation alternatives. For example, given the two allocation alternatives: [230,330] $\rightarrow \varnothing = 55$, and [385,105] $\rightarrow \varnothing = 15$, the value of $\Delta\varnothing$ will be 40.

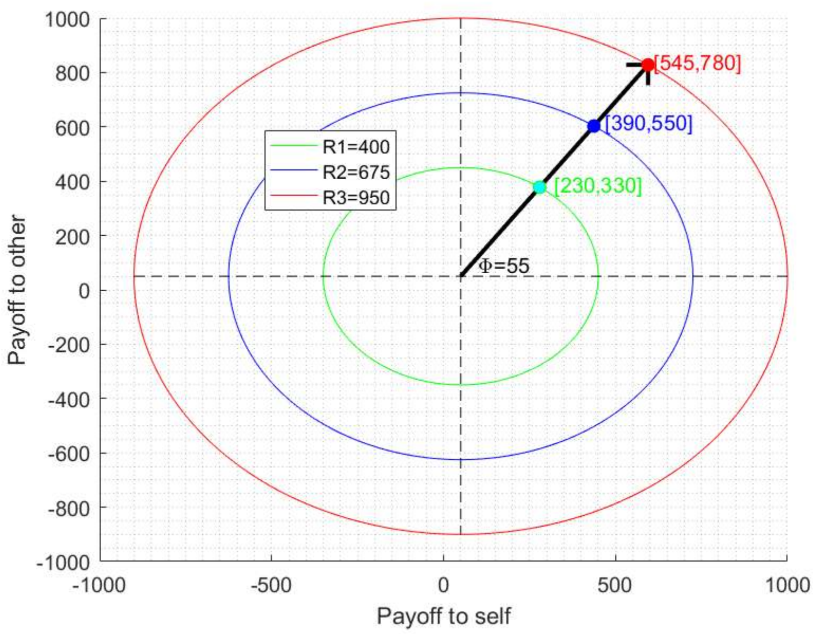

Figure 1. The SVO slider method parameters—radius and angle.

Based on a cutoff point of 22.5 degrees, 5 participants were labeled as "individualistic" (SVO angle less than 22.5 degrees) and 5 were labeled as "prosocial" (SVO angle greater than 22.5 degrees). Subsequently, EEG was recorded for 2 minutes with eyes open while participants were requested to gaze at a red cross situated in the middle of screen on a gray background (resting-state condition). Next, each player was then presented with a resource allocation task that included 18 questions (see Appendix A). In each question, the player was presented with two resource allocation options which should be divided between himself and an unknown partner.

Figure 2 shows an example of a resource allocation question. In each question, one option was more prosocial while the other was more individualistic. The upper number of each question indicates the points gained by the player while the lower one the number of points gained by the partner. The position of each option on the screen (right or left) was randomly selected. The player had a time window of 8 s to choose one of the options, otherwise none of the players received any points. Participants were paid according to their level of performance, that is, according to the number of points they have accumulated throughout the entire experiment. Each participant underwent a training session prior to the experimental session to get familiar with the application.

Figure 2. Resource allocation application screen.

Figure 3 describe the outline of the resource allocation session. The stand-by slides contained the two vertical lines only to focus the gaze of the participants onto the middle of the screen. In the resource allocation problem shown in Figures 2 and 3, the player can choose between two options. In this case, the option on the left side of the screen means that one player will receive 79 points while the other player will receive 61 points. According to the other option, one player will receive 80 points while the other one will receive 50. In the first option, there is a gap of 18 points, whereas in the other option, there is a gap of 30 points. Noteworthily, the increase for the first player is by only one point, while the other player, should they lose significantly, has a payoff decrease of 11 points.

The design of the experiment enables to manipulate the two main parameters of the resource allocation problem. First, the attractiveness of the reward represented by the radius size that controls the total number of points, and second, the angle difference, which represents the gap between the allocation alternatives.

Each of the stand-by slides was presented for U(2,2.5) seconds. The sequence of the task trials was randomized in each session (Figure 3).

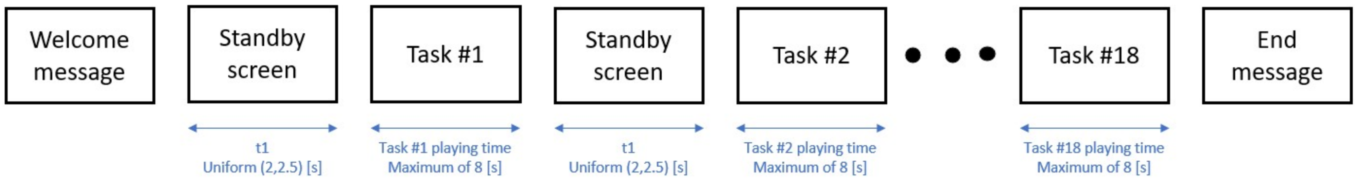

Figure 3. The experimental paradigm.

2.3. EEG Acquisition, Pre-Processing and Power Spectrum Feature Extraction

EEG was recorded using a 16-channel high performance biosignal amplifier, g.USBAMP (g.tec, Austria), together with an EEG cap that was placed over the scalp following the 10–20 system (see [23] for exact electrode placements). The OpenVibe [24] system was used for acquisition of the EEG signals. The sampling frequency of the EEG was defined as 512 [Hz] while impedance was kept below 5K [ohm].

Data preprocessing (see Figure 4) and feature extraction (see Figure 5) were performed using EEGLAB [25] in addition to in-house data processing scripts. To eliminate noise, a band-pass filter ([1, 32] Hz), followed by a notch filter of 50 Hz were used following by independent component analysis (ICA) that was applied on the filtered signal (e.g., [26,27]). Finally, the data was re-referenced to the average reference and down sampled to 64 Hz following baseline correction. Epoch windows of 1 [s] were extracted in each of the tasks relative to game onset. Response time was measured using the OpenVibe recording software with a 5 (ms) resolution from game onset.

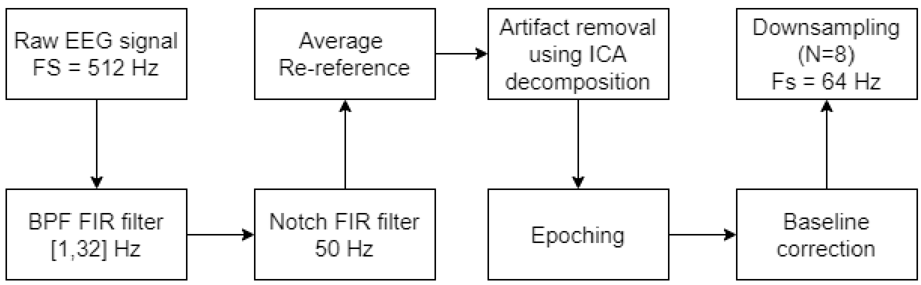

Figure 4. EEG preprocess pipeline.

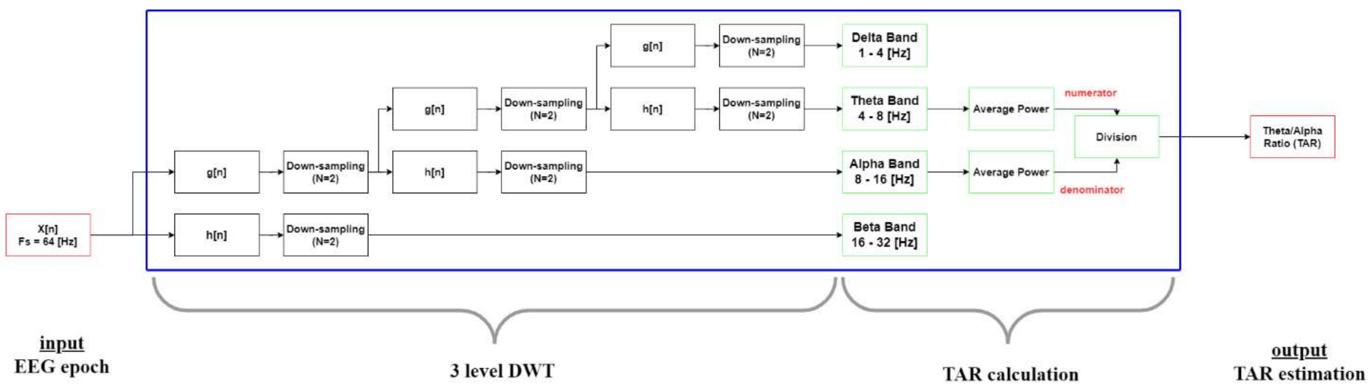

Figure 5. Theta-Alpha ratio calculation based on 3 level DWT scheme.

In this study, we have measured the difference in the Theta-Alpha Ratio (TAR) of each player in each task relative to the average TAR in his or her resting state recording. The TAR has been used as an index of mental workload and task engagement (see a review in [28]). To calculate the TAR based on the continues EEG recordings, we have used the Discrete Wavelet Transform (DWT) [29,30]. A combination of an EEG signal sampled at 64 [Hz] with a 3-level DWT resulted in four EEG frequency bands [Delta, Theta, Alpha, beta], and the relevant bands were used to calculate the TAR for each continuous EEG recordings (Figure 5).

Based on the literature (e.g., [31–34]), we have focused our analyses only on the following cluster of frontal and prefrontal electrodes (Fp1, F7, Fp2, F8, F3, and F4). TAR was calculated as the difference between the task and the resting-state condition (from herein referred to as normalized TAR). The TAR measure has enabled us to examine interactions between the attractiveness of the reward (radius), the conflict between alternatives ($\Delta\varnothing$), and the SVO of the player as shown in the results section below.

Figure 6 presents a summary of the experimental design stages. Following the SVO measurement stage that was used to label participants into proselfs and prosocials, participants were engaged in the resource allocation task while EEG was simultaneously recorded from the scalp. In this task we systematically varied both the radius size and $\Delta\varnothing$. In the following stages, we preprocessed the EEG signals, computed the TAR values, and used multivariant ANOVA analysis to study the interactions between these variables. Lastly, we have also run a step-wise regression model to evaluate the contribution of each of these three variables.

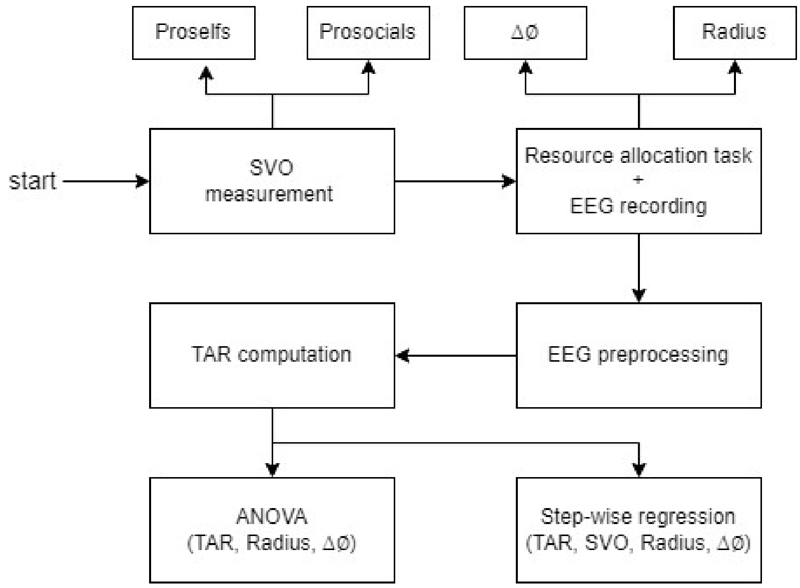

Figure 6. Summary of the experimental design stages.

3. Results

In this section we will describe two main interactions, one implicating the effect of the attractiveness of the options to be selected, and the other involving the conflict between the alternatives. The attractiveness is determined by the magnitude of the available payoff. Games in which the profit to oneself are expected to be larger are supposed to be more attractive than games in which the potential profit is lower. The attractiveness is reflected by the radius of the circle that is used to depict the locations of the social orientations. The conflict is determined by the magnitude of the difference between payoff of the player and the payoff of the partner. The conflict is reflected by the angle difference between the payoffs of the two options. The interactions described below emphasize the differential influence of the SVO as a function of both attractiveness and conflict.

3.1. The Effect of SVO on Attractiveness

Figure 7 displays the effect of the radius magnitude on normalized TAR as measured from all the participants. As can be seen there is a gradual increase in TAR as the size of the radius increases. This result reflects the effect of attractiveness on TAR. That is, there is a positive relationship between reward magnitude and TAR ($F(177,2) = 31.38$, $p < 0.0001$).

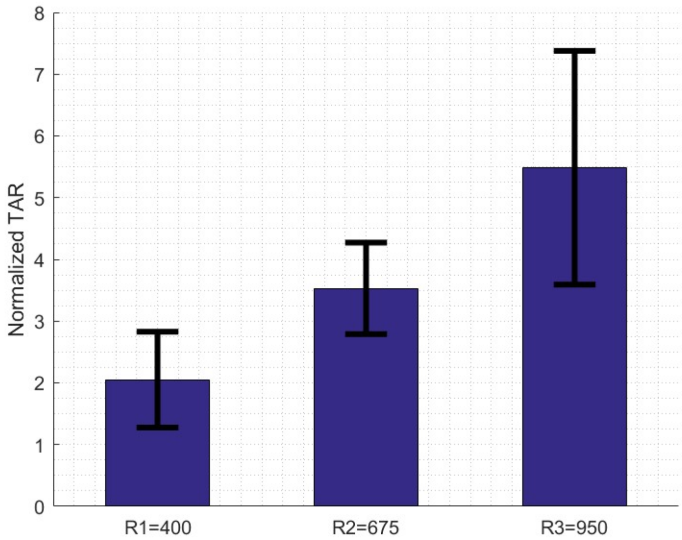

Figure 7. Normalized TAR as a function of the radius.

Figure 8 displays the interaction between radius size and SVO (prosocial, individualistic) (F(174,2) = 7.86, $p < 0.0001$). It can be seen that TAR increases dramatically for individualistic players while for prosocial players a more pronounced increase can only be seen between R2 and R3. This finding highlights the impact of SVO on the perception of the magnitude of the reward (attractiveness). It seems that individualistic players are more sensitive to the effect of the magnitude of the reward compared to prosocials.

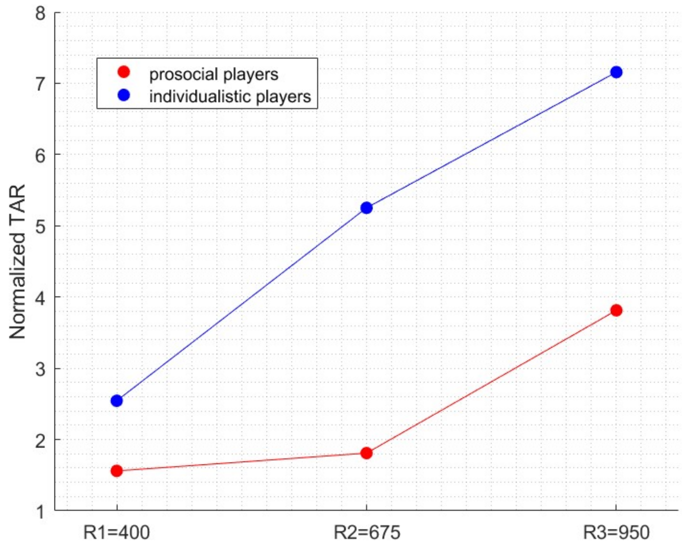

Figure 8. The interaction between SVO category and radius size for normalized TAR.

3.2. The Effect of SVO on Conflict

Figure 9 displays the effect of the angle difference ($\Delta\varnothing$) between a pair of alternative choices. Since smaller differences between alternatives increase uncertainty between choices, the angle difference reflects the amount of conflict the player faces. When $\Delta\varnothing$ is higher, the perceived difference between low and high reward magnitude is more pronounced. In the smaller and higher values of $\Delta\varnothing$, TAR is larger compared to the medium sized $\Delta\varnothing$, thus when conflict and attractiveness come into play, TAR increases accordingly.

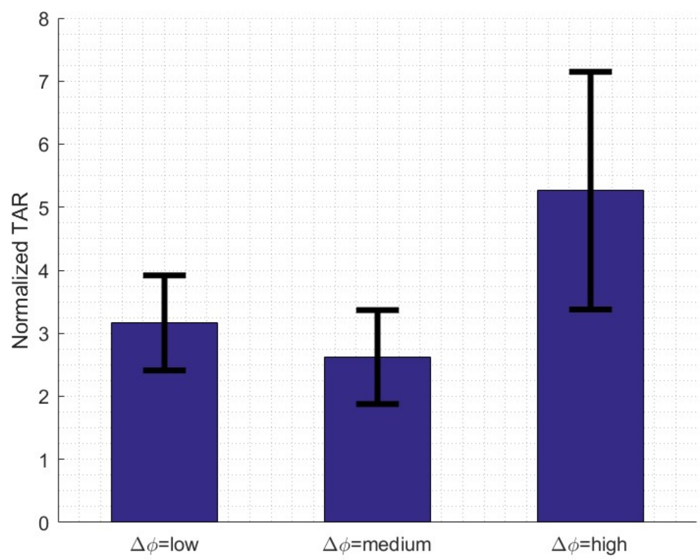

Figure 9. Normalized TAR as a function of distance between allocation resource alternatives.

Figure 10 displays the interaction between the magnitude of Δ∅ and SVO (prosocial, individualistic) (F(174,2) = 10.43, $p < 0.0001$). Overall, the behavior of both SVO types is similar across the three angle differences. However, the main differences between individualistic and prosocial players is evident in the transition between the medium size and highest angle difference. This result underscores the enhanced sensitivity of individualistic players to the effect of both conflict (smaller Δ∅) and attractiveness (highest Δ∅).

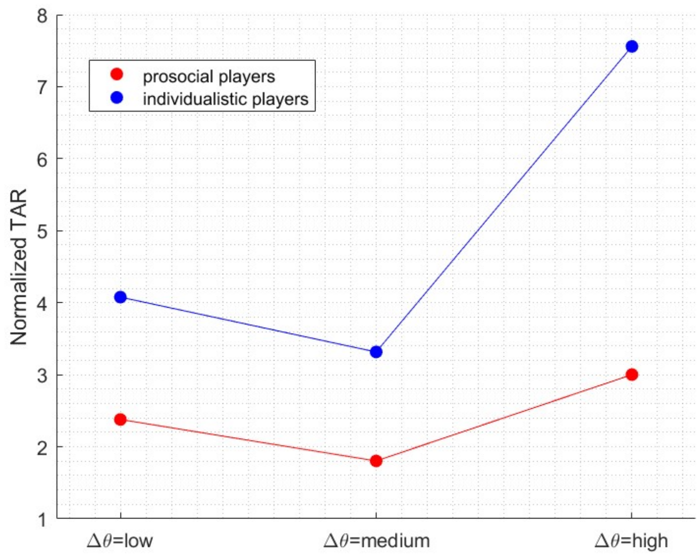

Figure 10. The interaction between SVO category and Δ∅ size for normalized TAR.

3.3. A Regression Model for TAR

To evaluate the added value of SVO on top of the radius and angle size difference, we have constructed a step-wise regression model. That is, we have iteratively selected the independent variables (SVO, radius size, angle difference (Δ∅)) to be included in the model in a step-by-step manner to predict TAR. In the first step the regressor was the radius and as can be seen in Equation (1), R^2 was 0.26.

$$Normalized\ TAR = -0.5237 + 0.0062 * Radius \tag{1}$$

$$R^2 = 0.260089,\ p < 0.001 \tag{2}$$

In the second step, we entered $\Delta\varnothing$ to the regression model on top of the radius (Equation (3)), and consequently R^2 has increased to 0.43 (Equation (4))

$$Normalized\ TAR = -1.3817 + 0.0062 * Radius + 0.1514 * \Delta\varnothing^4 \tag{3}$$

$$R^2 = 0.432452,\ p < 0.001 \tag{4}$$

In the third and final step we have entered all three regressors to the regression model, namely, SVO was added on top of the other two variables, radius, and angle difference. In this model, SVO was defined as a binary variable (see Equation (5)). The integrated model that included all three regressors achieved the highest R^2 that was equal to ~0.74 (Equation (6)). This finding highlights the added value of SVO to the prediction ability of TAR.

$$\begin{gathered} Normalized\ TAR = \\ SVO_{category} * \left(-2.0707 + 0.0084 * Radius + 0.2460 * \Delta\varnothing^4\right) + \\ \left(1 - SVO_{category}\right) * \left(-0.6927 + 0.0041 * Radius + 0.0568 * \Delta\varnothing^4\right) \end{gathered} \tag{5}$$

$$R^2 = 0.7390,\ p < 0.001 \tag{6}$$

4. Discussion

In the current study we aimed to investigate the effect of SVO on conflict and attractiveness on resource allocation problems. As the SVO describes the preferences of the decision makers when allocating joint resources between the self and another person, we assumed that SVO will have a substantial impact on the responses of players when faced with either conflict or attractive alternatives. We found that TAR can differentiate between individualistic and prosocial players and that SVO has a profound effect on the predictive ability of TAR. Specifically, individualistic players were more sensitive to the magnitude of the overall payoff (reflected by the radius size) as well as to the difference between two reward alternatives (reflected by $\Delta\varnothing$) in the resource allocation task. For extreme differences (small or large) TAR was higher in comparison to medium sized differences. These results may indicate that there is an interaction between the attractiveness of the reward (radius) as well as the conflict between alternatives ($\Delta\varnothing$) and the SVO of the player.

Taken together, these results corroborate previous findings implicating Theta in responses to conflict or reward magnitude. Theta has been previously implicated in economic decision biases and tended to be higher in cases of conflict between alternatives when uncertainty was relatively high [19,35,36] or when there is an increase in reward magnitude (expected reward modulates encoding-related theta activity before an event). The fact that SVO profoundly affects the Theta responses underscores the importance of this feature in the context of economic decision biases. Previously, we have shown that the SVO can be utilized to predict the cultural background of the player [15], and that it determines the strategic behavior of players in coordination problems [21,37]. Moreover, we have constructed an autonomous agent whose aim was to achieve an optimal solution by maximizing the payoff gained across a set of tacit bargaining games [22]. The agent selected stochastically between one of two possible solutions, a greedy solution or a focal point solution, and the decision was based on assessing the probability of a player converging on a focal point using a model that incorporated the SVO of the player as well as several game features.

This study also has practical implications. Various studies have shown that the SVO values of group members affect the dynamics of the group and its ability to succeed [38]. In addition, ref. [39] showed that the SVO value is associated with the emotional reaction of players towards violation of the equality rule in social dilemmas. Currently, the SVO index is calculated based on questionnaires, a method that might be susceptible to biasing expectations. Therefore, future studies could benefit from using an objective electrophysiological measure associated with the SVO.

5. Conclusions

Overall, our findings demonstrate two types of responses: one to create conflict or uncertainty and the other to the magnitude of reward or the level of attractiveness. Both types of responses are reflected by the magnitude of TAR. Specifically, when the magnitude of reward increases (increase in radius size) or when there is large conflict between alternatives (large $\Delta\varnothing$), the higher reward alternative is therefore more attractive, and TAR thus increases. However, when reward magnitude is low or when the alternatives are close to one another (small $\Delta\varnothing$), TAR tends to be smaller. Importantly, our findings demonstrate that the SVO has a profound impact on these Theta modulations. Specifically, individualistic players are more sensitive to conflict and reward magnitude than prosocial players as their normalized TAR is more susceptible to changes in the game features. When reward magnitude increases or when the alternatives are close to each other the TAR of individualistic players is higher than the TAR of prosocials.

There are some limitations of the current study that deserve consideration. First, all the participants in this experiment were selected from a homogeneous population, i.e., undergraduate students from the same university with the same demographic characteristics. It has recently been shown that cultural and demographic factors, such as cultural background [15], significantly influence behavioral results in coordination and resource allocation games. Therefore, it is essential to expand the study to other populations. Second, we have focused our analysis only on the frontal and prefrontal electrodes. Therefore, it might be that other scalp regions could contribute to the differentiation between individuals and prosocials. Moreover, this study used an EEG system that included 16 electrodes. A recording system with a more significant amount of electrodes, for example, 32 or 64, will allow producing a higher spatial resolution and thus add another dimension to the analysis of the results, e.g., implementing source localization algorithms (e.g., [40,41]). Additionally, the sample size in the study was small, however, each participant was engaged in a relatively large number of tasks (see Appendix A). Noteworthily, all the effects in the study were associated with a highly significant p-value, at least at the level of $p < 0.001$. However, it is recommended to increase the number of participants un future studies.

There are several avenues for future research. First, the SVO should be further investigated in the context of economic decision making while its effects on additional EEG measures involving Theta should be tested (e.g., theta to beta ratio. See also [17]). Second, the dissociation between conflict and attractiveness should be further investigated in other contexts involving SVO and conflict without reward cues (such as the Stop-Signal Task) to see whether SVO has an influence on participants responses in these contexts as well. Third, it is worthwhile to examine the responses to TAR when the player receives feedback during the game session informing them about the decision of the other player, and might therefore consequently change the strategic decision making of the subsequent game iterations. Fourth, EEG measures should be extracted relative to different time points in the analyzed EEG epoch, such as time locked to the beginning of the trial, to feedback information, or to the active response of the player. Finally, the practical implications of the research could also be manifested as a disruptive technology. Specifically, in future research, the EEG correlates of the SVO could be extracted from a resting-state EEG recording. Thus, by using an EEG mobile device and a short recording of only few minutes of resting-state EEG, it would be possible to assign potential candidates to form efficient task groups.

Author Contributions: D.M., I.L. and I.Z. carried out the stages of conceptualization, design of methodology, data curation, formal analysis, data modeling, model validation, writing, drafting and editing. D.M. was also responsible for visualization and implementation of supporting algorithms. I.Z. and I.L. supervised the research activity. All authors discussed the results, read and approved the final manuscript and are accountable for all aspects of the work. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: The experimental protocols used in this work were evaluated and approved by the Ethic Committee of Ariel university (confirmation number: AU-SOC-SL-20190901). Permission to perform the electrophysiological recordings in the experiment was given from 1 September 2019 to 31 August 2020.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: All the experimental data, which includes the players' electrophysiological recordings and the corresponding resource allocation logs, are stored on the servers of Ariel University. The data can be obtained by request from one of the authors.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Resource Allocation Task List

In this appendix, we will describe the set of resource allocation tasks, which includes eighteen tasks that were designed to evaluate the effect of the radius (i.e., number of total resources in the task) and angle difference (i.e., the distance between the 2 alternatives) on the subject's electrophysiological patterns in. The full task list is presented in Table A1.

Table A1. Experimental task list.

Task Number	SVO Radius	$\lvert \Delta\varnothing \rvert$	Option 1: Prosocial [You, Other] (Angle)	Option 2: Individualistic [You, Other] (Angle)
1	400	40	[230,330] $\varnothing = 55$	[385,105] $\varnothing = 15$
2	400	25	[230,330] $\varnothing = 55$	[345,200] $\varnothing = 30$
3	400	30	[280,280] $\varnothing = 45$	[385,105] $\varnothing = 15$
4	400	15	[280,280] $\varnothing = 45$	[345,200] $\varnothing = 30$
5	400	20	[330,230] $\varnothing = 35$	[385,105] $\varnothing = 15$
6	400	5	[330,230] $\varnothing = 35$	[345,200] $\varnothing = 30$
7	675	40	[390,550] $\varnothing = 55$	[650,175] $\varnothing = 15$
8	675	25	[390,550] $\varnothing = 55$	[585,340] $\varnothing = 30$
9	675	30	[475,475] $\varnothing = 45$	[650,175] $\varnothing = 15$
10	675	15	[475,475] $\varnothing = 45$	[585,340] $\varnothing = 30$
11	675	20	[550,390] $\varnothing = 35$	[650,175] $\varnothing = 15$
12	675	5	[550,390] $\varnothing = 35$	[585,340] $\varnothing = 30$
13	950	40	[545,780] $\varnothing = 55$	[920,245] $\varnothing = 15$
14	950	25	[545,780] $\varnothing = 55$	[822,475] $\varnothing = 30$
15	950	30	[670,670] $\varnothing = 45$	[920,245] $\varnothing = 15$
16	950	15	[670,670] $\varnothing = 45$	[822,475] $\varnothing = 30$
17	950	20	[780,545] $\varnothing = 35$	[920,245] $\varnothing = 15$
18	950	5	[780,545] $\varnothing = 35$	[822,475] $\varnothing = 30$

For each resource allocation task question in Table A1, the following parameters are presented: (1) task serial number, (2) the angle difference between the alternatives, and (3) the distribution of resources in each alternative. The distribution of resources in each of the alternatives is the product of the radius by the cosine and the sine of the angle of the alternative.

The order of the tasks appearing on the game screen was randomized for each player differently. This decision in the design of the experiment was made in order not to create a bias resulting from the systematic presentation of the order of the questions and their parameters (i.e., radius and angle difference between the alternatives).

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