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Nuel, I., Fayant, M.-P., Morgado, N., Subra, B., & Alexopoulos, T. (2022). The (Virtual) Reality of Social Approach-Avoidance Behaviours: Operationalisation Development and Construct Validity Testing. *Collabra: Psychology*, *8*(1). https://doi.org/10.1525/collabra.34197

Social Psychology

The (Virtual) Reality of Social Approach-Avoidance Behaviours: Operationalisation Development and Construct Validity Testing

Ivane Nuel[1] [a], Marie-Pierre Fayant[2] [b], Nicolas Morgado[3] [c], Baptiste Subra[4] [d], Theodore Alexopoulos[4] [e]

[1] Université Grenoble Alpes, Université Savoie Mont Blanc, Grenoble, France, [2] Laboratoire de Psychologie Sociale, Université Paris Cité, Boulogne-Billancourt, France, [3] Centre de Recherche sur le Sport et le Mouvement, Université Paris Nanterre, Nanterre, France, [4] Laboratoire de Psychologie, Université de Bordeaux, Bordeaux, France

Keywords: approach-avoidance behaviours, social group evaluations, Virtual Reality, grounded cognition, BAS/FFFS

https://doi.org/10.1525/collabra.34197

Collabra: Psychology

Vol. 8, Issue 1, 2022

Research suggests that interpersonal approach-avoidance behaviours influence group evaluations. However, previous work partly neglected the multi-sensory and contextual cues at stake during interpersonal interactions and may offer a limited picture of the phenomenon. Here, we argue that immersive virtual reality (IVR) represents a useful tool to address this issue. In IVR, we implemented interpersonal approach-avoidance behaviours and tested their construct validity. Based on a careful examination of the literature, we defined two construct validity criteria: the evaluative influence of repeated approach-avoidance behaviours as well as the activation of the corresponding neuropsychological systems. In two experiments (N_{Exp1} = 199, N_{Exp2} = 205), we tested whether, compared to avoidance, approach leads to more positive group evaluations on self-report, reaction time based and behavioural intention measures. Additionally, we investigated whether the IVR operationalisations influence the neuropsychological systems assumed to underlie approach-avoidance behaviours. Overall, the findings are not consistent with the hypotheses and do not conclusively validate our IVR approach-avoidance operationalisation. Although additional research should examine more thoroughly the issues raised by the current work by investigating new ways of implementing approach-avoidance in IVR, the present contribution paves the way for such future developments. Despite these challenges, we encourage a consideration of the full-fledged subtleties of social interactions via adequate tools (IVR) for the study of approach-avoidance.

Introduction

Social interactions frequently involve specific interpersonal nonverbal behaviours which help tailor the distance between interaction partners: approach and avoidance. The literature suggests that during social encounters these behaviours influence social evaluations: Enacting approach leads to more positive evaluations of others as compared to enacting avoidance. However, previous research mainly relied on oversimplified and minimalist settings. In the sense that they neglected the full range of sensorimotor and contextual cues which are usually part of the approach and avoidance movements. In doing so, previous research may have offered a limited picture of the evaluative influence of approach-avoidance. To fill this gap, we advocate the use of immersive virtual reality (IVR) to operationalise interpersonal approach-avoidance behaviours. In the present contribution, we provide a test of the construct validity of such an operationalisation.

The Evaluative Influence of Approach-Avoidance Behaviours: Literature Review

Approach and avoidance are defined as behaviours enacted in order to reduce or increase the distance between the individual and an aspect of the environment. Approach-

a Correspondence concerning this article should be addressed to Ivane Nuel, Université Grenoble Alpes, Université Savoie Mont Blanc, LIP/PC2S, 38000 Grenoble, France. email: ivane.nuel@gmail.com.

b http://www.mpfayant.sitew.com/

c https://licaenanterre.wixsite.com/licae/nicolasmorgado

d https://labpsy.u-bordeaux.fr/Membres/Membres-titulaires-et-associes/Subra-Baptiste

e http://www.alexopoulos.sitew.com/

avoidance enables individuals to efficiently evolve in their environment due to a tight coupling with evaluative processes (Neumann et al., 2003; Strack & Deutsch, 2004). Specifically, positive evaluations of a stimulus in the environment generally predispose individuals to approach it, while negative evaluations predispose them to avoid it (Chen & Bargh, 1999; for reviews see Laham et al., 2015; Phaf et al., 2014). For instance, Chen and Bargh (1999) showed that individuals are faster to pull a lever towards themselves (i.e., approach) in response to positive stimuli and to push a lever away from themselves (i.e., avoidance) in response to negative ones than vice versa.

While research shows that people react to their environment with approach and avoidance responses, it is also theoretically expected that these behaviours influence how individuals evaluate their environment. The general idea is that, due to the encoded relation between approach-avoidance behaviours and evaluations, when approach and avoidance behaviours are enacted, the corresponding evaluation is extended to encountered stimuli (Cacioppo et al., 1993; Eder & Klauer, 2009; Strack & Deutsch, 2004; Van Dessel et al., 2019). In line with this idea, research indicates that approach and avoidance behaviours are not mere responses to positive and negative stimuli, they also actively influence evaluations: Approach leads to more positive evaluations than avoidance (Cacioppo et al., 1993; Priester et al., 1996; but see Centerbar & Clore, 2006).

For example, in the seminal work of Cacioppo and colleagues (1993), individuals evaluated ideographs as more positive when seen during arm flexion (i.e., as when pulling a stimulus closer to the self: approach), than when seen during arm extension (i.e., as when pushing a stimulus away from the self: avoidance). This suggests that approach and avoidance behaviours can serve as rudimentary determinants of evaluations. Extending this reasoning, research investigated how the repetition of approach (vs. avoidance) behaviours in response to stimuli contributes to the formation (Huijding et al., 2011; Hütter & Genschow, 2020; Laham et al., 2014; Van Dessel et al., 2018; Woud et al., 2008, 2013; Zogmaister et al., 2016) and the change of attitudes (Jones et al., 2013; Kawakami et al., 2008). This effect applies to various types of stimuli ranging from animals (Huijding et al., 2011; Jones et al., 2013), consumer goods (Zogmaister et al., 2016) to more abstract stimuli like colours (Hütter & Genschow, 2020), shapes (Laham et al., 2014), pronounceable nonwords (Van Dessel et al., 2018) or abstract domains (mathematics, Kawakami et al., 2008).

These approach and avoidance behaviours also shape social evaluations (Kawakami et al., 2007; Phills et al., 2011; Slepian et al., 2012; Van Dessel et al., 2018, 2020; Woud et al., 2008, 2013). First, some work shows that approach-avoidance behaviours influence individual interpersonal evaluations. For instance, pictures of faces are evaluated as more trustworthy (Slepian et al., 2012) or positive (Woud et al., 2008) when they have been repeatedly pulled towards oneself (i.e., approach) than when they have been pushed away from oneself (i.e., avoidance) using a joystick. A similar effect is obtained when participants move a figure representing the self towards (i.e., approach) and away from (i.e., avoidance) the faces instead of using a joystick (Woud et al., 2013). Second, research documents that approach and avoidance behaviours towards individuals influence evaluations of the groups they belong to (e.g., Blacks; Kawakami et al., 2007; Phills et al., 2011; Turks; Van Dessel et al., 2020). For example, repeatedly pulling a joystick towards the body (i.e., approach) in response to pictures of Turkish people leads to less negative evaluations of this group as a whole than repeatedly pushing a joystick away from the body (i.e., avoidance; Van Dessel et al., 2020). This finding suggests that approach can improve evaluations of existing groups as compared to avoidance. Interestingly, approach-avoidance may also contribute to the formation of attitudes towards unknown or novel social groups. Repeatedly moving a figure representing the self towards the names of fictitious group members (e.g., "Luupites", "Niffites") leads to more positive attitudes towards this group as a whole than moving the figure away from these names (Van Dessel et al., 2018, Experiment 3).

Based on the aforementioned findings, one could conclude that when individuals encounter unknown others, enacting interpersonal approach and avoidance behaviours could differently shape evaluations of these strangers as well as the evaluation of the groups they belong to. However, there is some degree of inconsistency regarding the conclusions about the effect of approach and avoidance on evaluations. First, some studies failed to replicate the effect (Krishna & Eder, 2018). Regarding social evaluation specifically, repeatedly pulling pictures of faces towards oneself (i.e., approach) with a joystick did not influence evaluations of these faces as compared to pushing pictures of faces away (i.e., avoidance, Vandenbosch & De Houwer, 2011). Second, some research questions the necessity to *perform* genuine approach and avoidance *behaviours* in order to obtain an evaluative effect. Although the available evidence points to the existence of an effect of performing these genuine behaviours, it appears to be weak (Van Dessel et al., 2016, 2020). This research suggests that the emergence of the effect of approach and avoidance is heavily conditional on other variables and therefore calls for further examination of their operationalisation (Schwarz & Clore, 2016).

Previous research on the influence of approach-avoidance on social evaluations considers an overly restricted window onto the phenomenon as it presents several shortcomings. Past investigations display high experimental control, but at the expense of mundane realism (i.e., the extent to which an experiment is close to everyday life situations; Aronson & Carlsmith, 1969).

First, the social environment is generally reduced to words or fixed pictures presented on a screen and the behaviours are frequently operationalised through overly elementary and ecologically-stripped motor responses (e.g., basic arm movements; Kawakami et al., 2007; Phills et al., 2011; Slepian et al., 2012; Van Dessel et al., 2020; Vandenbosch & De Houwer, 2011; Woud et al., 2008) or through their mere symbolic representations (e.g., movement of a schematic figure representing the self; Van Dessel et al., 2018; Woud et al., 2013). In doing so, past research overlooked the fact that real social interactions involve parties which are dynamic and afford a broad range of specific whole-body interpersonal approach-avoidance behaviours (Valenti & Gold, 1991). It follows that some operationalisations are not always optimal to investigate approach-avoidance behaviours that occur in the context of social interactions. Most notably, arm movements involved in interactions with graspable objects are not the types of approach-avoidance behaviours that should occur primarily during a social interaction.

Second, managing genuine interactions involves the adjustment of interpersonal distance, and such an adjustment cannot be adequately recreated in minimalist experimental settings. Indeed, in daily life, individuals try to maintain a certain distance between themselves and others (Coello et al., 2012; Iachini et al., 2014). When this distance is not secured, individuals may experience negative reactions in response to others (e.g., flight; Bailenson et al., 2003). Physical interpersonal distance may therefore represent a boundary condition to the evaluative influence of approach-avoidance. If the real-life situations in which the psychological process occurs are not adequately mimicked, the focal link between approach-avoidance and social evaluations may appear as a poor approximation of its real-life counterpart. What's more, it may take a fairly different form as the granularity (i.e., the sensorimotor and contextual richness) of the situation increases.

In other words, previous research did not sufficiently consider the full set of multi-sensory and contextual cues at stake during social interactions (Lewin, 1936). In doing so they seem to neglect the fact that cognition can be conceived as grounded in individual-environment interactions advocating that cognitive activity, including evaluation, is meshed in modality-specific systems, in the body, and in its interactions with the current physical and social environment (Barsalou, 1999, 2008, 2015; Niedenthal et al., 2005; Pecher & Zwaan, 2005; Wilson, 2002). Cognition depends on both past experiences and the ongoing context in order to tailor individuals' interactions with the environment (E. R. Smith & Semin, 2004; Versace et al., 2014). Due to their lack of mundane realism, past approach-avoidance operationalisations appear relatively non-prototypical of interpersonal behaviours. Therefore, it may be more or less difficult to solicit the encoded relation between these behaviours and evaluations, which is supposed to underlie the effect, thereby contributing to variability in the findings. As a consequence, previous work may offer a limited or twisted picture of how approach-avoidance behaviours influence evaluations. Some recent methodological attempts laid down the foundations for proposing improved operationalisations based on more ecological whole-body movements (Krpan & Fasolo, 2019; Nuel et al., 2019; Rougier et al., 2018) or by supplementing them with a contextual framing (Laham et al., 2014). In the present contribution, we further pursue this endeavour. We propose to rely on IVR as a method of choice for addressing the previously neglected criteria of ecologically-bound social interactions and the shortcomings of previous research.

Approach and Avoidance: From Real Situations to Immersive Virtual Reality

As illustrated in Figure 1, IVR allows the digital layout of a virtual environment and the simulation of the users' physical presence according to the tracking of their movements (Fox et al., 2009). Compared to more traditional research paradigms in psychology, IVR allows the investigation of individual-environment interactions that are close to those unfolding in the real world (Pan & Hamilton, 2018), while maximising experimental control (an aspect which is difficult to manage outside the laboratory). First, thanks to real-time sensory feedback in response to their movements participants get a realistic subjective experience of possessing a body and perceiving modality-specific inputs within the virtual environment from a first-person perspective (i.e., self-embodiment; Kilteni et al., 2012; Slater et al., 2010). Second, by affording an environment that perceptually surrounds the user, IVR enables the reproduction of the complexity and richness of social situations, going beyond the mere presentation of social stimuli on a computer screen (e.g., a bus stop; Dotsch & Wigboldus, 2008; Gillath et al., 2008; Nuel et al., 2019). Indeed, in IVR the interaction partner is represented as a dynamic virtual individual affording specific interpersonal behaviours (e.g., whole body behaviours). In this way, IVR enables the match of the behaviours typically afforded in an interpersonal context with the ones that individuals have to perform, and thereby increases the meaningfulness of the situation. Second, and unlike previous paradigms, the immersive nature of the IVR enables us to consider the physical distance between interactants. Finally, by immersing participants in realistic situations with multi-sensory stimulations (including movement, sound, speech, vision, etc.) IVR allows us to better capture the grounded nature of cognition.

In sum, the use of IVR offers promising perspectives for manipulating interpersonal approach-avoidance behaviours. It constrains the influence of undesirable variables (e.g., behavioural ambiguity), while allowing to take into

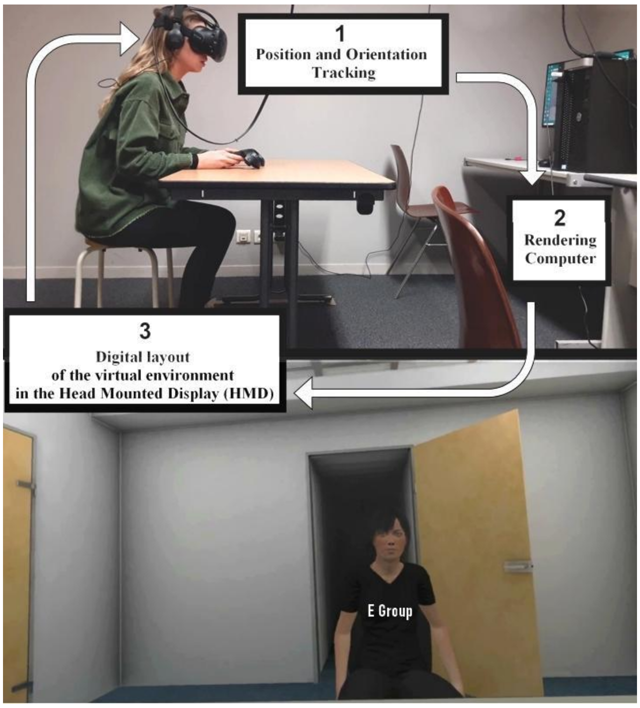

Figure 1. Outline of the implemented immersive virtual reality setting.

account previously neglected variables (e.g., interpersonal distance) and considering the contribution of important features (e.g., sensorimotor and contextual cues). If a host of studies emphasised the benefits of IVR in the study of social interactions (Dotsch & Wigboldus, 2008; Gillath et al., 2008; McCall & Singer, 2015), these studies focused *on measuring* approach and avoidance behaviours and the question of the manipulation of these behaviours has still to be tackled. Developing and testing the construct validity of an IVR approach-avoidance operationalisation is thus a crucial first step to better understand their involvement in the course of social interactions. This is precisely the goal of the present contribution.

In order to assess the construct validity of an approach-avoidance operationalisation, it is necessary to select construct validity criteria, which should represent indicators known to be sensitive to approach-avoidance behaviours. After a careful examination, we identified two such criteria: the evaluative influence of repeated approach-avoidance behaviours and the activation of the corresponding neuropsychological systems. First, as already mentioned, the literature suggests that repeatedly performing approach behaviours towards group members leads to improved group evaluations than performing avoidance behaviours (Kawakami et al., 2007; Van Dessel et al., 2018, 2020). Therefore, we will consider an operationalisation of approach-avoidance as valid, provided its repetition influences evaluation accordingly. Second, approach and avoidance behaviours are supposed to be sustained by distinct neuropsychological systems[1]: The Behavioural Approach System (BAS) governs approach behaviours in responses to appetitive stimuli, while the Fight-Flight-Freeze System (FFFS) governs active avoidance behaviours in response to aversive stimuli (Gray & McNaughton, 2000; McNaughton et al., 2016). Therefore, we will consider an operationalisation of approach-avoidance to be valid provided it activates the BAS and FFFS, respectively.

Granting that IVR is highly promising for the study of social interactions and the operationalisation of approach-avoidance, its implementation is not without challenges (Pan & Hamilton, 2018). First, when recreating naturalistic interactions, the important feature is not the objective realism per se, but rather the maximisation of the subjective experience of this realism. This subjective experience is generally captured by the feeling of presence (i.e., the subjective experience of being in one environment even when one is physically situated in another, Witmer & Singer, 1998). Second, individuals may experience sickness symptoms due to a conflict between the visual and vestibular systems—when users perceive they are moving using their eyes but not their body. In IVR experiments, particular care should thus be taken to ensure that the settings do not provide a poor feeling of presence and/or a high level of sickness that may hinder the IVR experience.

Overview

In the present contribution, we argue that IVR is the optimal tool to manipulate interpersonal approach-avoidance as it enables realistic sensorimotor and contextual settings. As an important initial step, we investigate the construct validity of an approach-avoidance manipulation in IVR. To this aim, we relied on two complementary indicators of construct validity.

First, based on the literature, if approach-avoidance behaviours have been properly operationalised, repeatedly approaching or avoiding newly encountered persons who belong to a group should colour the evaluation of this group. More specifically, we expect a more positive attitude towards members of the approached group than towards members of the avoided group. Second, if our IVR operationalisation holds, performing approach and avoidance behaviours towards or away from the group members should activate the corresponding neuropsychological systems (i.e., BAS and FFFS). We expect higher BAS activation when approaching than avoiding group members and, conversely, higher FFFS activation when avoiding than approaching them.

We tested these predictions in two preregistered (Experiment 1: https://osf.io/426f7, Experiment 2: https://osf.io/nyzke) and well-powered experiments. Participants were seated in a virtual room and had to approach or avoid virtual members of an unknown social group. We relied on fictitious rather than real social groups because individuals may already hold a strong attitude towards existing groups that could constrain the potential influence of approach-avoidance (Priester et al., 1996). By presenting a novel group, we controlled for the potential influence of pre-existing attitudes on group evaluations (for a comparable methodological strategy, see Van Dessel et al., 2016). To fit our ecological objective, we manipulated ordinary interpersonal approach-avoidance behaviours: upper-body forward and backward leaning movements (Galton, 1884; Mehrabian, 1968; Nuel et al., 2019; Word et al., 1974).

We then assessed the selected indicators of construct validity. First, we measured evaluations of the (approached or avoided) group by prompting participants to directly evaluate this group (i.e., via a direct measure) and by inferring these attitudes from participants' responses which are not directly related to group evaluation (i.e., via an indirect measure).[2] Second, we gauged the activation of the neuropsychological systems supposed to underlie approach-avoidance behaviours with the Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ, Corr & Cooper, 2016). Although the RST-PQ is initially intended to capture dispositions that reflect regularities in the operation of BAS and FFFS (Corr & Cooper, 2016; Corr & Krupić, 2017; Corr & McNaughton, 2012), comparable measurement tools of these dispositions (e.g., BIS [Behavioural Inhibition Sys-

1 Although approach and avoidance behaviours are supposed to be governed by specific neuropsychological systems, their actual instantiations are moderated by the constraints imposed by the context and the environment (Corr, 2013).

2 We decided to include both direct and indirect measures as the effect has been obtained on both measures with fictitious groups (Van Dessel et al., 2018), and as we have no a priori theoretical reason to favour one measure over the other.

tem]/BAS scales, Carver & White, 1994) show sensitivity to contextual influences (Haeffel, 2011; P. K. Smith & Bargh, 2008). We therefore decided to rely on such measures to capture contextual activation of these systems. We chose the RST-PQ over other scales as the RST-PQ affords the important distinction between the FFFS, governing active avoidance, and the BIS, governing passive avoidance (Gray & McNaughton, 2000).

Finally, the use of IVR prompted us to measure the feeling of presence and sickness symptoms to gauge participants' IVR experience. All data were collected and analysed anonymously in accordance with the Declaration of Helsinki ethical principles. In both experiments, we planned to run a minimum of 200 participants. Such a criterion enabled us to detect a minimum effect size (η_p^2) of .038 with a power of 80%. The 90% confidence intervals reported hereafter are based on the partial eta-squared (η_p^2).

Experiment 1

In Experiment 1, we tested the construct validity of an IVR operationalisation of approach and avoidance behaviours (forward and backward leaning; Figure 1) in the context of a social interaction. To this aim, we investigated the influence of this operationalisation on attitudes towards a novel group as well as the activation of neuropsychological systems. In order to secure mundane realism, we introduced the fictitious group as a recently discovered one, characterised by a new blood type (the "E-group"). We measured group evaluations with a direct measure of the general impression vis-à-vis the group (i.e., a Feeling Thermometer), as well as with an indirect measure (i.e., a Single-Category Recoding-Free Implicit Association Test; SC-RF-IAT; Haynes et al., 2016; Karpinski & Steinman, 2006; Rothermund et al., 2009). As in previous research, we predicted that repeatedly enacting approach behaviours towards unknown group members should yield more positive attitudes towards the group than enacting avoidance behaviours. We measured approach-avoidance neuropsychological systems activation with the RST-PQ (Corr & Cooper, 2016) and expected higher BAS (FFFS) scores when performing approach (avoidance) than avoidance (approach) behaviours.

Method

Participants

In total, 226 participants took part in the study in exchange for course credit or 15€. They were randomly assigned either to the approach or the avoidance condition. As preregistered, we excluded participants who guessed our hypothesis (i.e., mentioning the link between the performed behaviour and evaluations, n = 14), did not follow the instructions (n = 10), or reported severe sickness symptoms due to the IVR (n = 1), substance intake (n = 2), or dyspraxia (n = 1). Our final sample included 199 participants (M_{Age} = 21.62, SD_{Age} = 5.59, $n_{Approach}$ = 101, $n_{Avoidance}$ = 98).

Material

Six positive ($M_{Valence}$ = 6.07, $SD_{Valence}$ = 0.12; $M_{Arousal}$ = 4.59, $SD_{Arousal}$= 0.17) and six negative ($M_{Valence}$ = 2.02, $SD_{Valence}$ = 0.66; $M_{Arousal}$ = 4.45, $SD_{Arousal}$= 0.35) pictures taken from the Open Affective Standardized Image Set (OASIS; Kurdi et al., 2017) served as valenced stimuli in the SC-RF-IAT. The stimuli were controlled for arousal (see the OSF project for the analyses). Six pictures of virtual individuals specifically created for this purpose and thus not encountered in the main IVR task served as E-group stimuli in the subsequent SC-RF-IAT. To unambiguously identify this group, we added an "E-group" tag on these pictures.

Procedure

Virtual Reality Task. Upon their arrival, participants were informed that researchers recently discovered a new and rare blood type (i.e., the E blood type, which was actually a fictitious group invented for the purpose of the experiment). We told them that, because people have no a priori knowledge of this group, the aim of this research is to study how first impressions are formed. Thus, virtual individuals were presented as the avatars of their real counterparts with E blood type. On the basis of this information, participants signed a consent form.

After that, participants saw a short video presenting the general procedure of the task and the two upper-body inclinations (forward and backward, see Figure 1). Then, they were immersed into a virtual room and received all instructions through headphones connected to the headset (HTC Vive © connected to a Dell Desktop PC equipped with a Double Processor Intel Xeon E5-2609 V4, 1.7GHz, 1866 Mhz, and a NVIDIA GeForce GTX 1080, 8Gb, graphic card). In order to correctly perform the required behaviours, participants were first trained. During this training phase, participants performed both approach and avoidance behaviours. The contiguous presentation of both behaviours in the training phase was implemented in order to ease their construal as approach and avoidance. To do so, they were seated at a table and virtual individuals proceeded to occupy a chair on the opposite side. In two training trials, participants had to utter "hi" while leaning their upper-body 10 degrees forward (approach condition) and in the other two trials they had to utter "hi" while leaning their upper-body 10 degrees backward (avoidance condition) with the aid of a monitoring status bar. A sound signal informed participants that they performed the correct action, otherwise they received verbal auditory feedback to adjust their action. Virtual individuals maintained an upright position until participants performed the correct action. After a correctly performed action (1000 ms), virtual individuals replied "hi" and left. Then, participants returned to the central position and waited for the next virtual individual to repeat the action sequence. In the fifth training trial, participants had to lean their upper-body according to the condition they had been assigned to and were instructed to exclusively perform this action thereafter. Finally, in the sixth training trial, participants performed the behaviour without the aid of the monitoring status bar. After completing these training trials with the same virtual individual, participants randomly encountered 16 different virtual individuals (8 men and 8 women).[3] In order to increase the evaluative connotation of approach-avoidance behaviours we activated an evaluative mindset (Cacioppo et al., 1993): For each encounter, participants had to consider in their mind their impression of the target individual. Each virtual individual wore a T-shirt with an "E-group" logo on it in order to effectively identify her/him as a member of the E-group. A video of an approach condition trial and an avoidance condition trial in the virtual environment is available in the OSF project.

SC-RF-IAT. After the IVR task, participannts were seated in front of a computer screen to perform the SC-RF-IAT. In the SC-RF-IAT, participants had to categorise stimuli presented on screen (i.e., valenced pictures as well as pictures of virtual individuals) according to their category (i.e., positive, negative, E-group) with the help of two response keys, each randomly assigned to either one vs. two of the three categories. These involved either the E-group and positive categories assigned to the same key vs. the negative category to the opposite key or the E-group and negative categories assigned to the same key vs. the positive category to the opposite key (Figure 2). We recorded the response times (RTs) to categorise stimuli depending on trial type (i.e., E-group + positive vs. negative; positive vs. E-group + negative). Participants performed 144 experimental trials (72 per trial type). In this task, faster responses when the E-group and positive categories share the same response key as compared to when the E-group and negative categories share the same response key index a positive attitude towards the E-group. For the interested reader, a detailed description of the SC-RF-IAT is available in the OSF project.

Feeling Thermometer. Next, participants had to indicate their impression towards the E-group on a 101-point Feeling Thermometer (from -50: *very negative* to +50: *very positive*). To increase the credibility of the E-group cover story, we asked participants to indicate their blood type (including E as a possible option).[4]

Approach and Avoidance Neuropsychological Systems. Then, participants completed the French version of the RST-PQ (obtained from L.-C. Vannier, personal communication, December 4th, 2017; Corr & Cooper, 2016). Based on the revised reinforcement sensitivity theory (Corr & McNaughton, 2012), this questionnaire enabled us to measure the BAS (related to approach behaviours and appetitive stimuli; 29 items [e.g., "I am very open to new experiences in life"]) and the FFFS (related to active avoidance behaviours and aversive stimuli; 10 items [e.g., "There are some things that I simply cannot go near"]) anchored at 1: *not at all* and 4: *a lot*.

Supplementary Measures. Next, to ensure that participants perceived the virtual situation as realistic, we measured the feeling of presence (i.e., the feeling of being there) with the Multimodal Presence Scale by Makransky et al. (2017) anchored at 1: *strongly disagree* and 5: *strongly agree*.[5] Participants also indicated if they experienced any vision problems, disorientations, and/or nausea due to the IVR (1: *not at all*; 2: *slightly*, 3: *a lot*, 4: *severely*). Then, they reported any chronic condition or substance intake which could have impaired their performance, indicated their age, their gender identification and their ability in French language (i.e., "Are you fluent in French?"). Finally, participants were probed for suspicion, debriefed and compensated for their participation.

Results

In the following analyses we tested our predictions on five outcomes. Accordingly, we applied a Bonferroni correction to the alpha level and we divided the alpha by the number of measurements considered (i.e., adjusted alpha level: .01).

Preregistered Analyses

Concerning the SC-RF-IAT, we computed an evaluation score using the improved *D*-algorithm (D_4, Greenwald et al., 2003) such that a higher *D* score implied more positive evaluations of the E-group. We submitted the IAT score [Split-Half reliability $r(197) = 0.26$, $p < .001$][6], the feeling about the E-group, the BAS score (Cronbach's α = .83, 95% CI [.80, .87]), and the FFFS score (Cronbach's α = .76, 95% CI [.71, .81]) of the RST-PQ to separate simple regression analyses of variance with behaviour (approach, avoidance) as a between-participants variable. These analyses failed to reveal the expected effects: Participants in the approach condition did not evaluate the E-group any more positively nor did they report higher BAS (approach system) score or lower FFFS (avoidance system) score than those in the avoidance condition (Table 1).

Exploratory Analyses

Descriptive statistics of the IRV experience. In the literature, no standardised benchmarks exist for these indicators. Nevertheless, overall participants did not seem to report an excessively low level of felt presence (*M* = 3.14, *SD* = 0.71; midpoint of the scale = 3) nor an excessively high level of sickness due to VR (*M* = 1.17, *SD* = 0.37; the scale ranges from 1 to 4).

Subcomponents of the BAS. The neuropsychological system guiding approach behaviours (BAS) is composed of

3 All virtual individuals were white, of comparable body mass index and age but varied in terms of facial characteristics, hair and eye colour (see the OSF project for virtual individuals screenshots).

4 Three participants indicated group E as their blood type. Excluding these participants from the analyses does not change any of the reported results.

5 We did not include the feeling of presence in the following analyses as we included it in the preregistration merely for exploratory purposes. Including the feeling of presence in the analyses did not change the effects across the two experiments (see the OSF project for the analyses).

6 One could note the apparent low reliability of this version of the IAT. However, the literature is silent with respect to SC-RF-IAT reliability information. In the absence of any point of comparison, it is difficult to interpret the obtained reliability index.

Table 1. Preregistered analyses in Experiment 1.

	Avoidance n = 98		Approach n = 101		Comparison
	M	SD	M	SD	
SC-RF-IAT-D4	0.08	0.24	0.10	0.24	$F(1,197) = 0.48, p = .49, \eta_p^2 = .002$, 90% CI [.00, .03]
Feeling-Thermometer [a b]	5.03	16.53	4.99	14.42	$F(1,195) = 0.00, p = .99, \eta_p^2 = .000$, 90% CI [.00, .00]
BAS [c]	2.85	0.37	2.92	0.38	$F(1,197) = 1.59, p = .21, \eta_p^2 = .008$, 90% CI [.00, .04]
FFFS [c]	2.19	0.62	2.22	0.59	$F(1,197) = 0.14, p = .71, \eta_p^2 = .001$, 90% CI [.00, .03]

Note. SC-RF-IAT = Single Category Recoding Free Implicit Association Test, BAS = Behavioural Approach System, FFFS = Fight-Flight-Freeze System.
[a] Two supplementary participants in the approach condition were excluded from the Feeling-Thermometer due to missing data.
[b] Feeling Thermometer scores could vary from - 50 to + 50.
[c] BAS and FFFS scores could vary from 1 to 4.

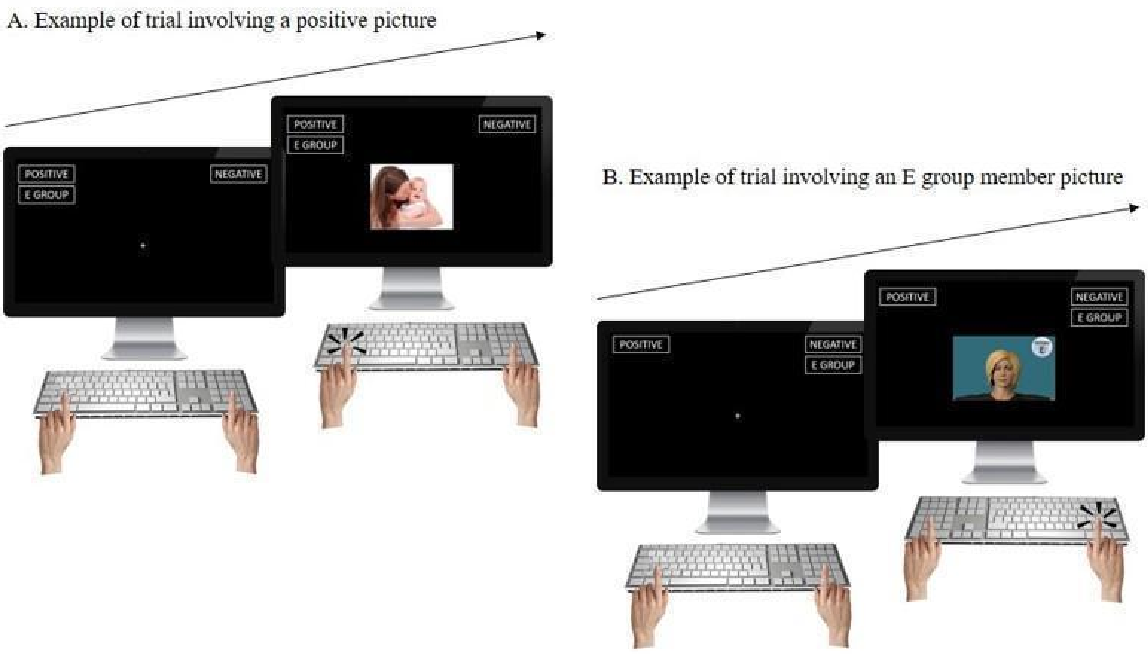

Figure 2. Illustration of trials in the Single-Category Recoding-Free Implicit Association Test.

When a valenced picture (e.g., positive) was presented at the centre of the screen (A), participants had to press the key corresponding to the valence category (e.g., the left key). When an E-group picture was presented at the centre of the screen (B), participants had to press the key corresponding to the E-group category (e.g., the right key). For each trial, the E-group response key was randomly combined either with the positive or with the negative response key.

multiple processes (Carver & White, 1994; Corr & Cooper, 2016). In order to reach a desired end-state, a series of sub-processes may be engaged. For instance, at the early stage of approach, behaviour is driven by reward interest, goal planning, and drive persistence. However, as individuals reach (or get closer to) the desired end state, behaviour is characterised by reward reactivity, and impulsivity.

Considering the multidimensionality of the BAS, we also planned to investigate the BAS sub-dimensions for exploratory purposes. We submitted the score of the six BAS components of the RST-PQ to a simple regression analysis of variance with behaviour (approach, avoidance) as a between-participants variable. From this analysis, we obtained results on the Goal-Drive Persistence (GDP) component–the motivation to set and maintain goals/sub-goals in order to achieve the desired end state (e.g., "I am very persistent in achieving my goals", Cronbach's α = .84, 95% CI [.80, .87], n_{item} = 9, Supplementary Material of Corr & Cooper, 2016). Interestingly, the analysis revealed that participants in the approach condition scored higher on the GDP ($M_{Approach}$ = 3.23, $SD_{Approach}$ = 0.45) than in the avoidance condition ($M_{Avoidance}$ = 2.99, $SD_{Avoidance}$ = 0.59), $F(1, 197) = 10.56$, $p = .001$, $\eta_p^2 = .05$, 90% CI [.01, .11] (see the OSF project for the analyses of the other components).

Discussion

In Experiment 1, we capitalised on IVR to ecologically operationalise approach-avoidance behaviours (upper-body forward and backward leaning) and assessed the construct validity of this operationalisation. As construct validity criteria we considered the effect of approach-avoidance on evaluations vis-à-vis a novel group as well as neuropsychological systems activation. However, based on the selected criteria, the presented IVR operationnalisation of approach-avoidance did not pass the litmus test. Indeed, contrary to what was predicted, participants did not evaluate the novel group any more positively, nor did they score differently on BAS and FFFS scores, in the approach than in the avoidance condition. Complementary analyses revealed that approach-avoidance behaviours significantly accounted for 5% of the variance in the GDP score (a subscale of the BAS): Participants who approached members of the E blood type scored higher on the GDP score than those who avoided them. This might suggest that participants in the approach condition reported higher motivation to persist in reaching their desired end-state. Although not predicted, this result is encouraging. Indeed, approach-avoidance behaviours are enacted in the first and anticipatory stage of motivation (Berridge, 1996), which is captured by the GDP dimension (Beaver et al., 2006; Corr & Cooper, 2016). At this point, the question of why approach-avoidance influenced only the GDP but not direct group evaluations lingers. First, it is possible that approach-avoidance behaviours simply do not influence group evaluations. Second, our evaluative measures may have been less sensitive than the GDP sub-scale to capture the influence of ecological interpersonal approach-avoidance behaviours (due to low reliability or the use of broad or unspecific evaluative dimensions). Finally, the E-blood type label could have mitigated the possible influence of approach and avoidance behaviours as blood types are generally not associated with personality inferences, and even if they do, these inferences may have led to essentialist appraisals due to their biological substrate (Dar-Nimrod & Heine, 2011).

Experiment 2

In Experiment 2, we aimed to address the limits of Experiment 1 to pursue our construct validity testing of the IVR operationalisation of approach-avoidance. Again, a proper operationalisation of approach-avoidance behaviours should translate into: 1) more positive attitudes towards the group, when repeatedly enacting approach towards unknown group members than when enacting avoidance, and 2) an activation of the corresponding approach-avoidance systems. We applied the following methodological adjustments to the procedure of Experiment 1. First, we relied on two newly discovered (fictitious) groups characterised by specific aesthetic and consumer preferences (for a similar social categorisation criterion, see Tajfel et al., 1971). Second, as people spontaneously infer traits about others (Crawford et al., 2002; Hehman et al., 2019), we measured group evaluations using a trait rating task. Third, we decided to replace the SC-RF-IAT by the Visual Approach-Avoidance by the Self Task (VAAST; Rougier et al., 2018, 2019). The VAAST measures group attitudes as interpersonal predispositions to approach or avoid a target social group (Rougier et al., 2019). Finally, we measured the willingness of participants to engage in a real interaction with a member of the encountered group. These measures of interpersonal behaviours and impression formation are more relevant and closer to a genuine social interaction context. In this way, we expected more positive evaluations in the approach than in the avoidance condition. These positive evaluations should translate into more positive trait ratings, increased approach (vs. avoidance) tendencies towards the group, as well as a greater willingness to interact with a member of this group.

Method

Participants

In total, 222 participants took part in the study in exchange for partial course credit or 15€. They were randomly assigned either to the approach or the avoidance condition. As preregistered, we excluded participants who guessed our hypothesis (i.e., mentioning the link between the performed behaviour and evaluations, $n = 9$), did not follow the instructions ($n = 2$), who reported psychomotor impairment ($n = 2$) and/or substance intake ($n = 1$). We also excluded participants who reported being non-fluent in French ($n = 1$). Our final sample included 205 participants ($M_{Age} = 20.62$, $SD_{Age} = 4.47$, $n_{Approach} = 107$, $n_{Avoidance} = 98$).

Procedure

Virtual Reality Task. Upon their arrival, participants were informed that they were taking part in a study about two newly discovered groups characterised by shared taste and preferences due to an exposition to similar learning and socialisation contexts: the "Alesophiles" and the "Udesophiles" (Tajfel et al., 1971; Van Dessel et al., 2016). We told them that, for anonymity purposes, they would encounter virtual representations instead of real Alesophile or Udesophile persons. On the basis of this information, participants signed a consent form.

The procedure for the IVR task was the same as in Experiment 1. In order to control for a potential group effect, half of the participants encountered the Alesophiles and the other half encountered the Udesophiles. Virtual individuals wore a T-shirt with an "ADESO" or "UDESO" logo depending on the encountered group.

Action Tendencies. After the IVR task, participants were seated at a computer and performed the VAAST (Rougier et al., 2018). In a virtual street background, they had to categorise virtual individuals presented on the screen as Alesophiles or Udesophiles (based on their T-shirt logo). More specifically, participants had to approach or avoid the individuals based on their group membership with the help of two response keys (Figure 3). In one block, participants had to approach the group encountered in IVR and avoid the other one, while in the other block they had to avoid the encountered group and approach the other one. We recorded response times (RTs) to categorise stimuli depending on the block. In this task, faster responses in the block in which the encountered group is approached (and

Figure 3. Illustration of an approach trial in the Visual Approach-Avoidance by the Self Task.

the other group is avoided) indexes a more positive attitude towards the encountered group as compared to the other one. For the interested reader, a detailed description of the VAAST is available in the OSF project.

Traits-Rating Task. Then, using a pencil and paper questionnaire, participants evaluated the group encountered in the IVR setting (i.e., "According to you, to what extent the Alesophiles/Udesophiles are …") on six positive (i.e., warm, intelligent, honest, competent, cultivated, sociable) and six negative (i.e., lazy, snob, unpleasant, stupid, shallow, boring) traits using a 10-points response scale ranging from 1: *not at all* to 10: *extremely* (see the OSF project for the material).

Willingness to Interact. As an index of the attitude towards the encountered group, we also asked participants if they would accept to discuss via email with a random group member (using a dichotomous item yes/no). We predicted that participants in the approach condition would display a higher propensity to accept the discussion opportunity than those in the avoidance condition.

Approach and Avoidance Neuropsychological Systems. Next, participants completed the French version of the RST-PQ (Corr & Cooper, 2016) described in Experiment 1.

Supplementary Measures. Finally, participants completed the same supplementary measures as in Experiment 1, were probed for suspicion, debriefed and compensated for their participation.

Results

In the following analyses we tested our predictions on eight outcomes. Accordingly, we applied a Bonferroni correction to the alpha level and we divided the alpha by the number of measurements considered (i.e., adjusted alpha level: .006). Preregistered results of Experiment 2 were presented in Table 2.

Table 2. Preregistered analyses in Experiment 2.

	Avoidance n = 98				Approach n = 107				Comparison
	M		*SD*		*M*		*SD*		
Traits-ratings	5.7		1.08		5.98		1.14		$F(1,203) = 3.13, p = .08, \eta^2_p = .02$, 90% CI [.00, .05]
BAS[a]	2.9		0.39		2.89		0.34		$F(1,202) = 0.13, p = .72, \eta^2_p = .00$, 90% CI [.00, .02]
FFFSa	2.22		0.57		2.21		0.56		$F(1,202) = 0.01, p = .93, \eta^2_p = .00$, 90% CI [.00, .00]
Willingness to interact	81.63%				75.70%				$\chi^2(1) = 1.06, p = .30$, OR = 0.70, 95% CI [0.35, 1.37]
VAAAST[b]	$RTto_{avoid}$		$RTto_{approach}$		$RTto_{avoid}$		$RTto_{approach}$		
	M	*SE*	*M*	*SE*	*M*	*SE*	*M*	*SE*	
	853.10	6.29	844.61	6.07	864.2	5.42	862.4	8.03	$b = 6.65, SE = 3.38, t = 1.83, \chi^2(1) = 2.33, p = .127$

Note. VAAST = Visual Approach-Avoidance by the Self Task, BAS = Behavioural Approach System, FFFS = Fight-Flight-Freeze System.

[a] Traits-ratings scores could vary from 1 to 10.

[b] BAS and FFFS scores could vary from 1 to 4.

[c] One participant (in the approach condition) was excluded because of reporting having confounded the anchors in the RST-PQ completion.

[d] Two supplementary participants were excluded from the analyses due to missing data on one block and two others for having more than 30% of errors in the task ($n_{Approach} = 105$, $n_{Avoidance} = 96$).

Preregistered Analyses

Action Tendencies. Following Nuel and colleagues (2019), we examined RTs for experimental trials only, removed incorrect trials (2.91%) and suppressed RTs below 200 ms as well as above 2000 ms (0.95%). Due to technical issues, two participants performed only one block of the VAAST and were thus excluded from the analysis. As preregistered, we also excluded two participants with more than 30% of errors. Analyses were performed on the remaining 201 participants ($n_{Approach}$ = 105, $n_{Avoidance}$ = 96). The Split-Half reliability of the VAAST is high, $r(199)$ = .88, p < .001. We submitted RTs to a General Linear Mixed Model analysis with an Inverse Gaussian distribution and an identity link function (that better fit the highly positively skewed distribution of RTs [skewness index: 1.58]; Lo & Andrews, 2015) in which block type (block in which participants approached the encountered group, block in which participants avoided the encountered group) and IVR behaviour (approach, avoidance) were fixed independent variables and participants as well as stimuli were random variables. For this analysis, we reported the means and standard errors estimated by the model.

We observed a non-statistically significant main effect of the IVR behaviour on RT: Participants who enacted avoidance vis-à-vis the encountered virtual individuals in IVR were descriptively faster to respond ($M_{Avoidance}$ = 848.85, $SE_{Avoidance}$ = 5.71) than those who enacted approach ($M_{Approach}$ = 863.30, $SE_{Approach}$ = 6.38), b = 14.45, SE = 6.14, t = 1.51, $\chi^2(1)$ = 0.34, p = .56.[7] Participants were also faster to approach members of the encountered group ($M_{App.encountered}$ = 853.49, $SE_{App.encountered}$ = 7.01) than to avoid them ($M_{Av.encountered}$ = 858.66, $SE_{Av.encountered}$ = 5.55). This difference was not statistically significant, b = -5.17, SE = 2.06, t = -2.39, $\chi^2(1)$ = 5.64, p = .018.

The expected interaction between block type and behaviour was not statistically significant, b = 6.65, SE = 3.38, t = 1.83, $\chi^2(1)$ = 2.33, p = .127. Contrary to what was expected, the interaction pattern revealed that the approach bias towards the encountered group (i.e., the difference between RT to approach and RT to avoid the group) was larger by 6.65 ms for participants who enacted avoidance vis-à-vis the encountered group members in the IVR (Approach bias $_{Avoidance}$ = -8.49, $SE_{Avoidance}$ = 2.86) than for those who enacted approach (Approach bias $_{Approach}$ = -1.85, $SE_{Approach}$ = 2.76).

Trait Ratings. We computed an evaluation score by averaging the six reversed negative traits with the six positive ones in the traits-rating task. This score could vary between 1 and 10, with higher scores indicating a more positive evaluation of the encountered group, Cronbach's α = .78, 95% CI [.73, .82]. The evaluation score was submitted to a simple regression analysis of variance with behaviour as a between-participants variable. Overall, comparatively to the midpoint value of 5.5, participants evaluated the encountered group positively (M = 5.85, SD = 1.12), $F(1, 203)$ = 5632.01, p < .001, PRE = .97, 90% CI [.96, .97]. Although the effect was not significant, participants in the approach condition evaluated the target group more positively ($M_{Approach}$= 5.98, $SD_{Approach}$ = 1.14) than those in the avoidance condition ($M_{Avoidance}$ = 5.70, $SD_{Avoidance}$ = 1.08), $F(1, 203)$ = 3.13, p = .08, η_p^2 = .02, 90% CI [.00, .05].

Willingness to Interact. Answers to the willingness to interact item (answer "no" = 0, answer "yes" = 1) were submitted to a logistic regression analysis with the behaviour as a between-participants variable. In total, 78.54% of participants were willing to interact with a member of the encountered group. This willingness was smaller for the participants in the approach condition (75.70%) than for those in the avoidance condition (81.63%). This effect was not statistically significant $\chi^2(1)$ = 1.06, p = .30, OR = 0.70, 95% CI [0.35, 1.37].

Approach and Avoidance Neuropsychological Systems. Concerning the RST-PQ, the simple regression analysis did not reveal any statistically significant effect of the approach-avoidance manipulation on the BAS score (Cronbach's α = .81, 95% CI [.77, .85]; $M_{Approach}$ = 2.89, $SD_{Approach}$ = 0.34 and $M_{Avoidance}$ = 2.90, $SD_{Avoidance}$ = 0.39), $F(1, 202)$ = 0.13, p = .72, η_p^2 = .00, 90% CI [.00, .02], nor on the FFFS score (Cronbach's α = .71, 95% CI [.65, .77]; $M_{Approach}$ = 2.21, $SD_{Approach}$ = 0.56 and $M_{Avoidance}$ = 2.22, $SD_{Avoidance}$ = 0.57), $F(1, 202)$ = 0.01, p = .93, η_p^2 = .00, 90% CI [.00, .00].[8] Also, we did not replicate the Experiment 1 results on the GDP score (Cronbach's α = .84, 95% CI [.81, .87]; $M_{Approach}$ = 3.13, $SD_{Approach}$ = 0.53 and $M_{Avoidance}$ = 3.24 $SD_{Avoidance}$ = 0.54, $F(1, 202)$ = 2.04, p = .16, η_p^2 = .01, 90% CI [.00, .04]).

Exploratory Analyses

Descriptive statistics of the IRV experience. As in Experiment 1, we gauged the participants' IVR experience through the levels of presence and sickness. Overall, and as in Experiment 1, participants did not seem to report an excessively low level of presence (M = 3.05, SD = 0.72; midpoint of the scale = 3) nor an excessively high level of sickness due to VR (M = 1.14, SD = 0.38; the scale ranges from 1 to 4).

Traits-rating task dimensions. The traits-rating task was supposed to distinguish evaluations in terms of positivity and negativity. Before testing the influence of approach-avoidance on the traits ratings, we checked the dimensionality of the scale. An exploratory factor analysis on trait ratings with an oblimin rotation did not reveal the expected two factors: positivity and negativity. Instead, the analysis suggested three factors: One grouped items related to competence (e.g., stupid, competent), one grouped items

7 Due to the way variance is partitioned in linear mixed models (e.g., Rights & Sterba, 2019), there is no consensus on the calculation of standard effect sizes. Wherever possible, we report unstandardized effect sizes in line with general recommendations of reporting effect sizes (e.g., Pek & Flora, 2018).

8 One participant (in the approach condition) was excluded because of reporting having confounded the anchors in the RST-PQ completion.

related to warmth (e.g., unpleasant, sociable) and another one grouped all negative items (see the OSF project for detailed analyses). This warmth-competence distinction is theoretically sound as it is the most relevant dimension in social perception (Fiske et al., 2018).

For exploratory purposes, we computed a warmth (Cronbach's α = .78, 95% CI [.72, .83]) and a competence (Cronbach's α = .77, 95% CI [.73, .82]) score for each participant (after reverse coding the six negative items) and submitted these scores to the same analysis of variance with behaviour as a between-participants variable. Although non-significant, results revealed that participants evaluated the encountered group as warmer in the approach ($M_{Approach}$ = 5.33, $SD_{Approach}$ = 1.90) than in the avoidance condition ($M_{Avoidance}$ = 4.81 $SD_{Avoidance}$ = 1.73), $F(1, 203) = 4.18$, p = .04, η_p^2 = .02, 90% CI [.00, .06] and more competent in the approach condition ($M_{Approach}$ = 5.85, $SD_{Approach}$ = 1.23) than in the avoidance condition ($M_{Avoidance}$ = 5.60 $SD_{Avoidance}$ = 1.27), $F(1, 203) = 2.20$, p = .14, η_p^2 = .01, 90% CI [.00, .05].

Discussion

In Experiment 2, we tested the construct validity of IVR approach (leaning forward) and avoidance (leaning backward) behaviours via their influence on the evaluation of a newly discovered (fictitious) social group and the activation of corresponding neuropsychological systems. Again, the satisfactory level of presence and sickness suggested that our IVR settings were able to recreate a realistic experience of social interaction for participants. However, with respect to our benchmark criteria, the developed IVR paradigm does not represent a valid operationalisation of interpersonal approach-avoidance behaviours: it did not influence group evaluations, nor the activation of the relevant neuropsychological systems.

Also, the present (non-)findings are somewhat mitigated when considering action tendencies towards the encountered group. Indeed, participants who enacted approach towards the group in IVR were then descriptively faster to initiate avoidance (vs. approach) towards members of the target group than those who avoided the group in the IVR. A tentative explanation might come from the fact that measurements are not process-pure (Jacoby, 1991; Sherman, 2009). Indeed, although approach-avoidance tendencies are sensitive to group attitudes (for the use of the VAAST to measure group attitudes see Rougier et al., 2019) they are also sensitive to variables unrelated to attitudes (e.g., goals, Bossuyt et al., 2014; power, P. K. Smith & Bargh, 2008). If individuals are usually faster to approach positive entities (e.g., positively evaluated groups) and avoid negative entities (e.g., negatively evaluated groups), this does not necessarily imply that approach is unequivocally linked to positive attitudes and avoidance to negative attitudes (Harmon-Jones et al., 2013). Research shows that even when evaluated positively, a target can trigger avoidance (Heuer et al., 2007) and anger-related stimuli trigger approach (Alexopoulos & Ric, 2007). Moreover, as IVR reproduces interpersonal distances, participants may have perceived the virtual individuals to be too close in the approach condition. Subsequently, and due to regulation, this may have activated avoidance tendencies (Bailenson et al., 2003).

General Discussion

In the present research, we advocated the use of IVR to propose an adequate operationalisation of approach-avoidance behaviours because of IVR's capacity for recreating realistic individual-environment interactions. With the use of IVR we sought to manipulate interpersonal approach and avoidance behaviours in more ecological settings than was done previously, while concomitantly securing sufficient experimental control. As the use of IVR to manipulate approach-avoidance is innovative, we investigated the construct validity of such an operationalisation in the context of social interactions. Based on a careful examination of available theoretical and empirical elements, we reasoned that a valid operationalisation of approach-avoidance behaviours should: 1) translate into more positive group evaluations in the approach than in the avoidance condition, and 2) activate the corresponding neuropsychological systems (i.e., BAS and FFFS). Overall, the findings suggest that the proposed setting cannot be regarded as a satisfactory operationalisation of approach-avoidance. Experiment 1 did not reveal the expected positive effect of approach on social group evaluations but yielded an effect of approach-avoidance behaviours on one specific sub-dimension of the BAS (i.e., the GDP component). Experiment 2 failed to show the expected approach-avoidance effect on traits ratings, and the effect on action tendencies was opposite to what was expected. Therefore, on the basis of the defined construct validity criteria, we were not able to validate our IVR operationalisation of approach-avoidance behaviours.

In the current work, we investigated the influence of approach-avoidance behaviours on group evaluations and neuropsychological systems activation to validate our IVR operationalisation. However, there are several, admittedly post hoc, possible explanations for not obtaining these effects.

First, it is possible that portions of the effect obtained in previous studies were driven by specific experimental settings. Decontextualised operationalisations of approach-avoidance behaviours may appear ambiguous as well as meaningless and participants would then actively seek ways to inject meaning into the experimental setting (Kihlstrom, 2021; Orne, 1962). For instance, to create meaning they may generate thoughts like: "Maybe I have to perform this behaviour because this picture is positive". As a consequence, an overly decontextualised setting may give more weight to instructions in the production of the effect (Van Dessel et al., 2015) than an IVR setting. Moreover, it is possible that 16 repetitions of approach or avoidance behaviours in response to group members (vs. 40 trials per group in previous research for an influence on fictitious groups; Van Dessel et al., 2016, 2018) are not sufficient to influence group evaluation. If a more intensive training is necessary to obtain an evaluative influence of approach-avoidance on group evaluation, this may represent a non-negligible challenge for investigating the effect in IVR as this would considerably increase the time of immersion and consequently the risk of sickness problems (Kennedy et al., 2000). These limitations should be addressed in further studies.

Second, it is possible that features of the IVR procedure or aspects of the implemented environment hindered the effect by cueing some psychological states or perceptions. Indeed, our settings may have activated different goals (e.g., affiliation, aggression, dominance, submission; Bossuyt et al., 2014) or emotional states (e.g., happiness, anger; Mayan & Meiran, 2011; Yan & Dillard, 2010) functionally linked to approach (and avoidance) behaviours that could have mitigated the effect. For instance, in the virtual environment used here, a neutral room in which the participant finds herself in front of someone separated by a table may resemble a job interview situation, activating different goals (e.g., power, dominance, positive self-image management). Finally, in both experiments we obtained a level of presence close to the middle of the scale. As no standardised benchmark exists for the presence level in the literature, we can only surmise that our IVR settings did not recreate a too unrealistic experience of social interaction for participants. However, it is possible that a higher level of presence is required. Future work should refine IVR settings to recreate a realistic experience of interpersonal approach and avoidance behaviours, while controlling potential moderators.

Third, it is possible that the choice of construct validity criteria was not optimal. We wanted to address the previously neglected criteria of ecologically-bound social interactions in the study of the evaluative influence of approach-avoidance. Therefore, as a first criterion for construct validity we selected this evaluative influence. If the evaluative influence of approach-avoidance is generally obtained in the literature, its boundary conditions are sometimes questioned (Van Dessel et al., 2020; Vandenbosch & De Houwer, 2011). For now, it is hard to tell whether this is due to a non-optimal approach-avoidance operationalisation or from the conditions of emergence of the evaluative effect. Future work examining the construct validity of IVR approach-avoidance behaviours should consider different options. As a second construct validity indicator, we decided to measure approach-avoidance neuropsychological systems activation. To this purpose we relied on the RST-PQ (Corr & Cooper, 2016) assuming it to be sensitive to contextual variations as other related scales (Carver & White, 1994). A recent study, however, reveals that the RST-PQ shows moderate fluctuations across situations and mostly captures stable interindividual differences (Vecchione & Corr, 2021). We are not aware of comparable information for other related scales that would have indicated better sensitivity to contextual variation, but this remains possible. If this is the case, the RST-PQ may probably not be the best measure as we initially thought. Nevertheless, one finding suggests that the IVR operationalisation of approach-avoidance could induce variations on this measure (i.e., the GDP component of the BAS in Experiment 1). This effect should be taken with caution as not replicated but might suggest that the RST-PQ could capture state variations and therefore is encouraging regarding our novel approach-avoidance operationalisation. Future research should examine this issue further for instance by relying on a measure of state variations in the activation of approach-avoidance systems.

This study failed to demonstrate the construct validity of our approach and avoidance behavioural manipulation (see also Nuel et al., 2019 for a comparable strategy on individual evaluations). Yet, we still believe that it is crucial to develop ecological manipulations of approach-avoidance. As elaborated on in the introduction, considering the multiplicity of sensory and contextual cues emerging during a social interaction is crucial to capture the encoded relation between approach-avoidance behaviours and evaluations supposed to underlie their evaluative influence. Metaphorically speaking, keeping up with impoverished or minimalist paradigms to study human behaviour would be like observing fishes out of the water to draw general inferences about their swimming behaviour. In other words, we are not stating that IVR is the perfect tool revealing all effects provided that they exist. Rather, we believe that IVR is a promising technology to investigate human behaviour in situations as close as possible to those in which they occur. Future research on approach-avoidance should benefit from IVR technologies to increase the realism of their operationalisation. The current research represents a crucial first step in this direction: by developing a new approach-avoidance operationalisation this work lays the foundations for the systematic investigation of this type of IVR inductions. It is now a matter of finding the optimal, in the sense of the most valid, possible operationalisation.

Conclusion

In the present contribution we advocated the use of IVR as an appropriate and insightful tool to operationalise interpersonal approach-avoidance behaviours. By immersing individuals in a meaningful virtual environment and manipulating whole-body movements we went beyond previous paradigms that relied on minimalist and decontextualised settings. Although we did not validate our IVR approach-avoidance operationalisation, some results are encouraging and pointing in the expected direction. We hope this work will be helpful in informing further attempts towards this endeavour.

Author Note

This research was part of Ivane Nuel's thesis under the supervision of Theodore Alexopoulos and Marie-Pierre Fayant.

Contributions

Ivane Nuel: Conceptualisation; Methodology; Software; Formal analysis; Investigation; Data curation; Writing - Original Draft; Writing - Review & Editing

Marie-Pierre Fayant and Theodore Alexopoulos: Conceptualisation; Methodology; Writing - Original Draft; Writing - Review & Editing; Supervision; Funding acquisition

Nicolas Morgado and Baptiste Subra: Conceptualisation; Writing - Review & Editing

Acknowledgements

We thank the other members of the consortium of the ESPRIT project (Giuseppe Di Liberti and Norbert Schwarz) as well as Dominique Muller for their valuable insights and the experimenters who contributed to data collection (Mehdi Daddane, Jules Mercier, Jonathan Juy, Margaux Laspreses, Antoine Louvet, and Eleonor Nogues). We also thank Séverine Maggio for capturing the example video and the RV-PSY Platform at the Institut de Psychologie, Université Paris Cité.

Competing Interests

None to declare.

Funding

This work was supported by grants from the Agence Nationale de la Recherche [ANR-16-CE39-003 and ANR-20-CE28-0009].

Supplementary Material

The Supplementary Material for this article can be found online at: https://osf.io/9jb8a/?view_only=eb885e8942654089ba7cff2fd880ed98

Data Accessibility Statement

All materials, analysed datasets with the corresponding R scripts for the two experiments can be found in Open Science Framework (https://osf.io/9jb8a/?view_only=eb885e8942654089ba7cff2fd880ed98). Preregistration for Experiment 1: https://osf.io/426f7. Preregistration for Experiment 2: https://osf.io/nyzke.

Submitted: October 28, 2021 PDT, Accepted: March 29, 2022 PDT

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