



Article

Prosocial Virtual Reality, Empathy, and EEG Measures: A Pilot Study Aimed at Monitoring Emotional Processes in Intergroup Helping Behaviors

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Abstract: During a non-invasive procedure, participants both helped and helped by a confederate with features that create social distance (membership in an ethnic outgroup or another social group). For this purpose, we created a set of virtual scenarios in which the confederate's ethnicity (white vs. black) and appearance (business man vs. beggar, with casual dress as a control condition) were crossed. The study aimed to explore how the emotional reactions of participants changed according to the confederate's status signals as well as signals that they belong to the same or a different ethnic group. Participants' alertness, calmness, and engagement were monitored using electroencephalogram (EEG) during the original virtual reality (VR) video sessions. Participants' distress and empathy when exposed to helping interactions were self-assessed after the VR video sessions. The results pointed out that, irrespective of whether they helped the confederate or were helped by him/her, white participants showed higher levels of alertness when exposed to helping interactions involving a white beggar or a black businessman, and their emotional calmness and engagement were higher when interacting with a black beggar or a white businessman. The results for self-assessed distress and empathy followed the same tendency, indicating how physiological and self-assessed measures can both contribute to a better understanding of the emotional processes in virtual intergroup helping situations. Based on the presented results, the methodological and practical implications of VR in terms of enhancing self-reflective capacities in intergroup helping processes are discussed.

Keywords: virtual reality; helping relations; empathy; EEG; engagement

1. Introduction

The present work aims to test the emotional dimensions of intergroup helping interactions using a virtual environment. According to classical socio-psychological literature, both the decisions to give and seek help are associated with emotional arousal. Giving help may be associated with a personal evaluation ("Am I capable of helping?" "Can my help be effective?"), eventually leading to a final decision regarding whether to help [1]. When seeking help, emotions are aroused by the admission of incapability and implication of dependence on the donor in any explicit request [2]. Moreover, since helping interactions decrease social distance when the helper and helpee are perceived as dissimilar from one another, as in cases in which one belongs to an outgroup, emotional arousal is theoretically expected to increase [3] and the decision to help or request help is expected to become lower. However, empirical pieces of evidence collected according to this theoretical framework while directly observing

help-seeking and help-giving behaviors, hypothesized how emotions and self-assessed emotional arousal could be associated with social desirability of respondents. We, therefore, planned to run a pilot experimental study within a virtual reality (VR) environment in which participants' emotional reactions could be both directly monitored and self-assessed. Social distance during helping interactions was manipulated by exposing participants to virtual scenarios in which they were faced with both seeking and giving help to a confederate helper/helped with three different types of dress (business man vs. beggar, with casual dress as a control condition) and different ethnicities (white vs. black), which were either the same or different from the ethnicity of the participants (all of whom were white Italian university students). Aside from the control scenario, when crossed, these two variables led to four different conditions. Two conditions involved maximum similarity between the participants and confederate (played by a white actor), and either high status (the actor was dressed as a businessman) or low status (the actor was dressed as a beggar) was signalled. The other two conditions involved maximum dissimilarity between the participants and confederate (played by a black actor), and either high status (the actor was dressed as a businessman) or low status (the actor was dressed as a beggar) was signalled.

Within this research, the role played by empathy was taken into account using traditional self-assessed measures. According to the consolidated scientific definition [4], empathy is a complex emotional state composed of a positive empathic experience of being focused on the other (which causes one to feel soft-hearted, compassionate, and moved), as well as a negative experience of personal distress due to others' suffering (which causes one to feel upset and distressed).

The results revealed that the two self-assessed sides of empathy (personal distress and empathic interest) loosely mirrored the EEG measures of alertness, calmness, and engagement. Thus, these were directly monitored during participants' exposure to helping interactions with confederates. Participants showed higher alertness according to the EEG measure and self-reported more personal distress while exposed to a helping interaction in which the person in need was either a high-status member of another ethnic group or a low-status member of the same ethnic group. On the contrary, participants showed higher levels of calmness and engagement when interacting with a person in need who was either a low-status member of another ethnic group or a high-status member of the same ethnic group. The rest of the paper is organized as follows: Sections 2 and 3 present classical works on helping, empathy, and intergroup relations and look at studies that use VR; Section 4 illustrates the performed experiment and discusses the results, and the last section discusses conclusions and future work.

2. Intergroup Helping and Empathy

According to psychological studies, cognitive processes based on prosocial decisions are strictly associated with emotional processes [5]. Classical studies on prosocial behavior have tested how positive emotions like empathy [4,6] can promote prosocial behaviors. In addition, they have tested more generally how low-arousal emotions, like sadness, can drive other-oriented cost-benefit processing rather than automatic and more intuitive processing, which is used when emotions are stronger and more difficult to regulate [7]. The decision to help or not has been largely studied with the theoretical model of intergroup helping relations as status relations [8], which stresses that giving help can perpetuate the social dependency of people in need. Within this framework, outgroup people in need are perceived by "powerful" helpers as people with low competence and opportunities, and the powerful helpers tend to help the people in need since they can elicit emotions of sadness or pity [8,9]. From this perspective, the helping process should depend on helpers' expectations. On the other hand, refugees and immigrants are generally described [10] as criminals ("cimmigration") [11] and associated with the stigma of dependence [12,13]. They are perceived as dependent people (e.g., as "parasites") in need of humanitarian protection. Thus, immigrants can be perceived as "dangerous" or "helpless" [11] and therefore, can be associated with negative emotions, such as anger [12], pity, sadness and bitterness [14]. Based on prior studies, intergroup helping interactions are mediated by the helpers'

expectations and perceptions of dissimilarity, which can be associated with motivation to defend the ingroup image [3,15]. When dissimilarity is high, the helper can perceive more psychological costs and then can avoid making the decision to help. The aim of this preliminary study is to observe potential differences in calmness, engagement, and alertness in relation to the helpee's ethnicity (black or white) and relative autonomy or dependence.

In addition to these theoretical considerations, we also want to observe the role played by empathy, which can promote helping behaviors [16,17] since it is based on perspective-taking of the other. Empathy can be considered a complex emotional state composed of a cognitive side, which involves perspective-taking and a positive approach toward the other, and an affective side, which involves the emotions related to the act of taking the other's perspective. In this context, Stephan and Finlay [18] differentiated between parallel empathy, which involves trying emotions similar to those of the target, and reactive empathy, which involves feeling emotions in response to the emotions of the target [19]. Also, Batson [4] acknowledged the complex nature of empathy, which is composed of the empathic experience of being focused on the other (in which one is softhearted, compassionate, and moved) and personal distress for others' suffering (in which one is upset and distressed). From psychological studies on empathy, we know that it is important to differentiate between the two sides of empathy: spontaneous empathic interest in the other, which is close to an altruistic orientation, and the negative side, defined in the literature as personal distress in reaction to another person's need or suffering. This double nature of empathy has been also explored in psychophysiological studies, in which scholars pointed out that empathy can be associated with both left and right EEG asymmetry as it is an emotional response to the other's need (left frontal asymmetry) and, at the same time, involves emotional sharing of the other's pain (right frontal asymmetry) [20].

3. Prosocial Virtual Reality

Schutte and Stilić [21] have shown that prosocial behavior is closely related to the degree of involvement in VR, which can, in turn, increase user empathy. The experiment conducted by Groom and colleagues [22] was significant, as it showed that experience in VR (a job interview) with an avatar of different skin colour might be affected by prejudice; the interaction with a black avatar generated negative evaluation and a higher level of implicit bias. A more recent study by Peck et al. [23] obtained results in the opposite direction. Using sophisticated technology involving body transfer into avatars, Peck and colleagues found that when participants embodied an avatar with black skin, they tended to present fewer racial implicit biases than those who embodied an avatar with white skin. Similarly, in a study by Gillath et al. [24], participants seated at a bus stop witnessed an accident involving a blind man's dog. The verbal reactions to the man's request for help showed that VR scenarios can arouse positive behavioral emotions and tendencies towards virtual people in need, similar to scenarios involving needy people in the real world. However, a study done by Eastwick and Gardner [25] showed that the helping relationship in VR follows a certain logic: people tend to help similar helpees. In their experiments, white helpers tended to give less help to black-colored avatars than white ones. More recently, Gamberini et al. [26] analyzed helping behavior in a VR emergency, which generally increased participants' level of anxiety, and showed that time pressure worsens the effect of ingroup favoritism and results in less help given to black victims.

4. The Pilot Study

The majority of the cited studies that involved VR contexts focus on the elicitation of negative emotions of anxiety or concern and pay less attention to helping behaviors within familiar contexts, in which an outgroup member may be in a temporary state of need or may provide help. The research goal of this pilot study is to explore potential differences in calmness, engagement, and alertness in simulated helping situations (both seeking and giving help) in relation to the ethnicity (black or white) of passersby and in relation to the relative autonomy or dependence of the passersby, manipulated by their external social appearance (dressed like a businessman, casually, or like a beggar). By crossing

these two variables, we created a stereotypical condition, called the socially expected situation, and a counter-stereotypical one called the socially unexpected condition. Since we referred to the classical theorization of stereotypes, in the interpersonal judgements, we used simplified schema that generally associates Africans or black people with low status and white people with high status [27]. In our case, the stereotypical conditions include a black passerby dressed like a beggar and a white passerby dressed like a businessman. The opposites are regarded as counter-stereotypical conditions. Another goal was to test empathic responses, considering both personal distress and empathic interest, during the VR intergroup helping session.

4.1. Method

4.1.1. Participant and experimental design

The total number of participants was 40 (19 women and 21 men, mean age 23.76). All were white Italian university students in human sciences programs, mainly from Rome, and they were randomly and equally distributed across the experimental conditions. We initially included participants from other countries and ethnicities, but we deleted them from the present sample. The study consists of a 3×2 between-subjects experimental design, in which we manipulated the following independent variables: the social appearance of the confederate (businessman vs. casual vs. beggar) and the ethnicity of the passerby (white vs. black), which determined their membership in the ingroup or outgroup, respectively. We assumed an effect on the dependent variables—calmness, engagement, and alertness (EEG measures)—during the helping VR session and self-assessed empathy, personal distress, and empathic interest at the end of the VR session.

4.1.2. Procedure and tools

The experimental procedure involved three phases. In the first phase, the participants were subjected to a pre-test in order to explore their previous experiences with VR. In the second phase of the experiments, participants were involved in a VR video session with a total length of seven minutes. The VR experience had a medium level of immersion since participants could, from their point of view, be partially physically present in the context (which was familiar), and they could decide and respond to the actors, but they could not influence the virtual scene (i.e., the user had a low level of agency). For recording, we used a 4K Ricoh Theta V monoscopic camera to obtain 360° video and audio. The 360° videos were watched by wearing a headset (HTC Vive) that could track users' position in space by increasing the level of immersion. After instructions on using the display were provided and the EEG sensors for calmness, engagement, and alertness were positioned, the participants began to see a video that corresponded to one of the six experimental conditions. The video introduced the participant to the virtual environment through a training session, which was appropriately designed to familiarize them with the device and provide him/her with the instructions necessary to interact with actors in the scenes and with the pop-up system used in the scenario. During the training, the participant was shown his "travel" kit, which consisted of a metro pass, two metro tickets and four 50-cent coins, which he could have used during his experience. The participants did not have anything else with them.

The training scene was followed by an environmental scene that served as the real experimental session, with a duration of about five minutes. In this session, a guiding voice accompanied the participant throughout the route. The participant then entered the heart of the experience and was projected at the entrance of a metro station, where he/she met a hurried friend who informed him/her of a party and invited him/her to come, giving him/her the name of the street. In the following scene, called "Google Maps," the participant met a passerby—a potential helper (ingroup vs. outgroup \times businessman/casual/beggar; Figure 1a–c)—who, if asked, could help the participant find his way. Through the pop-up system, participants made a choice to either ask or not ask for help, provided reasons for their choice, and moved on to the next scene. This scene, called "Ticket Office," presented the opposite situation, which was focused mainly on help-giving interactions, and participant encountered

a helpee with the same features, for social appearance and type of group, of the first session. Thus, the two confederates, both male, encountered during the virtual experience, had the same features of the assigned experimental condition, even if two different actors interpret them.

In the second session, the participant became a potential helper for a confederate passerby (ingroup vs. outgroup \times businessman/casual/beggar), who was asking for a change in order to buy a metro ticket. In this case, the participant had more possibilities: provide the helpee with a complete solution (i.e., give the confederate one of the tickets made available to him/her in the kit), provide partial help (i.e., offer to change the confederate's coins), or not provide help. Again, after making a decision in the pop-up system, the participant went on with the scene and arrived at the final scene, the aim of which was to provide a positive message: the helpee in "Ticket Office" helped a passerby who had dropped his wallet. Subsequently, the helpee was found to be a friend of the hurried friend who appeared in the first scene. This mutual connection served as a unifying element that led the participant and helpee to the party together. At the end of the VR experience, the participant was introduced to the third and final phase of the experiment, in which participants completed scales regarding empathy [4] and attitude toward immigrants. Furthermore, in order to check the usability of VR, we employed a user experience scale for VR based on achievement emotions in learning [28]. The post-test phase was followed by a debriefing session.

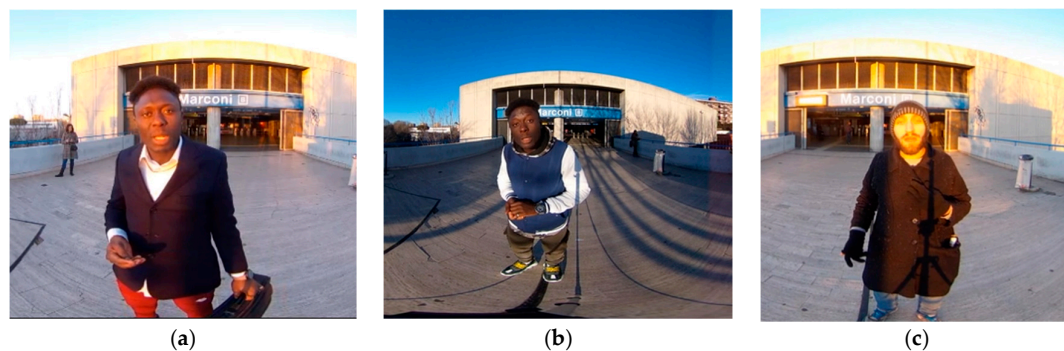


Figure 1. Examples of experimental conditions created by crossing the ethnicity and social appearance of the confederate: (a) black confederate dressed as a businessman; (b) black confederate dressed casually; and (c) white confederate dressed as a beggar.

4.2. Measures. Emotions experienced in VR

A preliminary scale was used to assess the user experience in VR based on achievement emotions. It was composed of a reduced version of Pekrun's [28] achievement emotions with Cronbach's alpha ($\alpha = 0.72$) and contained nine items, like "I enjoyed being in this virtual environment."

4.2.1. EEG measures

EEG data were recorded (sampling rate: 100 Hz) using an Emotiv EPOC[®] helmet (www.emotiv.com). Raw EEG data from 14 locations (AF3, F7, F3, FC5, T7, P7, O1, O2, P8, T8, FC6, F4, F8, and AF4) were stored for each virtual scenario session and each participant and processed off-line using MATLAB 2019a. Using the pipeline applied in former experiments [29], the following processing steps were applied to raw data that corresponded to the entire duration of the scenario session: (1) artefact rejection through an ICA-based procedure [30]; (2) selection of the channels that displayed an SNR, calculated as the ratio of the power in the 3–30 Hz bandwidth and that of the 30–64 Hz bandwidth, which was higher than 3 dB; and (3) band-pass filtering of the data (finite impulse response with 500 samples; frequency range: 3–40 Hz). To estimate power spectral density (PSD), Welch's method was used, with the data segmented into 1-s-long windows and 50% overlap. Then, to compute the EEG indicators for each channel, PSD was segmented into the following EEG bands, and the power contained in each one was calculated: α (8–13 Hz), β (13–30 Hz), β_{low} (13–15 Hz), β_{high} (23–30 Hz),

and θ (4–8 Hz). The values of the indicators described below were then calculated as averages for the selected channels.

1. Calmness Index (TBR)

The calmness index (theta-beta ratio, or TBR) was calculated based on the ratio between the beta band and theta band (see Equation (1)) [31]. A decrease in beta band power (which leads to higher TBR) is associated with a decrease in information processing, which leads to a more relaxed condition. TBR has been shown to be negatively correlated to attention and anxiety [31]. Conversely, it increases when the level of attention decreases, and thus it is defined an objective marker of executive cognitive control [32].

$$TBR = \frac{\theta}{\beta} \quad (1)$$

2. Engagement Index (EI)

The engagement index (EI) was obtained by considering alpha, beta, and theta activities (see Equation (2)). An increase in beta activity is directly related to task engagement, while an increase in alpha and theta activities reflects relaxation, a low level of alertness, and a decrease in information processing [33,34]. An increase in the EI index reflects an increase in the level of engagement [35].

$$EI = \beta / (\alpha + \theta) \quad (2)$$

3. Alertness Index (BBR)

The alertness index (beta-beta ratio, or BBR) was calculated based on the ratio between the upper beta band and the lower beta band (see Equation (3)) [36]. It has been shown that an increase in β_{high} is linked to an increase in alertness and strain [37], while an increase in β_{low} can be linked to an increase in inattention [36,37]. Therefore, an increase in BBR may indicate an increase in alertness and attention levels.

$$BBR = \beta_{\text{high}} / \beta_{\text{low}} \quad (3)$$

4.2.2. Self-Reported Measures: Empathy

The level of empathy felt towards the confederate in a state of need was measured using the Batson scale [4], which is composed of fourteen adjectives that describe emotional states of personal distress (alarmed, embittered, annoyed, uncomfortable, baffled, embarrassed, worried, and upset) and empathic interest (empathetic, sensitive, affable, compassionate, affectionate, and moved). Participants indicated on a seven-point scale (1 = not at all, 7 = very much) the intensity of each emotion.

The data obtained from the Batson empathy scale [4] were subjected to a preliminary analysis to measure their reliability using the Cronbach's alpha index. Factorial analysis confirmed the two-dimensional structure of the scale (the saturation for each item was higher than 0.30). In order to obtain a single general index of empathy, we followed validated methodological suggestions [4], initially calculating the sum of the scores of the personal distress and empathic interest indexes. Subsequently, personal distress scores were subtracted from the empathic interest scores. This score theoretically represents the classical significant measure of empathic response [4].

4.3. Results

The following results are related to combined indexes for the two sessions (Google Maps and Ticket Office), both when participants receive both when they give help to the virtual confederate; only in one case we reported a measure referred in particular to the second session (Ticket office), and it has been reported in the Table 1.

Starting from the participants evaluation of the VR experience, a repeated-measures analysis of variance (ANOVA) of participants' evaluations of their VR experiences (Figure 2), we can definitively report that the participants felt mainly interested, curious, relaxed, and at ease within effect: $F(8) = 56.03$; $p < 0.000$; $\eta^2 = 0.25$. No significant effect of ethnicity within effect: $F(1, 8) = 0.82$; $p = 0.37$ or social

appearance within effect: $F(1, 8) = 1.40$; $p = 0.13$] on the VR experience was reported, showing the global quality of the experience.

Table 1. Correlations between alertness and distress, empathic interest, and empathy.

		Distress	Empathic Interest	Empathy
Total Alertness (BBR)	Pearson Correlation	0.369 *	−0.346 *	−0.457 **
	Sign.	0.041	0.050	0.010
	N	31	31	31
Session 2 Alertness (BBR)	Pearson Correlation	0.392 *	−0.343 *	−0.446 **
	Sign.	0.022	0.050	0.008
	N	34	34	34

* Correlation Significant at level 0.05; ** Correlation Significant at level 0.01.

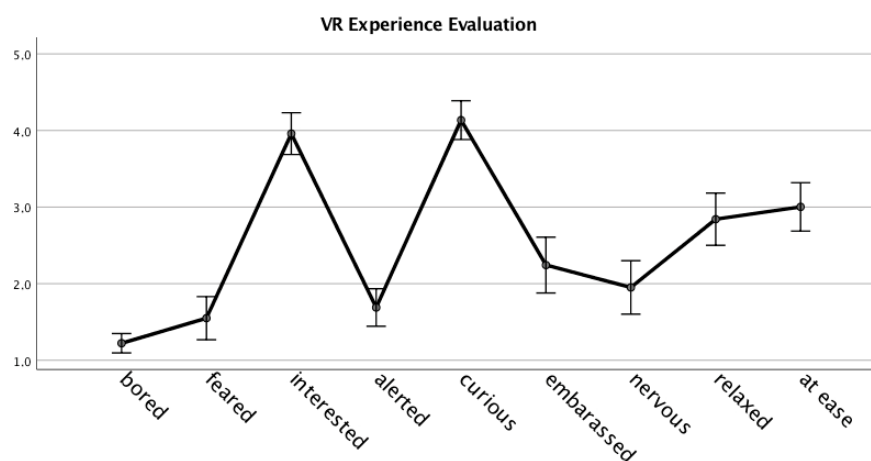


Figure 2. VR experience evaluation. The y-axis represents the mean of each item reported on the x-axis. Bar Errors ± 2 SE.

Without considering the experimental conditions, the results revealed the correlation between EEG measures and the two main components of self-assessed empathy (distress and empathic interest) are correlated (Table 1). The level of alertness recorded during the VR session is positively correlated the self-assessed negative part of empathy, personal distress ($r^2 = 0.369$; $p < 0.041$), and negatively correlated with empathic interest ($r^2 = -0.346$; $p < 0.050$) and empathy ($r^2 = -0.457$; $p < 0.010$). Thus, when participants felt a high level of alertness in general and in the second session in particular (“Ticket Office,” when participants are given the opportunity to offer help to a stranger), they displayed higher levels of distress ($r^2 = 0.392$; $p < 0.022$) and less empathic interest ($r^2 = -0.343$; $p < 0.050$) and empathy ($r^2 = -0.446$; $p < 0.008$). Thus, the level of alertness seems to indicate a sense of distress regarding the person in a state of need rather than the positive part of empathy (i.e., empathic interest). In the case of calmness and engagement, the correlations with empathy are not significant (specifically, for the correlation between *calmness* and respectively distress, empathic interest and empathy: $r^2 = 0.084$; $p = 0.63$; $r^2 = -0.076$; $p = 0.66$; $r^2 = -1.00$; $p = 0.57$; for the correlation between engagement and respectively distress, empathic interest and empathy: $r^2 = 0.029$; $p = 0.87$; $r^2 = 0.036$; $p = 0.84$; $r^2 = 0.14$; $p = 0.89$).

Multivariate ANOVA with the confederate social appearance and group type used as independent variables revealed that alertness (Figure 3a) is higher in counter-stereotypical conditions—those in which a member of the outgroup, who had black ethnicity, was dressed as a businessman and an

ingroup member, who had white ethnicity, was dressed as a beggar. The level of control in the situation, which is associated with a feeling of calmness (Figure 3b), and the optimal level of involvement in the situation [38], which is associated with a feeling of engagement (Figure 3c), were higher in the businessman and casual conditions compared to the beggar conditions (main effect on calmness and engagement: $F [2, 30] = 3.13$; $p < 0.05$; $\eta^2 = .20$; $F [2, 30] = 3.43$; $p < 0.05$; $\eta^2 = 0.21$). This was also true in the stereotypical and socially expected situations, when an ingroup member was dressed as a businessman and an outgroup member was dressed as a beggar (significant interaction effect on calmness and engagement: $F [1, 38] = 3.80$; $p < 0.05$; $\eta^2 = .14$; $F [1, 38] = 3.34$; $p < 0.05$; $\eta^2 = 0.14$); on alertness: $F [1, 38] = 1.90$; $p < 0.08$).

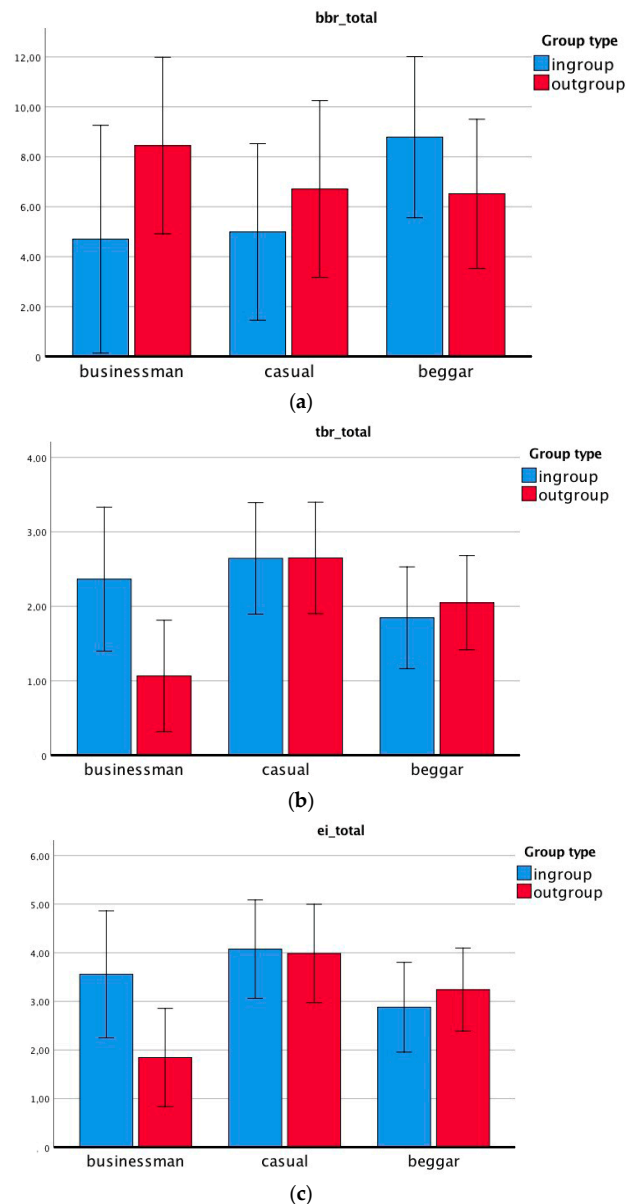


Figure 3. (a) Alertness. The y-axis represents the mean of alertness across the three conditions (confederate social appearance) reported on the x-axis, the color of the bars represents the variable confederate group type. Bar Errors ± 2 SE; (b) Calmness. The y-axis represents the mean of calmness across the three conditions (confederate social appearance) reported on the x-axis, the color of the bars represents the variable confederate group type. Bar Errors ± 2 SE; (c) The y-axis represents the mean of engagement across the three conditions (confederate social appearance) reported on the x-axis, the color of the bars represents the variable confederate group type. Bar Errors ± 2 SE.

Regarding self-assessed empathy, an ANOVA with the two independent variables described above revealed that personal distress increased significantly with the type of helper/helped (main effect on distress: $F [2, 38] = 3.43; p < 0.05; \eta^2 = 0.18$), since it increased in the beggar condition compared to the casual and businessman conditions (Figure 4a). Moreover, distress was higher when participants interacted with an outgroup member (with dark skin) in the businessman condition and an ingroup member (with the same skin color) in beggar condition (i.e., counter-stereotypical conditions). In contrast, the level of empathy is generally higher when participants interact with a businessman, especially if the latter is an ingroup member (main effect on empathy: $F [2, 38] = 3.29; p < 0.05; \eta^2 = 0.10$; Figure 4b).

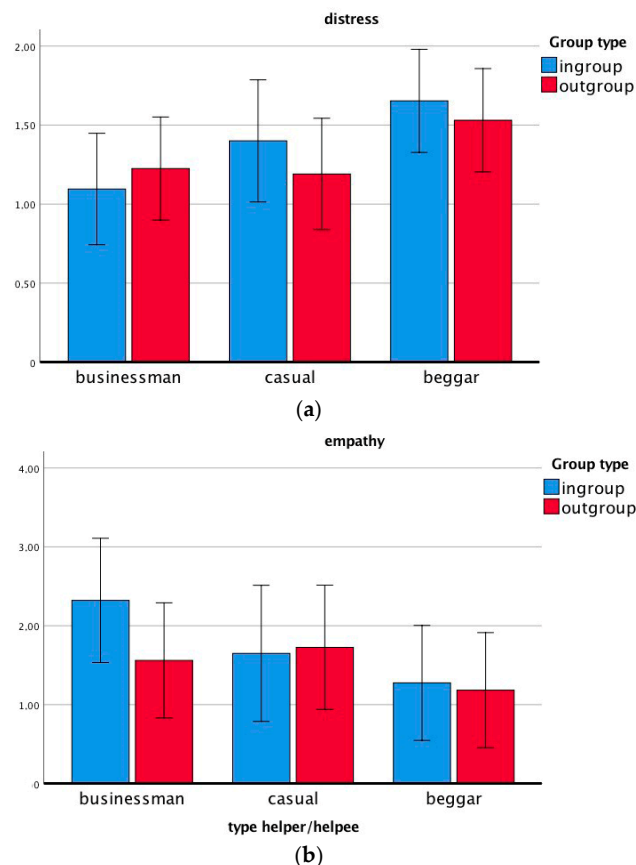


Figure 4. (a) Distress. The y-axis represents the mean of distress across the three conditions (confederate social appearance) reported on the x-axis, the color of the bars represents the variable confederate group type. Bar Errors ± 2 SE; (b) Empathy. The y-axis represents the mean of empathy across the three conditions (confederate social appearance) reported on the x-axis, the color of the bars represents the variable confederate group type. Bar Errors ± 2 SE.

5. Discussion

The present study aimed to test an original procedure in VR in order to better understand emotional arousal during intergroup helping behaviors. Arousal was both directly monitored during participants' exposure to intergroup helping interactions, which occurred in a familiar, non-emergency environment, and it was self-assessed by participants at the end of their VR experience. Since a relevant effect of helping interactions was the reduction of the social distance between the helper and helped, signals of pre-existing social distance were expected to amplify emotional arousal during a helping interaction. In order to test the theoretical assumption that was previously discussed in this paper, participants were asked to interact with two confederates, one in the first scenario who provided help and another one who asked for help. The social distance of the confederate was manipulated by crossing two

independent variables: the confederate's ethnicity and social status. During both the help-giving and help-seeking interactions, participants were confronted by a person of the same or different ethnic group (i.e., white or black), who showed signals of either high status (i.e., was dressed like a businessman) or low status (i.e., was dressed like a beggar), depending on the condition. Interestingly, the physiological monitoring of emotional arousal during actual helping interactions, extracted by an EEG tool, and self-assessment of empathic involvement in personal distress, measured after the end of the VR experience, seemed to converge. Regarding alertness, both the information extracted from EEG data and the responses to the empathy scales suggested that participants reacted with alarm and were evaluated as more personally distressed when intergroup helping interactions—both help-seeking and help-giving—involved either a low-status member of the ingroup (i.e., a white beggar) or a high-status member of the outgroup (i.e., a black businessman). In contrast, socially expected conditions elicited a state of calmness or engagement [38] or, in terms of self-assessed measures, empathic interest.

Two theoretical frameworks can be used to deepen our discussion of these data. On the one hand, several scholars proposed that intergroup contact situations [39] can increase what they called “intergroup anxiety [40],” which makes the social distance between people belonging to different groups more salient. On the other hand, it has been proposed that socially-expected situations produce a higher sense of control, while situations with events that do not follow stereotypical assumptions elicit a state of alarm since people have less possibilities to foresee and manage these surprising occurrences. Based on this, it could be argued that irrespective of their role as the helper or helpee, participants felt alarmed in helping interactions with a low-status ingroup member or a high-status outgroup member, as things occurred in an unexpected and troubling way.

Another reason these data are of interest is the fact that the results for self-assessed distress and empathy followed the same tendency as directly measured physiological reactions. This suggests that using both EEG monitoring and self-assessed measures can significantly contribute to deepening the understanding of emotional processes involved in intergroup helping processes. Moreover, allowing participants to discuss virtual intergroup settings can be a powerful tool for enhancing their self-reflective capacities. This proposed application is strongly supported by the fact that, at the end of their VR experience, all participants positively evaluated the setting as immersive and familiar, which allowed them to behave naturally. These appreciative comments suggest that such a methodology could be used for not only collecting empirical data but also offering participants a precious opportunity to reflect on their daily reactions to intergroup helping dynamics [13,41–43].

It must be stressed that this pilot study was limited. Specifically, the relative paucity of the sample did not allow for generalization of the results. Further research must be performed using the same procedure, but recruiting a larger number of participants and extending the variables to include other familiar [44] and cultural backgrounds. Despite these limitations, however, the results encourage us, and we propose that VR experiences could be a useful methodology for integrating into future studies and may be applied to efforts to deepen the real time emotional processes [45] and to overcome the social exclusion of discrimination.

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

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