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# Toward a grounded view of social interactions regulation: the contribution of approach-avoidance behaviours to interpersonal evaluations

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# Université de Paris

Ecole doctorale École Doctorale 261 « Cognition, Comportements, Conduites Humaines »

*Laboratoire de Psychologie Sociale : Contextes et Régulation*



## Toward a grounded view of social interactions regulation

*The contribution of approach-avoidance behaviours to interpersonal evaluations*

Thèse de doctorat de Psychologie


Par **Ivane NUEL**

Dirigée par **Théodore ALEXOPOULOS**


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## REMERCIEMENTS

A mes yeux, tout ce que je ressens perd de sa puissance et de sa richesse lorsque je le transforme en mots. Tout devient plus fade. Pourtant, vous le verrez à la lecture du document, je considère que le langage, comme toute activité cognitive, prend racine dans les sensations. Mais ce n'est pas pareil. Certes on peut faire ressentir tout un tas de sensations à travers les mots comme faire pleurer, faire rire ou même faire frissonner. On peut rappeler le goût d'une madeleine, l'odeur d'une rose ou la douce mélodie de la nature. Mais si on peut faire ressentir tout cela par les mots, ils ne suffiront jamais à exprimer tout ce que je ressens. Ce serait comme décrire le ciel étoilé à quelqu'un qui ne l'a jamais vu. Il ne pourrait jamais ressentir la sensation d'immensité, de petitesse et de paix qu'on ressent en l'admirant. A vrai dire, aux mots j'ai toujours préféré les images pour m'exprimer. Mais encore une fois ce n'est pas pareil. Alors, parce que je ne parviendrai jamais à vous faire ressentir ce que je ressens exactement je m'en tiendrai à ceci :

*Mercci*

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# Abstract

Due to the centrality of social interactions in the life of human beings it is important to understand how individuals regulate their interactions with others. In this work, I adopt a view of cognition as grounded in sensorimotor individual-environment interactions to investigate this issue. By helping tailor the distance between interaction partners, approach and avoidance behaviours would play a crucial role in this process. Arguing that approach-avoidance behaviours are sensorimotor individual-environment interactions, I defend the thesis that they actively participate in how individuals regulate their social interactions by influencing evaluations. If this is the case, during a social interaction 1) approach and avoidance behaviours should influence how individuals evaluate the other so as to facilitate appropriate behaviours and 2) this process should flexibly adapt to changing demands by integrating any modification in the current situation. In the first two empirical chapters, I test the hypothesis that performing approach behaviours would lead to more positive interpersonal evaluations (at the individual and at the group level) than performing avoidance behaviours. To test this hypothesis through a grounded perspective of cognition, I rely on i) Virtual Reality settings inspired from real life situations and ii) prototypical whole-body movements (i.e., upper body incline, one step displacement). Results are mitigated and give little support to the hypothesis. In the third chapter, I emphasise the importance of considering the social interaction situation as a whole, that is, as involving (at least) two individuals. I test the hypothesis that, from the perspective of the person who is approached, approach is threatening and leads to negative evaluations. In line with this idea, I show that individuals are evaluated more negatively when approaching than when staying on spot. Overall, the current work paves the way for new avenues of research and new questions concerning the evaluative influence of approach-avoidance. It constitutes a first step toward more ecological and epistemological considerations in the study of approach-avoidance and social cognition in general.

**Keywords:** Grounded cognition; social interactions; regulation; approach-avoidance behaviours; evaluations



# Résumé

Du fait de l'importance des interactions sociales chez les humains, il est crucial de comprendre comment les individus régulent leurs interactions avec autrui. Dans ce travail, j'adopte une vue de la cognition comme étant ancrée (grounded) dans les interactions sensorimotrices individu-environnement afin d'étudier cette régulation. Plus précisément, en considérant que les comportements d'approche-évitement sont des interactions sensorimotrices individu-environnement, je défends la thèse selon laquelle ils participent de manière active à la régulation des interactions sociales en influençant les évaluations. Si tel est le cas, lors d'une interaction sociale 1) l'approche et l'évitement devraient influencer la manière dont les individus évaluent autrui de sorte à faciliter les comportements adéquats et 2) ce processus devrait s'adapter de manière flexible aux changements de demandes en intégrant toutes modifications de la situation. Dans les deux premiers chapitres empiriques, je teste l'hypothèse selon laquelle, réaliser des comportements d'approche mèneraient à des évaluations interpersonnelles (au niveau individuel et au niveau du groupe) plus positives que réaliser des comportements d'évitement. Pour tester cette hypothèse à travers une perspective grounded de la cognition, j'utilise i) la Réalité Virtuelle en nous inspirant de situations de la vie courante et ii) des mouvements prototypiques mobilisant l'ensemble du corps (i.e., inclinaison du buste, déplacement d'un pas). Les résultats sont mitigés et n'apportent qu'un faible support à l'hypothèse. Dans le troisième chapitre, j'attire l'attention sur l'importance de considérer la situation d'interaction sociale dans son ensemble, c'est-à-dire comme impliquant (au moins) deux individus. Je teste l'hypothèse selon laquelle, du point de vue de celui qui est approché, l'approche peut être menaçante et mener à des évaluations négatives. Je montre que les individus sont évalués plus négativement lorsqu'ils approchent que lorsqu'ils restent sur place. Dans l'ensemble, le présent travail ouvre la voie à de nouvelles pistes de recherche et à de nouvelles questions concernant l'influence évaluative des comportements d'approche et d'évitement. Il constitue un premier pas vers des considérations plus écologiques et épistémologiques dans l'étude de l'approche-évitement et de la cognition sociale en général.

**Mots clefs :** Grounded cognition ; interactions sociales ; régulation ; comportements d'approche-évitement ; évaluations

## **List of main abbreviations**

**BAS** = Behavioral Approach System

**BIS** = Behavioral Inhibition System

**FFFS** = Fight-Flight-Freeze System

**GDP** = Goal Drive Persistence

**IVR** = Immersive Virtual Reality

**SC-RF-IAT** = Single Category – Recoding Free – Implicit Association Test

**RST-PQ** = Reinforcement Sensitivity Theory – Personality Questionnaire

**VAAST** = Visual Approach-Avoidance by the Self Task



*It was six men of Indostan  
To learning much inclined,  
Who went to see the Elephant  
(Though all of them were blind),  
That each by observation  
Might satisfy his mind.*

*The First approached the Elephant,  
And happening to fall  
Against his broad and sturdy side,  
At once began to bawl:  
“God bless me! — but the Elephant  
Is very like a wall!”*

*The Second, feeling of the tusk,  
Cried: “Ho! — what have we here  
So very round and smooth and sharp?  
To me ‘t is mighty clear  
This wonder of an Elephant  
Is very like a spear!”*

*The Third approached the animal,  
And happening to take  
The squirming trunk within his hands,  
Thus boldly up and spake:  
“I see,” quoth he, “the Elephant  
Is very like a snake!”*

*The Fourth reached out his eager hand,  
And felt about the knee.  
“What most this wondrous beast is like  
Is mighty plain,” quoth he;  
“‘T is clear enough the Elephant  
Is very like a tree!”*

*The Fifth, who chanced to touch the ear,  
Said: “E’en the blindest man  
Can tell what this resembles most;  
Deny the fact who can,  
This marvel of an Elephant  
Is very like a fan!”*

*The Sixth no sooner had begun  
About the beast to grope,  
Than, seizing on the swinging tail  
That fell within his scope,  
“I see,” quoth he, “the Elephant  
Is very like a rope!”*

*And so these men of Indostan  
Disputed loud and long,  
Each in his own opinion  
Exceeding stiff and strong,  
Though each was partly in the right,  
And all were in the wrong.*



This tale is an extract of *The Blind Men and the Elephant* of John Godfrey Saxe (1816–1887). It is a good parallel of the way social cognition—the elephant or, more consensually, how people make sense of others and of themselves in order to coordinate with their social world (Fiske & Taylor, 2013)—is generally investigated. Researchers—the blind men—approach social cognition phenomena by only considering one or a limited number of components. By the way, they may obtain a restricted vision of these phenomena, just as each blind man has a distorted vision of the elephant. This work intends to consider social cognition in a more global manner than previously, or at least to represent a first step in this direction, in the study of approach-avoidance behaviours.



*Tout n'est qu'une question de perception sociale.*



Theodore Alexopoulos

Personal communication, December, 5, 2017

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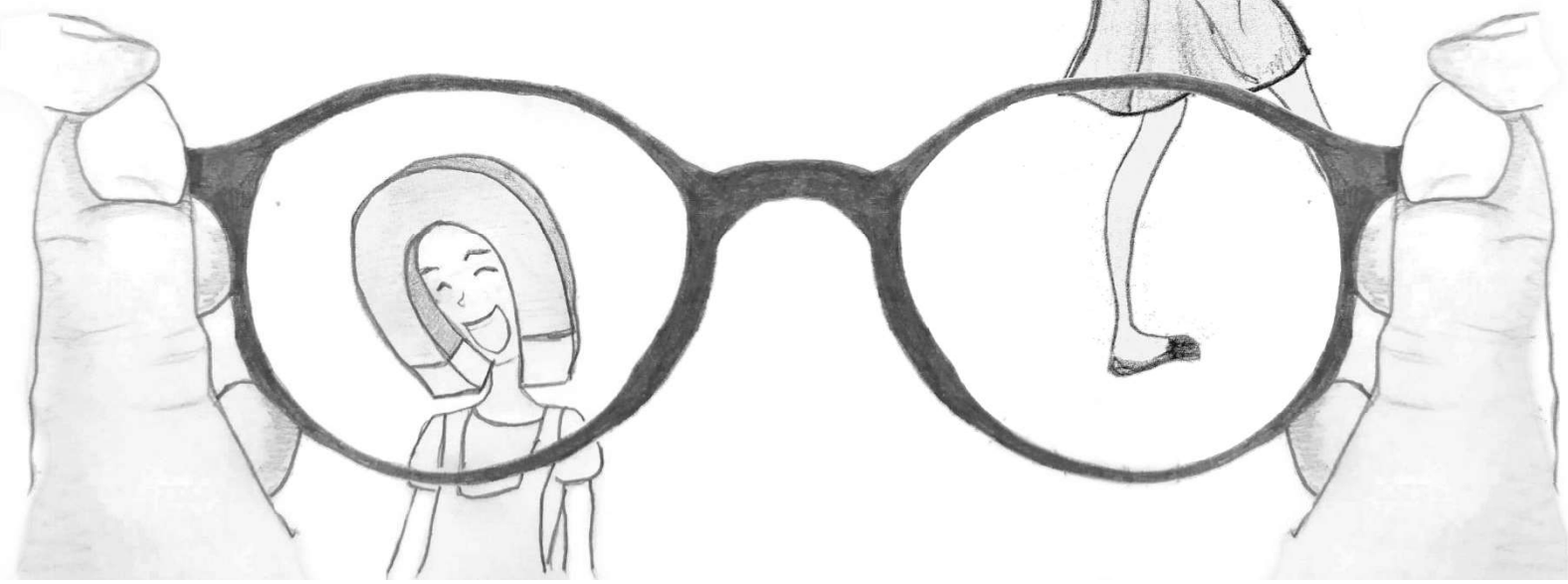
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# General Introduction



## **1. NO ONE IS AN ISLAND: ON THE IMPORTANCE OF SOCIAL INTERACTIONS IN INDIVIDUALS' LIFE**

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To begin with, just think about the number of times you interacted with someone during the last week. These interactions could vary from a mere greeting to the supermarket cashier to strong bonds with family members, from discussion with people physically present to a phone, mail or letter exchange, from a rendez-vous between two people to a group meeting. Even if you have decided to retire into the depths of my native Lozère (i.e., the least populated French department), these social interactions will be relatively numerous. Indeed, human individuals are social animals. As such, from early childhood, interacting with others is a central ingredient in individuals' lives (Bowlby, 1969). Individuals seek out connections with others and strive to maintain them (Baumeister & Leary 1995; Deci & Ryan, 2000). From an evolutionary perspective, creating and maintaining interactions with others has a selective advantage for survival (Myers, 2003; Neumann, 2009). Through interactions, individuals may share food, defend and protect each other—including parents towards their offspring and vice-versa—and communicate as well as cooperate to solve potential problems. Interacting with others represents a fundamental need, an innate psychological nutriment essential for individuals' functioning because social interactions offer many advantages for them (Deci & Ryan, 2000; for a review see Reis et al., 2000). I will now briefly illustrate this point.

First, social interactions are beneficial for individuals' health and well-being (Cohen et al., 2000; Uchino et al., 1996). The more individuals interact with others, the more they report being in good health (Fiorillo & Sabatini, 2011) and happy (Sandstrom & Dunn, 2014), even for weak tie interactions (i.e., mere acquaintances, Sandstrom & Dunn, 2014). Globally, interactions promote positive psychological states and attenuate the effect of stressful experiences (Cohen, 2004). Conversely, if the need for social interactions is not met, such as for instance when being victim of ostracism or experiencing loneliness, individuals suffer from negative consequences at the psychological (e.g., depression, alienation, Allen & Badcock, 2003) and physiological level (e.g., immunodeficiency, Kiecolt-Glaser et al., 1984).

Second, social interactions influence how individuals perceive themselves. Social interactions may influence momentarily self-perception by generating good or bad feelings about the self. For example, if individuals perceive being accepted by those with whom they interact, they feel good about themselves and, on the contrary, they feel bad about themselves

if they are rejected (Leary, 2005). Individuals may also use others to evaluate themselves (Festinger, 1954). For instance, during an informal scientific exchange with a very bright and ingenious colleague, one could experience a contrast effect, feeling oneself smarter than during a scientific exchange with their own grand-mother (who is bright but in other way) or an assimilation effect, feeling oneself dumber than during the scientific exchange with their own grand-mother (Suls & Wheeler, 2007). In a more lasting way, the nature of individuals' first social interactions in their childhood may develop in specific patterns regarding how they perceive themselves when being adults (Bowlby, 1973). Indeed, those for whom caregivers were available during infancy and responded appropriately in times of need have a higher self-esteem and a better organized self-structure later on (Mikulincer, 1995).

Third, through social interactions, individuals expand the possibilities of knowing and interacting with their environment. For instance, people develop a shared knowledge of their social environment and of each individual's abilities on which they could rely (Wegner, 1986). If despite all your efforts, the self-assembly desk looks nothing like the expected picture, you will not hesitate to call your friend who is a Do-It-Yourself enthusiast. Individuals can also learn new behavioural skills through the observation of others (Bandura, 1962). Moreover, during an interaction, others' facial expressions (Darwin, 1872; Hess & Thibault, 2009) or gaze orientations (Friesen & Kingston, 2003) can inform individuals about something in their environment that they missed and contribute to their emotional development (e.g., through social emotional communication, Barrett & Campos, 1987).

Following this brief overview, you can see that social interactions are central in human beings' life. They contribute to their health and well-being, to their self-perception and to the development of new knowledge about their environment. If individuals need to connect with others, to create and maintain social interactions, it is crucial to understand how they regulate their interactions with others to meet this need. This is exactly the aim of this thesis. Approach and avoidance behaviours seem to play a key role in this regulation. By changing the distance between individuals, these behaviours enable them to create or prevent contact with the other. Here, I investigate how these behaviours may actively participate in the regulation of individuals' social interactions through their influence on interpersonal evaluations. For the sake of simplicity, I restrict this investigation to social interactions that involve only two individuals (even when individuals' group membership is considered). Indeed, the greater the number of individuals involved in the interaction, the greater the number of interactive dynamics should be considered. And this could complexify the phenomenon to investigate.

## 2. ATTRACTION AND REPULSION: FROM EVALUATIONS TO BEHAVIOURS

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### 2.1.A PRIMER ON (SELF-) REGULATION

In order to understand how individuals regulate their social interactions, I deem important to clarify what I refer to as regulation in this thesis. Let me illustrate this point with the example of temperature. At the time of writing these lines, Paris is on a heat wave alert and body temperature may easily exceed 37°C. There is no need to draw you a picture, the body starts sweating and breathing accelerates. Everyone uses their imagination to refresh themselves and any ideas on how to lower body temperature around 37°C are welcome (e.g., take a shower, eat ice cubes, freeze some clothes, become one with the cooling fan). These physiological and behavioural adjustments aimed to maintain a variable at a reference value (or range of values), despite any disturbances, constitute regulation. All living beings must keep their own internal, physical as well as psychological conditions at an optimum level, despite environmental constraints, to keep themselves alive. Important deviations from the optimum level are deleterious and call for readjustments. To this purpose, humans regulate their behaviours but also their thoughts and feelings (Zimmerman, 2000). The reference values that living beings seek to attain or maintain apply to various variables like the body temperature, the fasting level of glucose or the quantity and quality of social interactions. In human regulation, the variables at stake could be abstract like self-evaluation (Sedikides & Strube, 1997) or achievement (Fryer & Elliot, 2008) and reference values are generally referred to as needs or goals<sup>1</sup> (Brendl & Higgins, 1996; Carver & Scheier, 1990; Deci & Ryan, 2000; Leary, 2005). This process of regulation is a *self*-regulation process, in the sense that individuals apply corrective adjustments to themselves and that these corrective adjustments arise within themselves (Carver & Scheier, 2011). This means that individuals are the agents of their own regulation. Social interactions are concerned by this regulation process: Because individuals need to create and maintain social interaction they have to regulate their interactions with others so as to satisfy this need.

The literature suggests that individuals are able to efficiently regulate their social interactions by: 1) evaluating whether the encountered individual would facilitate or impede the satisfaction of their need and, on the basis of these evaluations, 2) acting on their environment to apply the necessary corrective adjustments. Both evaluation and action are

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<sup>1</sup> According to Leary (2005), a need is a state or outcome that is necessary for individuals' physical and psychological functioning while a goal is a state or outcome that they merely prefer or desire.

necessary for such adaptive regulation (Wentura & Rothermund, 2003). And how people make sense of others and themselves in order to coordinate with their social world is the very core of social cognition (Fiske & Taylor, 2013, p. 44). The following sections will be devoted to the contribution of evaluation and action in the regulation process. More specifically, I will present the tight coupling between evaluations and specific distance change behaviours, namely approach and avoidance.

## **2.2.EVALUATING THE ENVIRONMENT THROUGH THE LENSES OF OUR NEEDS**

Individuals perceive their environment in terms of the reference values that they tend to maintain or attain, and in terms of the need that they tend to satisfy (e.g., body temperature, number of social interactions; Di Paolo, 2005; Frijda, 2016). On the basis of whether situations and stimuli promote or impede the satisfaction of individuals' needs, they acquire a *valence* from the perspective of individuals (Brendl & Higgins, 1996; Frijda, 2016; Lewin, 1935). In the literature, this attribution of valences to the environment is generally referred to as evaluation/valuation (Corr & Krupić, 2017; Corr & McNaughton, 2012), appreciation (Barrett & Campos, 1987) or appraisal (Moors et al., 2013). Situations and stimuli that enable individuals to satisfy their needs acquire a positive valence for them: They are evaluated as positive. Conversely, situations and stimuli acquire a negative valence when impeding individuals to satisfy their needs: They are evaluated as negative. It should be specified that, although referring to a property of an event, valence derives from a person-situation relation and is not intrinsic to the event (Brendl & Higgins, 1996; Lewin, 1935). To ease the comprehension of this point, let us return to the temperature regulation example. If one desires to cool off during a heat period, the cold water in the shower has a positive valence while the hot water has a negative one. But if one tries to get warm in the middle of winter, this is the hot water which has a positive valence and the cold water which has a negative one. In the same way, when considering the need for satisfying social interactions, a person we can trust and who seems nice is perceived as positive, while a person who seems dishonest and mean is perceived as negative. But when playing a game in which lying and cheating is a non-negligible advantage, the latter will no longer be perceived as negative: On the contrary, you would like to have this person in your team and perceive them more positively than the trustworthy one. In other words, the valence of the environment and the needs of the individual are correlative (Lewin, 1935, p. 123). Empirical evidence supports this notion, showing that thirsty individuals evaluate drink concepts more positively than non-thirsty ones (Ferguson & Bargh, 2004) and

that individuals who have been appetised by food products evaluate less favourably non-food products (that could not satisfy their need to eat) than those who have not been appetised (Brendl et al., 2003; for a review about the motivational nature of evaluation see Ferguson and Bargh, 2008).

The evaluation of the environment in terms of positive and negative valence steers individuals' behaviours (Lewin, 1935; Neumann et al., 2003; Strack & Deutsch, 2004; Wentura & Rothermund, 2003). Indeed, originally, the term valences derives from the German word *Aufforderungscharaktere* which is defined as “imperative environmental facts [that] determine the direction of behaviour” (Lewin, 1935, p. 77). Evaluating the environment activates behavioural tendencies that *predispose* individuals to apply specific adjustments in their environment, to behave in a particular way, in order to satisfy their needs. Stimuli evaluated as positive attract individuals, they predispose them to reduce the distance between themselves and the stimuli (i.e., approach tendency). On the contrary, stimuli evaluated as negative repel individuals, they predispose them to increase the distance between themselves and the stimuli (i.e., avoidance tendency). Empirical research supports the behavioural orienting function of evaluation. Individuals move faster towards positive stimuli and away from negative stimuli than the other way round (Chen & Bargh, 1999; Solarz, 1960; for a review see Beatty et al., 2016; Phaf et al., 2014). For instance, when individuals are hungry and need food, they evaluate food stimuli more positively and are more predisposed to approach (vs. avoid) these stimuli than if they are satiated (Seibt et al., 2007). This is also true for social stimuli: Individuals approach friends who help them in satisfying their goals (e.g., a friend who helps them to be athletic) quicker than those who do not, and avoid those who do not help them to reach their goals quicker than those who do (Fitzsimons & Shah, 2008). In order to fulfil the need to create and maintain social interactions, it is advantageous to surround oneself with trustworthy and sympathetic people. Indeed, one can safely rely on these persons and thus maintain the interaction with them. Trustworthy or smiling people are thus supposed to be attractive and predispose individuals to move towards them (Slepian et al., 2012; Stins et al., 2011). This evaluation appears to be automatic in the sense that their behavioural facilitation does not require the conscious goal to evaluate the target (Chen & Bargh, 1999; Krieglmeyer et al., 2010) and it occurs even when targets are suboptimally presented (Alexopoulos & Ric, 2007).

To summarise, individuals evaluate their social environment relatively to their need for satisfying social interactions, and these evaluations predispose them to specific behaviours related to the satisfaction of this need (Brendl & Higgins, 1996; Lewin, 1935; Tolman, 1932).

### **2.3. ACTING ON THE ENVIRONMENT THROUGH APPROACH AND AVOIDANCE BEHAVIOURS**

Evaluating the social environment is necessary but not sufficient to allow an effective regulation of social interactions. Indeed, evaluation predisposes individuals to behave in a particular way, towards or away from specific people. However, you will admit that the satisfaction of your need to create and maintain social interactions would be quite random if you were merely predisposed to approach or avoid others. In order to satisfy your need, you have to enact approach and avoidance behaviours. Therefore, an effective regulation of social interaction requires that individuals apply the necessary corrective adjustments and act according to their evaluations.<sup>2</sup> They have to enact approach and avoidance behaviours. Although not always explicitly stated in the literature, approach and avoidance behaviours are generally and respectively conceived as behaviours enacted in order to reduce and increase the distance between the individual and an element of their environment (Strack & Deutsch, 2004; Van Dantzig et al., 2008). In this way, these behaviours are motivated because they are energised and directed by the environment evaluation, and thus by the possibilities of reaching specific reference values (Elliot, 2006).

In the literature, the distinction between approach and avoidance is considered to be a basic conceptual distinction in living beings (Bradley & Lang, 2007; Cacioppo et al., 2012; Di Paolo, 2005; Hull, 1943; Konorski, 1967; Lewin, 1935; McNaughton et al., 2016; Miller, 1959; Schneirla, 1959; Strack & Deutsch, 2004; Tolman, 1932; Tooby & Cosmides, 1990; Zajonc, 1998; for a review see Elliot & Covington, 2001). The approach-avoidance distinction is so fundamental to deal with the environment that dedicated neuronal circuits have evolved to organise approach and avoidance behaviours (Davidson, 1993; Lang & Bradley, 2008; Tooby et al., 2008). It is generally assumed that the control of approach and avoidance behaviours has been lateralised in the nervous system of vertebrate species (e.g., toads, Lipollis et al., 2002; dogs, Quaranta et al., 2007). Research on humans suggests that while the control of approach behaviours is related to higher left frontal activity, the control of avoidance behaviours is related to greater right frontal activity (Davidson, 1993; Harmon-Jones, 2003; Harmon-Jones et Gable,

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<sup>2</sup> I admit that in some situations approach and avoidance remained behavioural tendencies. For instance, social norms or physical obstacles could impede individuals to move towards or away from the other. In these cases, individuals could merely disengage themselves from the target (Lewin, 1935). They could also send signals to the other, like smiling or frowning, in order to invite them to come closer or force them to move away (Marsh et al., 2005; Stins et al., 2011). This type of behaviour will not be investigated in this thesis.



2018; Rodrigues et al., 2018).<sup>3</sup> This lateralisation is thought to increase the efficiency of regulation through approach-avoidance behaviours because the lateralised functions can proceed in concert and relative independency at various stages of processing (Davidson, 1993; Maxwell et al., 2005). In other words, individuals possess two lateralised behavioural systems enabling them to appropriately act in the environment with regard to their need for social interactions.

To summarise, due to their tight relation with evaluation, approach-avoidance behaviours appear to have a significant regulatory function. They enable individuals to engage interactions with those who could potentially satisfy their need for social interactions and to prevent interactions with those who could not. However, presented as such, approach and avoidance would only have a passive role in the regulation of social interactions. They appear as mere responses of individuals to the evaluation of their environment. Actually, the influence of evaluations on individuals' behaviours may represent only one side of the process through which individuals regulate their social interactions.

### **3. THE ACTIVE CONTRIBUTION OF APPROACH-AVOIDANCE BEHAVIOURS TO THE REGULATION OF INDIVIDUALS' SOCIAL INTERACTIONS**

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#### **3.1. REGULATION IS GROUNDED IN INDIVIDUAL-ENVIRONMENT INTERACTIONS**

As mentioned above, in order to create and maintain social interactions, individuals evaluate whether the other helps or impedes them in meeting this need and behave in consequences. That is, they try to make sense of their environment in order to act appropriately. Some researchers proposed that this sense-making process is the core of cognition (Di Paolo, 2005; Di Paolo & Thompson, 2014; Fiske & Taylor, 2013; Weber & Varela, 2002). Broadly speaking, cognition comes from the Latin word *cognitio* (i.e., the act of getting to know, comprehension, investigation) and refers to the process (or set of processes) through which individuals develop knowledge and make sense of their environment (Eysenck & Brysbaert, 2018; Reed, 2007). Importantly, it has been pointed out that cognition did not evolve for its

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<sup>3</sup> In fact, there is a debate about the way approach-avoidance behaviours are lateralised as some studies propose that relative left activity is related to general behavioural activation (including both approach and active avoidance behaviours) and relative right activity is related to general behavioural inhibition (more passive avoidance, Wacker et al., 2003).

own sake but for the control of adaptive, or situated, action (Barsalou, 2008; Franklin, 1995; Smith & Semin, 2004). Therefore, cognition could be defined as an adaptive regulatory process which enables individuals to make sense of their environment and allows the control of adaptive actions in regards to the environmental demands (Eysenck & Brysbaert, 2018; Fiske & Taylor, 2013; Pecher & Zwaan, 2005; Smith & Semin, 2004; Wilson, 2002). In this way, according to this definition, how individuals regulate their social interactions is a cognitive activity. As such, investigating the regulation of individuals' social interactions cannot be done independently of some theoretical considerations about cognition.

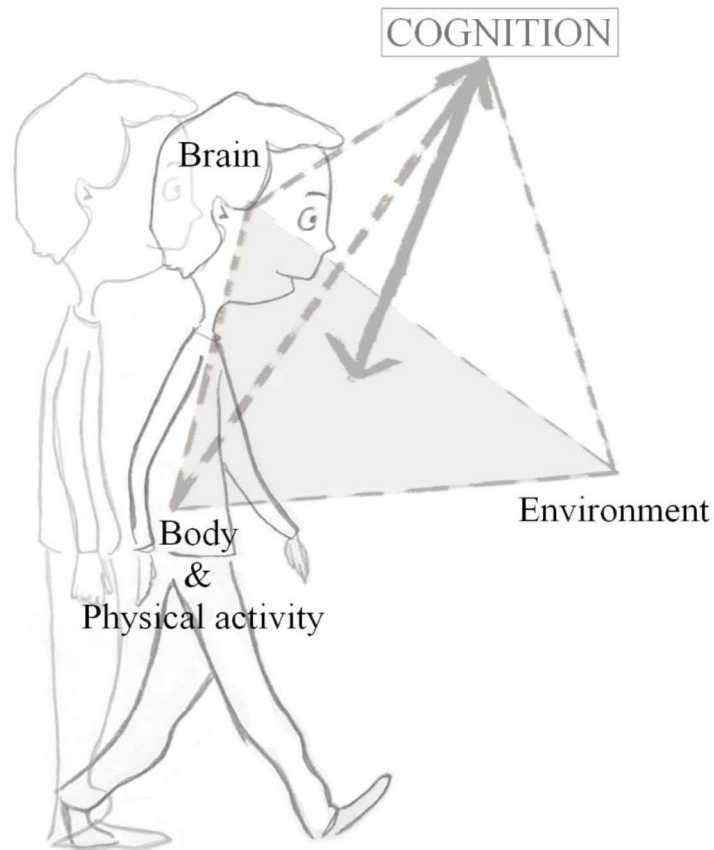
To capture the idea that cognition serves adaptive action, it has been proposed that cognitive activity could not be dissociated from the whole situation in which it occurs. More specifically, from this perspective, cognition is *grounded* in (and emerges from) the sensorimotor individual-environment interactions (Barsalou, 2008; 2020; Overmann & Malafouris, 2018; Pecher & Zwaan, 2005; Robbins & Aydede, 2009; Smith & Semin, 2004; Wilson, 2002). This means that cognition is not restricted to the brain and its neural activity, but instead, that all the components of the ongoing individuals-environment interactions, including modality-specific systems in the brain, the body, its activity as well as the physical and social environment, contribute to cognition (Overmann & Malafouris, 2018; Figure 1). More specifically, cognition emerges from the interactions of all these components (Barsalou, 2020; Semin et al., 2012, Varela et al., 1994).

In the literature, researchers may address the idea that cognition is grounded in sensorimotor individual-environment interactions in various ways (Wilson, 2002). Four claims come recurrently to the fore: the embodied, embedded, extended and enacted nature of cognition (i.e., 4E cognition, Barsalou, 2020; Menary, 2010; Newen et al., 2018). To assist the understanding of these claims, imagine the following situation. You and a friend, sitting in a restaurant, are having an intense debate about the choice of your next vacation destination. Each of you tries to convince the other that their idea is the best one. The cognitive processes involved in this debate could be considered as *embodied* in the sense that they are not limited to brain processes but also involve wider bodily structures (Barsalou, 2008; Rowlands, 2010; Shapiro, 2019; Wilson, 2002). According to the embodiment thesis, the characteristics of your body when debating with your friend influence the type of involved cognitive processes (Shapiro, 2004). For instance, if you adopt an expansive posture, you will have more novel and differentiated ideas for the vacation destination than if you adopt a closed posture (Andolfi et al., 2017). By adopting the expansive posture, you may also feel more dynamic and self-

confident than the other (Abele & Yzerbyt, 2020). During the debate, the cognitive processes may also be considered as *embedded* in the sense that they occur in a specific physical, social and cultural context. Therefore, the environment and its structure support cognitive processes (Newen et al., 2018). For instance, if your friend takes a spoon of fish oil before eating (intended to fill an Omega-3 deficiency), the fishy smell may make you suspicious and less inclined to pay for the holidays they propose (Lee & Schwarz, 2012). If you ordered a hot soup, you may be more inclusive in your categorisation and accept more places as being examples of an exotic destination than if you ordered a cold gazpacho (Ijzerman et al., 2014). Cognitive processes may also be considered as *extended* in the sense that the environment does not merely support cognition but represents a constitutive part of it (Clark 1997; Clark & Chalmers, 1998; Gallagher, 2013; Newen et al., 2018). You may check on your smartphone to obtain more convincing arguments about your favourite destination or note the arguments from the different parties on the cafe paper towel. In these cases, both the smartphone and the paper towel become part of your cognitive processes. You may also directly perceive specific affordances (i.e., possibilities of actions offered by the environment, Gibson, 1979) that could orient the interaction like their facial expression, gestures, etc. (Ferri et al., 2011; Fuchs, 2016; Valenti & Gold, 1991). Finally, the cognitive processes at stake in this debate could be considered as *enacted* in the sense that they involve an active engagement in and with the environment (De Jaegher & Rhode, 2010; Lindblom, 2015; Newen et al., 2018; Thompson, 2007; Varela et al., 1991). Your actions, but also your abilities and dispositions to act during the debate contribute to these cognitive processes (Newen et al., 2018). When listening to the arguments of your friend, you may begin to synchronise your behaviours one with each other. This sensorimotor activity could ease the memorisation of what your friend is saying (Macrae et al., 2008). In this way, individuals' actions, or more specifically, interactions with the environment, are not considered as mere outputs of cognition. On the contrary they contribute to cognition.

In a nutshell, the 4 E's converge on the idea of a "dynamic coupling, where the brain-body-world interaction links the three parts [the brain, the body, and the world] into an autonomous, self-regulating system" (Carney, 2020, p. 78). But they emphasise different aspects of this brain-body-world interaction. The embodied claim mainly focuses on the role of the body in cognition, the embedded and extended claims focus on the role of the environment (world) and the enacted claim focuses on the role of action in cognition. The general idea to keep in mind is that, cognition is grounded in the brain, the body and the environment and emerges from the sensorimotor individual-environment interactions (Barsalou, 2020). Both

modality-specific systems in the brain, the body as well as in the physical and social environment jointly (and not independently) contribute to cognition (Semin et al., 2012). The grounded conception of cognition can be difficult to grasp but Figure 1 attempts to illustrate it.



*Figure 1.* Schematic representation of grounded cognition. Cognition emerges from individual-environment interactions. The double arrow illustrates how the brain, the body, its activity and the environment conjointly contribute to cognition (upward direction) as well as are influenced by it for adaptive actions (downward direction).

The idea that cognition is grounded in sensorimotor individual-environment interactions fully captures its regulatory function (Balçetis & Cole, 2009). Indeed, individuals are constantly in interaction with their environment, which implies that cognition is rooted in the present and attuned to the ongoing interaction. It is not to say that past experiences do not matter or that individuals are unable to anticipate and project themselves in the future. After all, you are perfectly capable of remembering your somewhat crazy holidays with your friends and of planning to tell them to do it again sometimes. What is meant by saying that cognition is rooted in the present is that all cognitive activities are inseparable from the context of the ongoing interaction. In this way, cognition enables individuals to behave appropriately according to their

current internal and bodily states, the environment and the actions undertaken. Cognition is also rooted in past sensorimotor experiences. During their sensorimotor interactions with the environment, individuals represent internal and external events through constant neuronal states modifications. The grounded view of cognition proposes that the brain keeps track of traces of these neuronal modifications in a distributed manner across the relevant sensorimotor systems (Barsalou, 1999; Damasio, 1989; Niedenthal et al., 2005; Versace et al., 2014, but see Hommel, 2020). Therefore, the traces of various sensorimotor activities involved when interacting with someone (e.g., smelling the others' delicate perfume, seeing their facial expression or the colour of their clothes, moving toward or away from them) are memorised. These traces serve to represent the social interaction experience in a multisensorial and contextualised way. Importantly, these sensorimotor traces may be solicited on later occasions and participate in cognition. For instance, when their corrugator, involved in frowning, is paralysed by Botox injections individuals are slower to read sentences evoking anger or sadness (Havas et al., 2010). The underlying idea is that, for individuals to understand anger and sadness, the sensorimotor activity involved during the experience of these emotions should be present. By impeding the reactivation of sensorimotor traces of past anger/sadness experiences (i.e., frowning), the Botox injections hinder the processing of emotional sentences. Traces of past experiences would influence the ongoing experience at the same time that they are updated by it (Barsalou, 1999; Versace et al., 2014). As such, individuals are able to interact with their current environment on the basis of what they have learned in past sensorimotor experiences. The coupling of past and present sensorimotor experiences offers the possibility of a dynamic regulation. Some have even further suggested that if cognition is grounded in the brain-body-world interactions, this is to serve the functional purpose of regulation (Balcetis & Cole, 2009).

### **3.2. THE EVALUATIVE INFLUENCE OF APPROACH-AVOIDANCE BEHAVIOURS**

In the previous section, I presented a view of cognition, the regulatory process in the service of adaptive actions, as grounded in ongoing sensorimotor individual-environment interactions (Barsalou, 2008; Overmann & Malafouris, 2018; Robbins & Aydede, 2009; Smith & Semin, 2004; Wilson, 2002). The way individuals physically interact with their environment participates in how they make sense of their (social) environment in order to act appropriately. Approach and avoidance behaviours are specific sensorimotor individual-environment interactions. As such, all changes in brain modality-specific systems, in the body as well as in the physical and social environment occurring when performing approach-avoidance behaviour

should actively contribute to the regulation of social interactions. By actively I mean that, during the regulation process, approach and avoidance are not mere passive responses to the evaluation of individuals' environment. Their enactment can influence the regulation process.

One way in which approach and avoidance behaviours can actively participate in the regulation of individuals' interaction with others is through their evaluative influence (Balcetis & Cole, 2009; Neumann et al., 2003; Strack & Deutsch, 2004). Individuals generally approach what they evaluate positively and avoid what they evaluate negatively (Lewin, 1935; Neumann et al., 2003). When doing so, they keep in memory the traces of various experienced sensorimotor transformations. These traces code for different features of the interaction, including evaluative ones (e.g., features related to the physical environment, to one's own body, to action consequences, to affective response; Barsalou, 2016; Barsalou et al., 2003; Hommel, 2019; Papies & Barsalou, 2015; Versace et al., 2014). In later social interactions, the ongoing experience is thought to echo multisensory traces of past experiences in which individuals generally approached those they evaluate positively and avoided those they evaluate negatively (Barsalou, 1999; Hommel, 2019; Papies et al., 2020; Versace et al., 2014). These positive and negative memory traces, coupled with sensorimotor neuronal activity of the ongoing situation, may influence how individuals evaluate others: More positively when enacting an approach behaviour than an avoidance one.

**EMPIRICAL EVIDENCE.** A large body of evidence substantiates this evaluative influence of approach-avoidance behaviours on a variety of stimuli ranging from abstract symbols (Cacioppo et al., 1993), colours (Hütter & Genschow, 2020), and shapes (Laham et al., 2014), to pronounceable nonwords (Priester et al., 1996; Van Dessel, Eder & Hughes, 2018) or real objects (Streicher & Estes, 2016). Words and pictures have also been used, in which case the stimuli may refer to animals (Huijding et al., 2009; Jones et al., 2013), consumption products (Kakoschke et al., 2017; Krishna & Eder, 2018; Schumacher et al., 2016; Wiers et al., 2011) but also individuals (Mertens et al., 2020; Slepian et al., 2012; Woud et al., 2008; Woud et al., 2013) or groups they belong to (Kawakami et al., 2007; Phills et al., 2011; Van Dessel, Eder & Hughes, 2018; Van Dessel et al., 2020). Approach-avoidance behaviours seem to influence evaluations of the target stimulus after both a single encounter (Cacioppo et al., 1993; Priester et al., 1996; Slepian et al., 2012) and a handful or numerous encounters (Glashouwer et al., 2020; Huijding et al., 2009; Hütter & Genschow, 2020; Kawakami et al., 2007; Krishna & Eder, 2018; 2019; Laham et al., 2014; Mertens et al., 2018; Phills et al., 2011; Woud et al., 2008; Woud et al., 2013; Vandenbosch & De Houwer, 2011; Van Dessel, Eder & Hughes, 2018;

Van Dessel et al., 2020). In any case, performing an approach behaviour leads to more positive evaluations than performing an avoidance behaviour (for alternative results see Centerbar & Clore, 2006; Dru & Cretenet, 2008; Krishna & Eder, 2019; for null results see Glashouwer et al., 2020; Krishna & Eder, 2018; Vandenbosch & De Houwer, 2011).

Through their evaluative influence, approach and avoidance behaviours shift from mere passive reactions to active contributors to the regulation of individuals' social interactions (Balcetis & Cole, 2009). They enable individuals to perceive their environment in such a way that they maintain the behaviour required to meet their needs (Balcetis & Cole, 2009). First, we saw that the positive or negative evaluation of a stimulus orients individuals' approach-avoidance behaviours (Chen & Bargh, 1999; Slepian et al., 2012). During social interactions, a positive evaluation of the other predisposes to approach behaviours while a negative one predisposes to avoidance. Therefore, by influencing the evaluation of the other, approach and avoidance behaviours foster their own enactment (e.g., enacting approach → positive evaluation → predisposition to approach). In doing so, they could smooth the regulation of the interaction: Individuals remain engaged in adaptive behaviours to satisfy their need to create and maintain social interactions (Balcetis & Cole, 2009; Ferguson & Bargh, 2004; Neumann et al., 2003). Second, as situations of social interaction are sometimes ambiguous, the evaluative influence of approach-avoidance behaviour may disambiguate the situation (Neumann et al., 2003). Third, by influencing evaluations, approach and avoidance behaviours shape the affective traces of the target individual. On later encounters, these specific traces may assist individuals' behaviour (orienting towards approach or avoidance). In other words, approach and avoidance behaviours likely contribute to the regulation of both ongoing and future social interactions, which makes them critical elements of the regulation process. Along these lines, the influence of evaluation on interpersonal approach-avoidance behaviours may be considered as only one part of a much more dynamic process of social interactions regulation in which approach and avoidance would play a central and active role.

***THEORETICAL MODELS.*** The evaluative influence of approach-avoidance behaviours has been mainly explained by their association with a specific valence, which extends to the target stimulus. However, depending on the theoretical model, this behaviour-valence link does not hold to the same notion. Here, I will focus on three frequently tested models: The motivational account, the common-coding account, and the inferential account.



- From a *motivational account* perspective (Cacioppo et al., 1993; Neumann et al., 2003; Strack & Deutsch, 2004), contracting specific muscles groups (Cacioppo et al., 1993) or enacting specific behaviours interpreted as approach-avoidance in the ongoing context (Seibt et al., 2008; Van Dantzig et al., 2007) has been shown to activate corresponding approach-avoidance motivational orientations on the basis of past contingencies with positive-negative evaluative processes. More precisely, performing an approach behaviour is thought to activate an approach motivational orientation, thereby facilitating positive evaluative processes, while performing an avoidance behaviour would activate an avoidance motivational orientation, thereby promoting negative evaluative processes (Bradley & Lang, 2007; Cacioppo & Berntson, 1994; Neumann et al., 2003). According to the motivational account, this behaviour-valence link mediated by motivational orientations influences evaluations (Cacioppo et al., 1993). However, this explanation has been criticised for its lack of formalisation concerning the motivational orientations (Eder et al., 2016; Van Dessel et al., 2018). For instance, Eder and colleagues (2016) argued that “‘explaining’ approach-avoidance tendencies through activations of corresponding approach-avoidance systems is but a re-description of the to-be-explained phenomenon in allegedly explanatory terms, which we consider about as meaningful as, say, explaining perception through a ‘perception system’” (point number three of their commentary).

- Others rely on more general processes than the re-activation of specific motivational orientations to explain the evaluative influence of approach-avoidance behaviours. For instance, the *common-coding account* (Eder & Hommel, 2013, Eder & Klauer, 2009) assumes that it is the cognitive coding of behaviours in terms of valence that influence evaluation. According to this model, perception and action share a common representational network of cognitive and amodal codes, like valence, direction, etc. (Hommel, 2019; Hommel et al., 2001). When performing an action, the cognitive codes representing this action become more accessible in the coding network, thereby orienting the perception of events accordingly. Because approach and avoidance behaviours are generally and respectively motivated by the expectation of desired and undesired consequences, they are represented with positive and negative affective codes. When approaching (avoiding) a stimulus, the positive (negative) codes are activated and may facilitate the perception of affective features in the situation or may be bound with the representation of a perceived neutral stimulus (Eder & Klauer, 2009). From this model, any valenced action—including, but not limited to approach-avoidance behaviours—can influence evaluations through this process (e.g., upward and downward actions, Van Dessel,

Eder & Hughes, 2018). Importantly, the affective code of the performed behaviour depends on how this behaviour is construed in the cognitive domain and within the ongoing context (including instructions or labels). For instance, Van Dessel, Eder and Hughes (2018) showed more positive evaluation of stimuli after distance-increasing behaviours (i.e., avoidance) than distance-reduction behaviours (i.e., approach), if the former is labelled “up” (label with a positive connotation) and the latter “down” (label with a negative connotation).

- Another theoretical model, the *inferential account* (Van Dessel et al., 2019), assumes that people often infer stimulus evaluations from their actions and that the evaluative influence of approach-avoidance behaviours results from general inferential mechanisms. In this model, inferences are propositions constructed on the basis of other propositions that depend on the individuals’ goals, on the context and past experiences. Propositions are statements about the world in which the relationship between elements are conserved: Although containing the same elements, the proposition “I love my family” is different from the proposition “My family loves me”, (De Houwer, 2014; Van Dessel et al., 2019). When approaching (avoiding) a stimulus, people generate propositions about 1) the relationship between the action and the stimulus (e.g., I approach this person), the relationship between this action and an evaluation (e.g., I generally approach cool and reliable persons), 3) the relationship between the specific stimulus and an evaluation based on the previous inferences of the process (e.g., This person is cool and reliable) and 4) use this later inference to evaluate the stimulus. In line with this idea, evidence shows that the mere instructions of a contingency between some stimuli and approach-avoidance behaviours suffice to influence stimuli evaluations accordingly (Smith et al., 2019; Van Dessel et al., 2015; Van Dessel et al., 2016, but see Van Dessel et al., 2020).<sup>4</sup>

This brief literature review supports the idea that approach and avoidance behaviours may actively contribute to the regulation of social interactions. More specifically, approach and avoidance behaviours appear to influence evaluation: Enacting approach behaviour leads to more positive evaluations than enacting avoidance behaviour. At the theoretical level, this evaluative influence of approach-avoidance behaviours is well in line with a view of cognition as grounded in sensorimotor interactions. However, this is less true at the empirical level, when

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<sup>4</sup> I acknowledge that the presented theoretical models do not necessarily claim to belong to the grounded view of cognition. However, they are not incompatible with it either, as such a view encompasses many ideas, adopted with different degrees (Hommel, 2015). For instance, in the inferential account, the authors specify that “propositions are not necessarily verbal, but can involve embodied or grounded representations” (Van Dessel et al., 2019, p. 269). Hommel (2015, 2016, 2020) devoted specific papers to highlight the compatibility between the common-coding account and a grounded view of cognition.

considering the experimental settings used to investigate this influence. I develop this point in the following sections.

#### **4. INVESTIGATING THE EVALUATIVE INFLUENCE OF APPROACH-AVOIDANCE: LIMITATIONS OF THE FIELD**

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##### **4.1. PREVIOUS OPERATIONALISATIONS OF APPROACH-AVOIDANCE BEHAVIOURS**

In line with the view that cognition is grounded in sensorimotor interactions, previous research suggests that approach-avoidance behaviours influence interpersonal evaluations. In order to causally investigate this evaluative influence, one has to manipulate approach and avoidance behaviours and test whether this manipulation changes evaluations. Researchers have to adequately operationalise interpersonal approach-avoidance behaviours on the basis of their definition. Beyond the question of interpersonal behaviours, approach and avoidance are defined as (motivated) behaviours aiming to reduce and increase the distance between individuals and an element of their environment. One may rely on approach behaviours to bite into a sweet and juicy peach, to smell the gentle fragrance of a flower, to kiss the forehead of your beloved or simply to meet and greet the smiling person in front of you. By contrast, one may rely on avoidance behaviours to push away a disgusting object, to scare off a bee flying around you, to dodge an undesired kiss or escape from an angry person. To recreate these situations in an experimental setting, isolated and inanimate stimuli, like pictures, words or abstract symbols, are generally presented on a computer screen. Participants have to respond to these stimuli in particular ways depending on how the experimenter operationalises approach and avoidance. Two types of approach-avoidance behaviours operationalisations prevail in the literature about their evaluative influence: Those based on specific muscular contractions and those based on perceived distance changes between the individual and the stimulus (Figure 2).<sup>5</sup>

***OPERATIONALISATIONS BASED ON FLEXION-EXTENSION.*** Because people generally flex their arms to approach and extend their arms to avoid graspable or small objects (e.g., the juicy peach, the flower, the disgusting object, the bee), approach-avoidance behaviours have been frequently operationalised through arm flexion-extension. More

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<sup>5</sup> In the literature about the influence of evaluations on approach-avoidance behaviours, when the behaviours are measured rather than manipulated, there is more variability in the used operationalisations.

specifically, two types of flexion-extension paradigms have been used for investigating the evaluative influence of approach-avoidance behaviours: the palm pressure paradigm (Cacioppo et al., 1993; Centerbar & Clore, 2006; Cretenet & Dru & Cretenet, 2008; Slepian et al., 2012) and the joystick paradigm (Kawakami et al., 2007; Woud et al., 2008). To illustrate the palm pressure paradigm, press the palm of your hand below the surface of a table exactly as if you wanted to lift it up to you. You should feel the contraction of the flexor muscles. Now, place your forearm on the table and press your palm on it just as if you wanted to push it down, away from you. You should feel the contraction of the extensor muscles. In the joystick paradigm, individuals hold a joystick in their hand and have to pull it or push it (Kawakami et al., 2007; Laham et al., 2014; Van Dessel et al., 2020; Woud et al., 2008). If, in general, these pull and push movements have been respectively used to operationalise approach (like when pulling something closer) and avoidance (like when pushing something away), this has not always been the case. For example, Mertens and colleagues (2018) manipulated approach through a push movement (like when trying to catch something) and avoidance through a pull one (like when removing one's hand from something). Actually, both flexion and extension may be involved in reducing or increasing the distance between the self and a stimulus. For instance, you could extend your arm to approach and caress your lovely pet but also flex your arm to bring your pet closer and cuddle him/her. Also, you could extend your arm to push away the bug on the table or withdraw and flex your arm to avoid any contact with the bug (the bug is probably more scared of you than you are of it but you never know).<sup>6</sup> This creates an ambiguity in the operationalisation of approach-avoidance behaviours. Indeed, it becomes difficult to know if one manipulates approach or avoidance. In order to avoid such an ambiguity, an operationalisation in terms of perceived distance changes has been proposed (Van Dantzig et al., 2008).

***OPERATIONALISATION BASED ON PERCEIVED DISTANCE CHANGES.*** When approach-avoidance operationalisations are based on distance changes, what matters is the ultimate distance change that is perceived between the self and the target stimulus. If the required behaviour leads to the perception of a distance reduction between the self and the stimulus, whenever it involves flexion or extension, it will be considered as an approach behaviour. Conversely, if the behaviour leads to the perception of a distance increase between the self and the stimulus, whenever it involves flexion or extension, it will be considered as an avoidance behaviour. In the literature about the evaluative influence of approach-avoidance,

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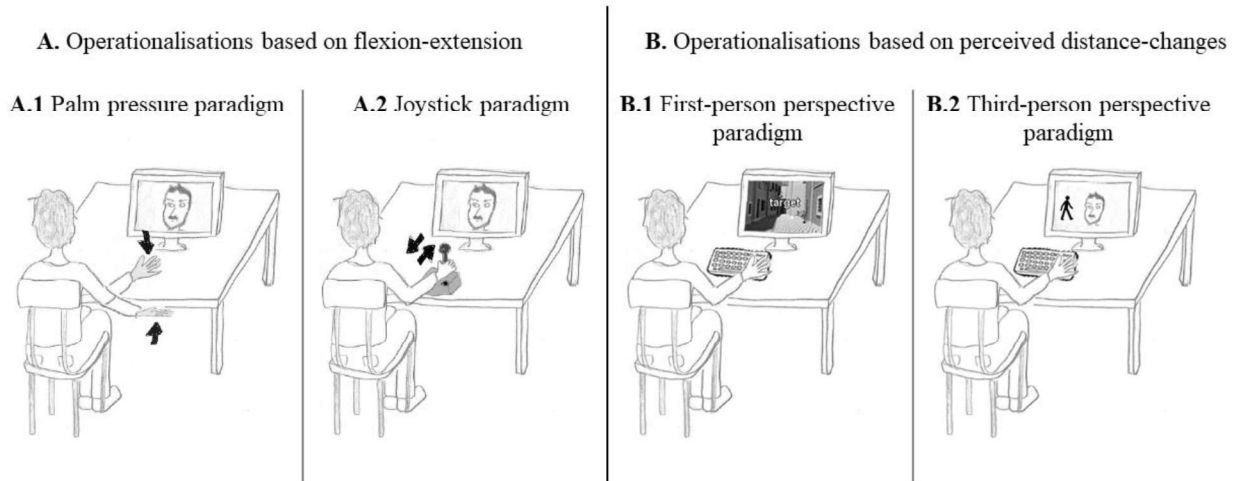
<sup>6</sup> One may also notice that for cuddling your pet and pushing the bug away, both flexion and extension are required.

perceived distance changes have been manipulated either from the first-person perspective (Batallier et al., 2019; Woud et al., 2008) or from the third-person perspective (Phills et al., 2011; Van Dessel, Eder & Hughes, 2018; Van Dessel, Hughes & De Houwer, 2018; Woud et al., 2013).

- From a first-person perspective, the reference point to determine whether the change in distance corresponds to an approach or an avoidance behaviour is the individuals' physical body. The visual stimulations occurring when individuals move towards or away from the stimulus are generally used to manipulate the perception of distance changes. For instance, researchers may rely on zoom-in and zoom-out effects. When these zoom effects are applied to the stimulus only (e.g., faces which become larger or smaller, Woud et al., 2008), they give the impression of bringing the stimulus closer (zoom-in, approach) or pushing it away (zoom-out, avoidance). When these zoom effects are applied to the whole visual environment (i.e., the stimulus and its background; Batallier et al., 2019), they give the visual impression of walking forward (zoom-in, approach) or backward (zoom-out, avoidance). In order to illustrate these zoom effects, put down this thesis manuscript and take a moment to navigate your environment. You can catch or push away some objects and observe changes in the size of the objects. You can also (discreetly) move towards or away from the persons around you and notice visual changes in both the stimuli and the environment. In both cases, the visual changes are relative to your own perspective but unperceivable from an outsider's point of view. Others relied both on flexion-extension and the perception of distance changes (Cervera-Torres et al., 2019; Woud et al., 2008; Zogmaister et al., 2016). For instance, zoom effects have been used to disambiguate flexion-extension movements (Huijding et al., 2009; Woud et al., 2008). To this purpose, the size of stimuli increases to give the impression of a distance reduction after pulling movements (i.e., approach) but decreases to give the impression of an increase in distance after pushing ones (i.e., avoidance). Another example of the combination of flexion-extension and perceived distance changes is the direct manipulation of stimuli presented on a touchscreen via swipe movements towards or away from individuals' body (Cervera-Torres et al., 2019).

- From a third-person perspective, the reference point to determine whether the change in distance corresponds to an approach or an avoidance behaviour is a *representation* of the individual. Individuals have to manipulate something that represents themselves like a little figure (Huijding et al., 2011; Hütter & Genschow, 2020; Van Dessel, Eder & Hughes, 2018; Van Dessel, Hughes & De Houwer, 2018; Woud et al., 2013) or a circle (Phills et al., 2011) towards or away from the stimuli. In this type of paradigm, the perceived distance changes do

not correspond to what is experienced by individuals when enacting approach and avoidance behaviours (e.g., specific muscular contraction, visual flow). Therefore, third-person perspective operationalisations of approach-avoidance are generally said to be symbolic (Woud et al., 2013).



*Figure 2.* Illustrations of operationalisations of approach-avoidance behaviours based on flexion-extension (A) and perceived distance changes (B)

#### 4.2. ISSUES WITH PREVIOUS APPROACH-AVOIDANCE OPERATIONALISATIONS

The fact that the literature shows evidence of an evaluative influence of approach-avoidance behaviours is well in line with a view of cognition as grounded in sensorimotor individual-environment interactions. Indeed, this view of cognition considers that sensorimotor interactions with the environment contribute to how individuals perceive their environment, including its evaluation (Barsalou, 2008; Newen et al., 2018; Niedenthal et al., 2005; Pecher & Zwaan, 2005). Because approach-avoidance behaviours are specific individual-environment interactions tightly linked to evaluative processes (Neumann et al., 2003; Strack & Deutsch, 2004), they are also supposed to contribute to this. Through such an influence, approach and avoidance behaviours would have an active (vs. passive) role during the regulation of social interactions. However, the way these behaviours have been operationalised in previous research about their evaluative influence (e.g., arm movements in a joystick task, displacements of a figure representing the self) does not sufficiently consider cognition as grounded in the sensorimotor interactions with the environment. More precisely, previous paradigms neglect 1) the role of the body and multisensory systems, 2) the role of the environment and 3) the role of action in cognition.

First, if cognition relies on the *body and multisensory systems* (i.e., the embodied nature of cognition), current operationalisations of approach-avoidance behaviours do not offer a sufficient grounding for cognition. Indeed, while real interpersonal approach and avoidance behaviours involve a multiplicity of multisensory cues (e.g., motoric, proprioceptive, interoceptive, auditory, visual), the above-mentioned operationalisations are mainly restricted to the motoric and/or visual modality. The lack of body concern is even more obvious in operationalisation relying on third-person perspective distance changes (Van Dessel, Eder & Hughes, 2018; Van Dessel, Hughes & De Houwer, 2018; Woud et al., 2013) in which participants do not experience any sensorimotor information involved in approach-avoidance behaviours. Not considering this multisensoriality is tantamount to considering only one part of the phenomenon. Indeed, each modality is part and parcel of a whole process which cannot be fully analysed through mechanical decomposition into its elements (Vygotsky, 1978). Even if one would aim to isolate the contribution of specific modalities in the effect, there is no reason to rely on single modality operationalisations because cognition is not the mere addition of single modality contributions. Of course, when considering cognition as grounded in individual-environment interaction, the solicitation of only one modality or the perception of distance changes between two stimuli could reactivate past multisensory experiences of approach-avoidance behaviours (Barsalou, 1999; Versace et al., 2014). Exactly in the same way that seeing the image of a lemon ice cream may produce the sensation of the acidic taste of the fruit, the cold sensation on your teeth and even the shiver that accompanies it when you eat it. However, each individual may reactivate very different traces depending on their past experiences. Therefore, when using a single modality, individuals could interpret the operationalised behaviours differently. And without the assurance that the chosen modality is the most prototypical one (the most able to reactivate similar traces across individuals), the risk of interindividual variability increases.

Some works distinguished themselves by proposing more ecological and multisensorial operationalisations of approach-avoidance to investigate their evaluative influence (Krpan & Fasolo, 2019; Streicher & Estes, 2016). For example, Streicher and Estes (2016) asked participants to contract their arm flexors or extensors in the presence of real products by moving a shopping cart differently (i.e., placing their hands on the underside or topside of the handlebar). In Krpan and Fasolo (2019), participants maintained an upper-body leaning forward or backward posture while surfing on a fictitious shop site. Beyond research about the evaluative influence of approach-avoidance behaviours, it is also possible to find promising



operationalisations of the behaviours like upper-body posture/inclination (Eder et al., 2020; Galton, 1884; Mehrabian, 1968; Word et al., 1974; Riskind, 1984; Price and Harmon-Jones, 2010) or walking steps towards vs. away from stimuli (Worthington, 1974; Dotsch & Wigboldus, 2008; Koch et al., 2009; Fayant et al., 2011; Stins et al., 2011).

Second, if cognition relies on the *environment* (i.e., the embedded and/or extended nature of cognition), current operationalisations of approach-avoidance behaviours do not offer a sufficient grounding for cognition. More precisely, past research investigating the evaluative influence of approach-avoidance behaviours were focused on the individual and underestimated the physical environment in psychological processes (Brunswik, 1957; Lewin, 1935; Tolman & Brunswik, 1935). The situations of social interactions under scrutiny are scaled down to isolated and minimal encounters with inanimate stimuli (Neisser, 1980; Smith & Semin, 2004). Participants performed approach-avoidance behaviours in response to pictures of individuals' face (Kawakami et al., 2007; Slepian et al., 2012; Van Dessel et al., 2020; Woud et al., 2008; Woud et al., 2013) or names of fictitious group members (Van Dessel et al., 2016; Van Dessel, Eder & Hughes, 2018). Failures to take into account the environment (stimuli and the context in which they occur) may lead to unsatisfactory or ambiguous operationalisations (Markman & Brendl, 2005; Seibt et al., 2008; Van Dantzig et al., 2008; Beatty et al., 2016). Indeed, both flexion and extension can either be considered as approach or avoidance depending on the context. For instance, imagine bringing a delicious, but slightly crushed, raspberry from your birthday cake to your mouth or withdrawing your hand from a slightly crushed raspberry left by someone else on a bench. Both situations involve arm flexion but one may agree that you approach the raspberry in the former and avoid it in the latter.<sup>7</sup> Depending on individuals, the operationalised behaviours may be contextualised in different ways and this ambiguity increases variability in the interpretation of behaviours (for a similar reasoning on the processing of concepts see Yeh & Barsalou, 2005). Certainly, this negligence is not new and specific to approach-avoidance. Yet, Egon Brunswik warned about it in 1957: "Both historically and systematically, psychology has forgotten that it is a science of organism-environment relationships and has become a science of the organism" (p. 6).

Research about the evaluative influence of approach-avoidance behaviours proposes some promising attempts to remedy the extra-bodily mis-embodiment situation. For instance, in the context of a social interaction, performing an approach or avoidance behaviour generally

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<sup>7</sup> Even among researchers, the categorisation of flexion as approach and extension as avoidance is not consensual (for the reverse categorisation see Mertens et al., 2018).

involves concurrent changes in visual angles of both the surrounding environment and the stimulus (Rougier et al., 2018). To better capture this specificity when investigating approach-avoidance evaluative influences, some relied on the simulation of whole-body movements in a realistic environment from a first-person perspective (Batallier et al., 2019). Although investigating approach-avoidance behaviours as measured outcomes (and not for their evaluative influence), some research has given even more weight to the environment relying on real everyday life situations (Worthington, 1974) or on Virtual Reality (Dotsch & Wigboldus, 2008; Eder et al., 2020).

Third, and related to the lack of embodiment considerations, we can also argue that if cognition relies on the *individuals' abilities and dispositions to act* (i.e., the enacted nature of cognition), current approach-avoidance operationalisations do not offer a sufficient grounding for cognition. Indeed, previous work somewhat overlooked the fact that, in real social interactions, the involved parties are dynamic. Generally, they presented static stimuli on the screen. By doing so, they adopted a too passive conception of social cognition and missed its interactive nature (Neisser, 1980). More specifically, they under-appreciated the fact that perceiving dynamic stimuli predisposes individuals to react to them (Kockler et al., 2010). Moreover, social stimuli like individuals afford a broad range of specific whole-body interpersonal approach-avoidance behaviours (Valenti & Gold, 1991). Because these affordances could change the realisation of the behavioural sequence (Becchio et al., 2008; Ferri et al., 2011), they may interfere with the enactment of operationalised approach-avoidance behaviours. For instance, during an experiment, stimuli like individual's face pictures may predispose participants to enact whole-body approach-avoidance behaviours rather than arm flexion-extension ones. These latter would be more relevant for interacting with graspable objects. Therefore, in front of face pictures arm flexion-extension operationalisations (Kawakami et al., 2007; Slepian et al., 2012; Woud et al., 2008) do not match with participants' predispositions and seem unwarranted.

Few studies emphasised the importance of considering the active individual's engagement in and with the environment when investigating the effect of approach-avoidance on evaluations. For instance, by respectively presenting flexion and extension as collecting and discarding actions in a foraging task, Laham and colleagues (2014) obtained a larger approach-avoidance training effect than without contextual framing. There is also evidence that approach-avoidance behaviours consequences, in terms of pleasant or unpleasant outcomes, influence the effect (Mertens et al., 2018; Van Dessel, Hughes & De Houwer, 2018). One study also suggests

that, depending on their internal state (i.e., thirst), individuals are engaged in different interactions with their environment, which can influence the effect of approach-avoidance behaviours on evaluations (Zogmaister et al., 2016). Nevertheless, each of these studies considers only one key element of cognition in isolation (e.g., the body, the situation of interaction) and still neglect that the evaluative influence of approach-avoidance behaviours should emerge from the individual-environment interaction as a whole.

To summarise, if one wants to investigate the evaluative influence of approach-avoidance behaviours, and thus their contribution in the social interaction regulation, one must take into account the whole situation of individual-environment interaction in which they occur. All constituents of this interaction, including modality-specific systems in the brain, the body as well as the physical and social environment, participate in cognition (Barsalou, 2008; Overmann & Malafouris, 2018). More importantly, when human cognition is investigated, these elements must not be considered separately. They must be integrated into a coherent whole embracing the ongoing and past experiences. Otherwise, researchers run the risk of low ecological validity, both in terms of the cues they relied on (i.e., the extent to which information available in the environment provides valid information about a distal stimulus; Brunswik, 1955) than in terms of their experiments (i.e., the extent to which experimental findings can generalise to the “real world” situation that a researcher wishes to understand; Orne, 1962).<sup>8</sup> This has not been sufficiently the case in previous research about the evaluative effect of approach-avoidance behaviours. This latter has overlooked the role of the body, the environment and the active engagement of individuals in this environment when operationalising approach and avoidance behaviours. Attempts to remedy this, while promising, usually do not address all issues at once or do not concern the role of approach-avoidance behaviours in interpersonal evaluations. In particular, the structural coupling between individuals’ brain, body and (social) environment must be considered. Quoting Wilson and Clark (2009), to study cognition is “to corral cognition in its den: To track nature taking its cognitive course” (p.74). Otherwise, the evaluative influence of approach-avoidance may appear as a poor approximation of its real-life counterpart and may be bound to take a fairly

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<sup>8</sup> For a detailed comparison of the Brunswik’s and Orne’s use of the ecological validity concept, see Kihlstrom (2021).

different form as the elaborateness of the situation increases. This could potentially represent a serious impediment in the comprehension of how individuals regulate their social interactions.<sup>9</sup>

## 5. THE CURRENT THESIS

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Due to the centrality of social interactions in the life of human beings, it is important to understand how individuals regulate their interactions with other people. Approach and avoidance behaviours seem to play a crucial role in this process. Indeed, individuals approach those who could satisfy their need for social interaction and thus whom they evaluate as positive. On the contrary, they avoid those who could not satisfy their need and thus whom they evaluate as negative. But this may only be one side of the process. Indeed, cognition, how individuals make sense of their environment, could be considered as grounded in the sensorimotor interactions between individuals and their environment (Barsalou, 1999; 2008; Pecher & Zwaan, 2005; Smith & Semin, 2004; Varela et al., 1991; Wilson, 2002). Cognition serves the adaptive regulation of action and emerges from the sensorimotor individual-environment interactions (Smith & Semin, 2004). The ongoing social interaction is supposed to echo multisensory traces of similar past experiences (Barsalou, 1999; Papiés et al., 2020; Versace et al., 2014). And this is the combination of current and past sensorimotor experiences should influence how individuals perceive their environment in order to ease the enactment of appropriate behaviours (Balçetis & Cole, 2009). In this way, sensorimotor interactions should play a crucial role in regulation processes. In line with this idea, the literature suggests that approach and avoidance behaviours are not mere responses to the environment but could actively participate in the regulation of individuals' social interaction by influencing how they evaluate others. More precisely, enacting approach behaviours towards someone leads to more positive interpersonal evaluations than enacting avoidance behaviours (Slepian et al., 2012; Woud et al., 2008). I argued that previous research in the field has not sufficiently appreciated the importance of considering cognition as grounded in individual-environment interactions. They overlooked how much the body, the environment and their interaction are central to cognition. Yet, this is crucial if one wants to understand how individuals regulate their social

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<sup>9</sup> One may retort that the grounding of cognition in the individual-environment interactions is a conception of cognition that one may or may not (or to the same extent) adopt (Menary, 2010). If researchers do not consider action to play a role in cognition (i.e., enacted cognition), whether or not the manipulated behaviours match affordances in the environment does not matter. However, researchers should design experiments in such a way that the assumptions of all conception have the same opportunities to be investigated.

interactions because cognition serves the regulation of individuals behaviours. Therefore, this neglect of the nature of cognition offers a too narrow and fixed picture of the potential regulatory nature of approach-avoidance behaviours in social interactions.

In the present contribution, I adopt a grounded view of social interactions regulation. Arguing that approach-avoidance behaviours are sensorimotor individual-environment interactions, I defend the thesis that they actively participate in how individuals regulate their social interactions by influencing evaluations. If this is the case, during a social interaction 1) approach and avoidance behaviours should influence how individuals evaluate the other so as to facilitate appropriate behaviours and 2) this process should flexibly adapt to changing demands by integrating any modification in the current situation (Balci et al., 2009; Semin & Cacioppo, 2008). Previous paradigms used to investigate the evaluative influence of approach-avoidance have not sufficiently considered human cognition as being grounded in and emerging from sensorimotor individual-environment interactions. They also revealed some inconsistent results with no influence of the behaviours on evaluations (Krishna & Eder, 2018; Vandebosch & De Houwer, 2011). Therefore, the picture of the phenomenon that the literature offers may appear as a poor approximation of its real-life counterpart. Obtaining a better estimation of the effect is thus a crucial step before testing any opposition of theoretical models or specific underlying mechanisms. To fill this gap, I aim to investigate the evaluative influence of approach-avoidance by transposing the theoretical implications of a grounded view of cognition to the experimental level. I took advantage of immersive virtual reality (IVR) to operationalise whole-body approach-avoidance behaviours in an interpersonal context.

### **5.1. TOWARDS A MORE ECOLOGICAL OPERATIONALISATION OF APPROACH-AVOIDANCE BEHAVIOURS**

In IVR, a virtual environment is presented to individuals according to the tracking of their movements in order to simulate their physical presence in this environment (Fox et al., 2009). IVR allows the investigation of individual-environment interactions that are close to those unfolding in the real world (Pan & Hamilton, 2018). Therefore, IVR is particularly well-suited for investigating the role of approach-avoidance in social interactions regulation. Contrary to previous paradigms, it permits us to fully consider the role that the body, the environment and individuals' actions play in cognition. First, IVR enables to take into account the embodiment of the investigated phenomenon. In the virtual environment, participants receive real-time sensory feedback (including movement, sounds, speech, vision, etc.) in

response to their own movements. By perceiving modality-specific inputs within the virtual environment from a first-person perspective, participants get a realistic subjective experience of possessing a body (i.e., self-embodiment; Pan & Hamilton, 2018; see also Kilteni et al., 2012; Slater et al., 2010). Second, IVR enables the reproduction of a rich and complex social environment in three dimensions. Participants can be immersed in virtual, but realistic, common everyday social interactions (e.g., a bus stop; Dotsch & Wigboldus, 2008; Gillath et al., 2008). Compared to classical paradigms, social stimuli are no longer inanimate stimuli presented on a computer screen but human-like animated agents. Third, IVR allows us to consider the role of action in cognition. Indeed, the presentation of dynamic virtual individuals accounts for the fact that people met in everyday life are dynamic and therefore predispose to react to them (Kockler et al., 2010; Valenti & Gold, 1991). Moreover, the surrounding virtual environment can naturally constraint the physical abilities of the user in a way that operationalised behaviours and afforded predispositions match one another. For example, beyond the experimenter instructions, one may constraint users to lean their upper-body (instead of walking) by placing them on a chair in front of virtual individuals sitting at a table.

In this way, IVR allows the investigation of the evaluative influence of approach-avoidance behaviours by fully considering cognition as grounded in sensorimotor individual-environment interactions. Importantly, it does so while maximising experimental control. For this reason, for this thesis, I have relied on IVR for operationalising approach-avoidance behaviours. More specifically, I have relied on two realistic virtual environments: A bus stop in the street, and an office room. For each virtual environment, a specific instantiation of approach-avoidance behaviours has been used to recreate real-life inspired situations. In the street environment, participants stood at a bus stop and had to take one step towards or away from virtual individuals. In the office environment, they were seated at a table and had to lean their chest towards or away from virtual individuals.

It must be specified that, when recreating naturalistic interactions, the important feature is not the objective realism of the environment *per se* but rather the maximisation of the subjective experience of realism of this environment. This subjective experience is generally well 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). Precautions should be taken to ensure that the experimental settings do not provide a poor feeling of presence that could hinder the IVR experience.

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). Here, we capitalise on the advances of IVR technology to highlight the contribution of approach-avoidance on interpersonal evaluations. By immersing participants in realistic situations with multisensory stimulations (including movement, sounds, speech, vision, etc.), IVR seems to be a promising tool for the implementation of interpersonal approach-avoidance behaviours.

## 5.2. THE CURRENT EMPIRICAL RESEARCH PROGRAM

I argued that approach-avoidance behaviours are not mere passive reactions to the environment. On the contrary, I defend the idea that they actively participate in the regulation of individual's social interactions. They contribute to how individuals evaluate the other so as to facilitate the appropriate behaviour. I investigate this idea in three empirical chapters (Figure 3).

If approach and avoidance actively contribute to the regulation of individuals' social interactions, they should influence how individuals perceive their environment so as to facilitate appropriate behaviours (i.e., relevant for their need to create and maintain social interactions, Balcetis & Cole, 2009). I investigate this point in the first two chapters. More precisely, I investigate how approach-avoidance behaviours influence evaluations of the others during social interactions. As a starting point, I focus my analysis to casual and relatively neutral daily life contexts of social interactions. In such contexts and in line with the literature, enacting interpersonal approach behaviours should lead to more positive evaluations of the other than enacting avoidance (Slepian et al., 2012, Woud et al., 2008)<sup>10</sup>. Because positive and negative evaluations foster approach and avoidance (Chen & Bargh, 1999), this evaluative influence may facilitate the enactment of adequate behaviours and the creation of social interactions. In **Chapter 1**, I test how approach and avoidance behaviours influence immediate interpersonal evaluation (i.e., directly after having performed the behaviour in response to the other). The effect of approach-avoidance on immediate evaluations has been quite rarely investigated in the literature (compared to their effect in training procedures). If approach and avoidance actively participate in the regulation of social interaction, they should influence immediate evaluations.

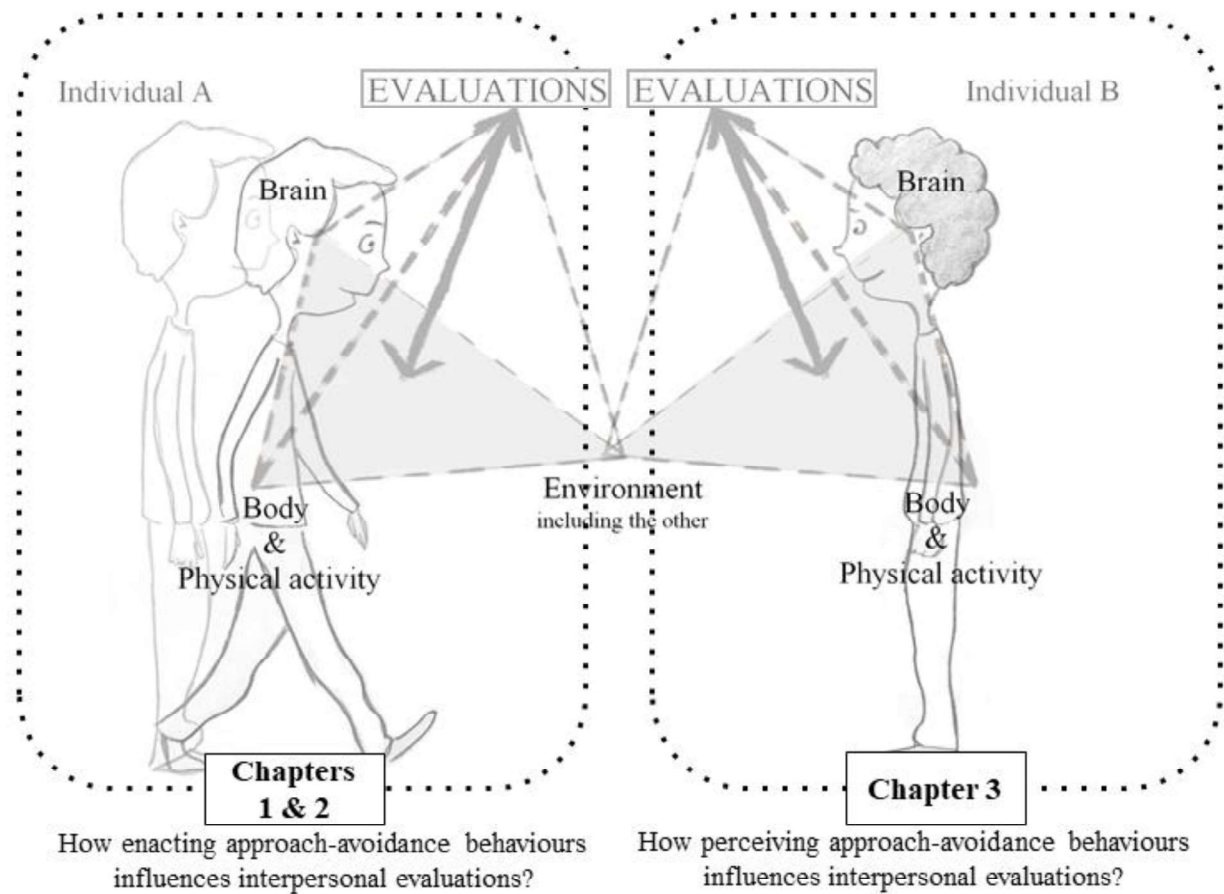
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<sup>10</sup> As already emphasised, the evaluative influence of approach-avoidance behaviours depends on the current context. If the positive influence of approach as compared to avoidance is expected to be observed in quite neutral and daily life situations, approach would probably not lead to more positive evaluations than avoidance in high threatening contexts (e.g., when approach is followed by electric shocks, Mertens et al., 2018).

Indeed, these evaluations would be directly relevant for the ongoing interaction. Contrary to previous work relying on very minimalist and unrealistic experimental situations, I rely on the insights of a grounded perspective of cognition to propose more encompassing operationalisations of approach-avoidance to investigate their influence on evaluations. Across six studies, we vary the approach-avoidance operationalisations (upper-body incline, upper-body posture and walking steps) and incrementally consider the grounded assumptions. Two of these studies are conducted in IVR and preregistered. In line with the literature, we predict more positive (immediate) evaluations of individuals when participants approach them than when they avoid them. In **Chapter 2**, I focus on the regulation of an interaction with an outgroup member. I investigate the contribution of approach-avoidance behaviours in group evaluations. If there is evidence of such an evaluative influence in the literature (Kawakami et al., 2007; Phillips et al., 2011; Van Dessel et al., 2020), previous work partly neglected the subtleties of interpersonal interactions and may offer a limited (or oversimplified) picture of the phenomenon. In two preregistered experiments, we appropriately operationalise interpersonal approach-avoidance behaviours to investigate their influence on group evaluations. We predict that approach behaviours should lead to more positive group evaluations than avoidance.

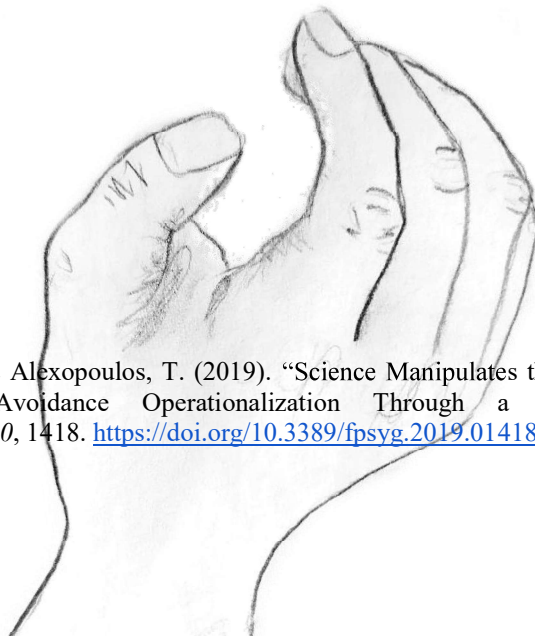
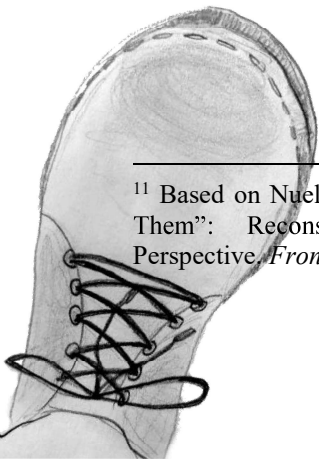
Social interactions necessarily imply the presence of another person who therefore, becomes part of the individual's environment. Importantly, this other is also engaged in the social interaction and dynamically reacts to the individual's behaviours. These reactions may influence the course of the social interaction (e.g., the other may react aggressively). If approach and avoidance behaviours actively participate in the regulation of social interaction, any change in the situation, including in the other, should be considered in their investigation. I apply this reasoning in **Chapter 3**. More precisely, as a first step for a more complete comprehension of how approach-avoidance behaviours regulate individuals' social interactions, I investigate how approach behaviours could influence the individual who is approached. Ironically, being approached could be negatively perceived and lead to more negative interpersonal evaluations: this is referred to as the approach-aversion effect (Hsee et al., 2014). Although previous research brings initial evidence of this approach-aversion effect, it leaves some questions unanswered regarding the explanation and the generalisation of such effect. To fill this gap, we rely on IVR and provide a powerful and highly ecological test of the approach-aversion effect in the context of social interactions. Across three well-powered preregistered experiments, participants gave their impression about approaching and static virtual individuals. We predict more negative evaluations for approaching than for static virtual individuals.





*Figure 3.* Schematic representation of the regulation process in social interactions and the focus of the current thesis

# Chapter 1<sup>11</sup>



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<sup>11</sup> Based on Nuel, I., Fayant, M. P., & Alexopoulos, T. (2019). "Science Manipulates the Things and Lives in Them": Reconsidering Approach-Avoidance Operationalization Through a Grounded Cognition Perspective. *Frontiers in Psychology*, 10, 1418. <https://doi.org/10.3389/fpsyg.2019.01418>

If approach-avoidance actively participate in the regulation of social interactions, they should influence how individuals perceive their environment so as to facilitate appropriate behaviours (Balci et al., 2009). One way of doing that is by exerting an influence on the evaluation of the other. When performing an interpersonal approach or avoidance behaviour, all experienced sensorimotor transformations should echo multisensory traces of past experiences in which individuals generally approached positive stimuli and avoided negative ones (Barsalou, 1999; Papies et al., 2020; Versace et al., 2014). The literature suggests that approach-avoidance behaviours contribute to the evaluation of the other: Performing an approach behaviour leads to more positive evaluations of the interaction partner as compared to performing an avoidance one (Slepian et al., 2012; Woud et al., 2008). Therefore, through this evaluative influence, approach and avoidance behaviours foster their own enactment because positive and negative evaluations predispose to approach and avoidance behaviours respectively (Lewin, 1935; Chen & Bargh, 1999).

However, current evidence of the evaluative influence of approach-avoidance is limited for two reasons. First, previous research did not sufficiently consider social cognition as grounded in the sensorimotor interactions with the environment. They relied on very minimalist and unrealistic settings, scaling down the situation of social interactions to isolated and minimal encounters with stimuli. By doing so, they were unable to fully capture the active role of approach-avoidance behaviours in the process of interpersonal evaluation. Second, the influence of approach-avoidance behaviours on interpersonal evaluations has been mainly investigated through delayed evaluations (Cacioppo et al., 1993; Slepian et al., 2012) or trainings to approach or avoid stimuli (Van Dessel, Eder & Hughes, 2018; Woud et al., 2008). The evaluative influence of approach and avoidance behaviours has been quite rarely investigated on immediate evaluations (i.e., directly after having performed the behaviour in response to the stimulus). Cacioppo and colleagues (1993) added immediate like-dislike judgments in their experiments to engage participants in an evaluative processing of the stimuli during arm flexion-extension. They did not obtain an influence of approach-avoidance on these judgments but specified that this dichotomy judgment was too insensitive to capture this influence. Moreover, although it was not their primary focus, Eder and Klauer (2009) showed that enacting an approach (avoidance) behaviour bias the immediate interpretation of neutral stimuli towards the positive (negative). If approach-avoidance behaviours actively participate in the regulation of individuals' social interactions, they should also influence evaluations on the spot. Therefore, the current state of the art may offer a limited picture of the phenomenon.

In order to understand the role of approach-avoidance behaviours in the regulation of social interactions it is thus necessary to 1) develop an operationalisation of approach-avoidance reflecting both their sensorimotor and interactive nature as well as past approach-avoidance experiences and 2) test their influence on immediate interpersonal evaluations. This is the aim of this chapter. By considering cognition as grounded in sensorimotor interactions I propose operationalisations of approach-avoidance and investigate their influence on ongoing evaluations thanks to IVR.



# “Science Manipulates the Things and Lives in Them”: Reconsidering Approach-Avoidance Operationalization Through a Grounded Cognition Perspective

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Approach and avoidance orientations are key elements of adaptive regulation at the evaluation-behavior interface. On the one hand, continuous evaluations of the world fuel approach-avoidance reactions as a function of the individual's immediate environment. On the other hand, in turn these individual-environment adjustments influence evaluations. A grounded perspective of social cognition, placing the sensorimotor aspects of individual-environment interactions at the core of cognition, has much to offer for the understanding of evaluative processes. Despite the growing enthusiasm for a grounded view of cognition and action in the approach-avoidance literature, its core principles are seldom reflected at the operationalization level. In this paper, we relied on the insights of a grounded perspective to propose more encompassing operationalizations of approach-avoidance orientations and investigate their influence on evaluations. Across six studies, we varied the approach-avoidance operationalizations (upper-body incline, upper-body posture and walking steps) and incrementally considered the grounded assumptions. We failed to obtain the theorized positive effect of approach (as compared to avoidance) on evaluations. Interestingly, further exploratory analyses on two studies conducted in Virtual Reality suggested that the more participants felt being *present* in the situation, the more the approach-avoidance ecological actions activated the corresponding neuropsychological systems. We discuss these emergent findings in light of grounded cognition and the notion of feeling of presence.

**Keywords:** approach-avoidance, grounded cognition, evaluations, construct validity, virtual reality

## INTRODUCTION

“Science manipulates things and gives up living in them” Merleau-Ponty (1964). Individuals' interactions with their social world are steered by two fundamental forces: approach and avoidance — i.e., the energization to move toward or away (Price and Harmon-Jones, 2016). The literature shows a flexible two-way influence between approach-avoidance and the way people evaluate their environment. Such an interplay enables individuals to tailor their behavior to the

current challenges and constraints of the immediate situation. A grounded cognition perspective has much to say about approach-avoidance orientations, as it specifically addresses the dynamic interactions between the brain, the body, and the environment. However, we contend that up to now experimental implementations of approach-avoidance have not fully exploited the theoretical insights provided by a grounded view of cognition. In this paper, the major goal is to capitalize on the grounded cognition perspective, which offers a useful theoretical toolbox to conceive appropriate and warranted operationalizations of approach-avoidance orientations. In doing so, we aim to circumvent the limitations of previous research and to offer a more ecological investigation of the influence of approach and avoidance on social information processing.

Approach and avoidance represent the elemental energization and direction of behavior for a majority of living organisms (from unicellular ancestors to more complex ones). Humans, like every organism, are able to adapt to their dynamic environments by reducing the distance toward appetitive stimuli and increasing the distance vis-à-vis noxious stimuli in keeping with their survival (Schneirla, 1959; Elliot and Covington, 2001; McNaughton et al., 2016). Hence, individuals' survival strongly depends on their ability to spontaneously detect approachable and/or avoidable entities (objects, people, events, ideas). This detection is assumed to spontaneously trigger appropriate behaviors (Chen and Bargh, 1999; Alexopoulos and Ric, 2007; Rougier et al., 2018). On a majority of cases, entities that entail a positive value for the organism trigger approach while those entailing a negative value trigger avoidance. Concerning interpersonal situations, research shows that, during social interactions, people tend to approach others if they seem trustworthy (Slepian et al., 2012), are smiling (Stins et al., 2011) or belong to the same group (Paladino and Castelli, 2008); but tend to avoid them if they display anger (Stins et al., 2011) or represent members of stereotyped and prejudiced groups (Word et al., 1974; Neumann et al., 2004; Paladino and Castelli, 2008). At the same time, when individuals are engaged in approach or avoidance behaviors, their cognitive activity is tuned to meet the specific requirements for goal attainment. For instance, people evaluate more positively stimuli or people they approach as compared to those they avoid (Cacioppo et al., 1993; Kawakami et al., 2007; Wiers et al., 2011; Slepian et al., 2012; Woud et al., 2013b). As a result, approach and avoidance regulate individual-environment interactions through a cyclical loop: continuous evaluation guides behavior appropriately and, in turn, ongoing behavioral activity spurs compatible evaluative processes. This cyclical influence possesses a functional value as it allows individuals to effectively pursue their actions until goal attainment (Förster et al., 2007).

As humans are social organisms endowed with a high level of complexity, they tend to deploy their approach-avoidance repertoire flexibly (Schneirla, 1959). Thus, the interplay between evaluated stimuli and approach-avoidance actions is not hard-and-fast but flexible and context-sensitive. Among other examples, the presence/absence of affective evaluation goals as well as the action outcome moderate the influence of approach-avoidance actions

on evaluations (Cacioppo et al., 1993; Mertens et al., 2018). Moreover, approach-avoidance orientations may support distal goals, meaning that evaluations can trigger incompatible behaviors (e.g., approaching a very critical researcher) if they ultimately lead to compatible effects (e.g., the exchange will benefit one's work; Krieglmeyer et al., 2011).

Obviously, approach-avoidance orientations represent the key elements of an adaptive process at the evaluation-behavior interface. Such a process implies a constant combination of sensorimotor interactions with the world involving the brain, the body and the situation. It appears thus compelling to conceptualize approach-avoidance orientations by capitalizing on a view of cognition that emphasizes the role of brain-body-environment interactions.

Historically, since the advent of the cognitivist revolution, cognition has been considered to involve a relatively independent brain system performing computations on abstract and amodal representations (i.e., involving the symbolic translation of perceptual, motor and introspective states). Within this computationalist tradition, approach and avoidance were considered as amodal action representations and the body was a mere vehicle executing those actions based, for instance, on their threshold activation (Bower, 1981; Carver and Scheier, 2000). It has been argued since, that such a view of cognition cannot be adaptive as it is far too rigid and detached from ongoing brain-body-environment interactions, and these objections set the stage for alternative views.

A grounded view of cognition offers a more encompassing account of the flexible two-way influence between approach-avoidance tendencies and evaluation than the computationalist view. From such a perspective, human cognition is *grounded*<sup>1</sup> in modality specific systems, in the body and actions, as well as in the physical and the social environment (Wilson, 2002; Niedenthal et al., 2005; Pecher and Zwaan, 2005; Barsalou, 2008, 2015). According to one common approach within this perspective, as individuals interact with their world, the brain captures and integrates traces of perceptual, motor and introspective states into multimodal and situated representations (situated conceptualizations, Damasio, 1989; Barsalou, 1999, 2008; Barsalou, 2003, 2015; Versace et al., 2014). A matching between actual experience and some previously captured traces can reactivate the (whole) patterns of traces of the corresponding past experiences. This multimodal simulation aligns the brain and the body with past experiential states (*re-enactment*) depending on what is relevant for the immediate situation (i.e., physical environment, potential for actions, motivational/emotional states, etc.). This process is adaptive because it enables individuals to both anticipate and adapt their interactions to the world based on their past sensorimotor interactions as well as their actual environment. From a grounded perspective, repeated approach-avoidance interactions with the world entail the accumulation of motor, perceptual and introspective states (including positive and

<sup>1</sup>In keeping with Barsalou (2008), we used the term *grounded* rather than *embodied* to address all forms of cognitive grounding: not only based on the body, but also on modalities, on situated actions and on physical as well as social environments.



negative ones). Thus approach-avoidance orientations can be defined as the re-enactment of these states which impels to move toward or away (Papies and Barsalou, 2015).

Such a grounded perspective dictates specific operationalizations at the empirical level. Indeed, an optimal approach-avoidance manipulation should enable a close matching between the ongoing experience and past approach-avoidance traces. This depends on the potential of the current setting or situation to activate: (1) *prototypical* (i.e., most representative in terms of memory traces), (2) *multimodal*, as well as, (3) *situated* traces of approach-avoidance experiences (Barsalou, 2003, 2005, 2015; Versace et al., 2014; Papies and Barsalou, 2015). Here, we argue that approach-avoidance operationalizations from previous research (even those which are anchored in a grounded perspective) do not entirely reflect their grounded essence, as they have not systematically and jointly integrated the three aforementioned aspects.

### Trace Prototypicality

Past research frequently operationalized approach-avoidance through arm flexion-extension as people generally flex (vs. extend) their arm to approach (vs. avoid) positive (vs. negative) graspable objects. These operationalizations involved among others: pressing the palm below/above the surface of a table, pulling/pushing a joystick, pressing/releasing a button, etc. (Cacioppo et al., 1993; Wentura et al., 2000; Kawakami et al., 2007; Laham et al., 2014). Others relied on oral muscular contractions resembling deglutition of edible substances (approach) or expectoration of noxious ones (avoidance; Topolinski et al., 2014). However, these two motor-based operationalizations cover a relatively restricted number of approach-avoidance experiences: not all external stimuli can be grasped, nor do they concern oral consumption (Rougier et al., 2018). Instead, whole-body operationalizations are more likely to capture most past approach-avoidance experiences. Among these whole-body operationalizations, we find: upper-body posture/inclination (Galton, 1884; Mehrabian, 1968; Word et al., 1974; Riskind, 1984; Price and Harmon-Jones, 2010), walking steps (Worthington, 1974; Dotsch and Wigboldus, 2008; Koch et al., 2009; Fayant et al., 2011; Stins et al., 2011), and simulation of whole-body movements (from a third-person perspective<sup>2</sup>, De Houwer et al., 2001; or from a first-person perspective, Rougier et al., 2018).

### Trace Multimodality

Some scholars constrained operationalizations of approach-avoidance to a single modality (e.g., motor information, Cacioppo et al., 1993; Topolinski et al., 2014; visual information, De Houwer et al., 2001; Rougier et al., 2018). From a grounded perspective, it is indeed conceivable that information in one modality activates other modality-specific

<sup>2</sup>Admittedly, the Manikin Task of De Houwer et al. (2001) does not involve whole-body movements *per se*. In this task, participants have to move a little figure representing the self toward or away from the stimuli. Even if the Manikin Task is not anchored in a grounded perspective, it is still conceivable that the perceived visual distance change could re-enact whole-body approach-avoidance experiences.

traces of approach-avoidance (Damasio, 1989; Barsalou, 1999; Versace et al., 2014). However, an efficient simulation of approach-avoidance states should involve as many different multimodal traces of past experiences as possible (Labeye and Versace, 2007). For instance, a (visual) zoom effect has been combined to the (motor) pulling/pushing joystick movements in order to enhance the operationalization of approach-avoidance orientations (Rinck and Becker, 2007; Krieglmeier and Deutsch, 2010). Hence, approach-avoidance operationalizations that combine motor, visual and proprioceptive information are more likely to enable the re-enactment of the corresponding states. Among these multimodal operationalizations, we consider: upper-body postures (Price and Harmon-Jones, 2010) or walking steps (Fayant et al., 2011; Stins et al., 2011; Bouman and Stins, 2018). Indeed, these whole-body approach-avoidance behaviors inherently entail changes in information flow and visual perspective while concurrently engaging motor components.

### Trace Situatedness

The majority of work relied on operationalizations of approach-avoidance experiences that scale down the situation to isolated and minimal encounters with stimuli (even when, paradoxically, they make use of prototypical and multimodal aspects, Fayant et al., 2011, Exp. 2; Rougier et al., 2018)<sup>3</sup>. Undoubtedly, this practice runs counter the assumption that the perceptual, motor and introspective traces of approach-avoidance states are not stored in isolation but together with traces of the situation settings in which these states occurred (e.g., elements of the environment, action possibilities, individuals' intentions, emotional states; Barsalou, 2003, Papies and Barsalou, 2015). Failures to take into account this situatedness may lead to unsatisfactory or ambiguous operationalizations (Markman and Brendl, 2005; Seibt et al., 2008; Van Dantzig et al., 2008; Beatty et al., 2016). Indeed, depending on the situation, the very same muscular contraction can either be considered as approach or avoidance: for example bringing a cake closer or withdrawing one's hand from a spider both involve arm flexion<sup>4</sup>, and deglutition involves the swallowing of appetitive food stimuli but could also be involved in stress reactions (Ritz and Thöns, 2006). Moreover, as any situation, the experimental setting offers specific action possibilities (i.e., *affordances*) that may interfere with traces targeted by the operationalization of approach-avoidance orientation (Cesario et al., 2010). For instance, intrinsically social stimuli as faces generally evoke whole-body approach-avoidance behavioral actions which are relevant for social interactions. In front of such stimuli, arm flexion-extension operationalizations that activate traces of approach-avoidance experiences in

<sup>3</sup>These experiments involved for example approach-avoidance toward isolated words presented on a screen. Indeed, in everyday life words on posters or signs may sometimes appeal or repel people, but evidently this constitutes a fairly small subset of approach-avoidance experiences.

<sup>4</sup>The same contraction can also be interpreted differently across studies. Generally, scholars considered that flexion is involved in bringing something closer to the self (approach) while extension is involved in pushing something away (avoidance). However, some studies operationalized approach as extension and avoidance as flexion (Mertens et al., 2018).

response to graspable objects (Kawakami et al., 2007; Slepian et al., 2012, but see Streicher and Estes, 2016) seem unwarranted, to say the least. Therefore, an optimal manipulation of approach-avoidance should rely on contextualized and ecological whole-body approach-avoidance experiences which by virtue of their situatedness re-enact more fully the corresponding states. As appropriate examples of situated approach-avoidance operationalizations we can readily identify those that rely on real life settings and/or confederates (Word et al., 1974; Worthington, 1974)<sup>5</sup> and those that rely on Virtual Reality (Bailenson et al., 2003; Dotsch and Wigboldus, 2008; Ruggiero et al., 2017) although these works dealt more with proxemics than approach-avoidance behaviors *per se*.

From this literature review, it follows that operationalizations of approach-avoidance orientations relying on **multimodal interactive and contextualized whole-body movements** are the most suitable to reflect their grounded essence. So far, and despite some promising attempts, approach-avoidance operationalizations did not jointly consider the prototypicality, multimodality and situatedness requirements that emerge from an analysis of grounded cognition.

## OVERVIEW OF THE STUDIES

In this paper, we argue that even if a grounded view of approach-avoidance orientations has gained in popularity over the past few years, somewhat ironically, its theoretical assumptions have not been systematically and jointly considered at the time of choice of operationalization. Bearing in mind that approach and avoidance orientations are grounded in sensorimotor interactions with the physical and social environment, we tentatively propose a prototypical, multimodal and situated operationalization. An appropriate and exhaustive operationalization of approach-avoidance orientations is crucial as this constitutes one of the major obstacles when connecting theory to data (Rakover, 1981). To assess the viability of this operationalization, we implemented it in the examination of the influence of approach-avoidance behaviors on interpersonal evaluations. In all studies, we manipulated approach-avoidance orientations through ecological whole-body approach-avoidance behaviors and measured evaluations in a self-reported way. As a general hypothesis, and in line with previous literature (Cacioppo et al., 1993; Slepian et al., 2012), we anticipated that, using highly ecological settings, approach behaviors would lead to more positive evaluations as compared to avoidance behaviors. We followed a two-stage process to test this hypothesis and incrementally consider the grounded assumptions. In a first stage, in order to provide continuity with past research, we relied on operationalizations that have been previously used in the literature (but not in the field of interpersonal evaluations) and that satisfied the prototypicality and the multimodality requirements: upper-body incline/posture. We set

<sup>5</sup>Obviously, the use of real life settings or confederates implies a lot of methodological shortcomings (e.g., confederates enter an experimental social interaction with their own past experiences background and perfectly controlling one's behavior in such situation is nearly impossible to achieve; McCall, 2015).

these behaviors in the context of social interactions as we deem them particularly relevant for this kind of situation and tested their effect on interpersonal evaluations in four pilot studies. In the second stage, and in a break with past research, we went further in the situatedness consideration and took seriously the grounded nature of approach-avoidance orientations. To this aim, we relied on upper-body incline and walking steps operationalizations in two main studies that we conducted through immersive virtual reality (VR). VR is increasingly viewed as a promising tool in the study of social interactions in that it allows considering the ongoing individual-environment interaction while maximizing experimental control (Blascovich et al., 2002; McCall, 2015; Pan and Hamilton, 2018). In all studies we planned to run at least 50 participants per condition as recommended by Simmons et al. (2013). Such a criterion enabled us to detect an effect size  $\eta^2$  comprised between 0.05 and 0.15 (depending on the design) with a power of 80%. We collected and analyzed anonymously all data with written informed consent from participants in accordance with the American Psychological Association's ethical principles. However, we did not seek the explicit ethics approval as it was not required for the present studies as per Université de Paris's guidelines and applicable national regulations.

## PILOT STUDIES

As an initial step in considering the grounded nature of approach-avoidance orientations in their operationalization we conducted four pilot studies. In these pilots, we aimed at replicating and extending the influence of approach-avoidance orientations on self-reported evaluations relying on prototypical and multimodal operationalizations by adapting existing inductions: upper-body incline/posture. We set these behaviors in the context of a social interaction (i.e., face stimuli). By doing so, we intended to maximize trace activation and expected more positive evaluations in the approach than in the avoidance condition. The procedure was comparable throughout the pilots: participants evaluated faces while performing an approach or avoidance behavior. At the end, they also indicated to what extent they found the task pleasant, difficult and tiring to control for any potential confounded variables. We present the main elements of the pilot studies below and provide details for these pilots in **Supplementary Material 1**.

In Pilot 1 ( $N_{\text{Analyzed}} = 50$ ), participants were seated between two wooden boards perpendicular to which we affixed two computer mice and facing a computer screen (see **Supplementary Material 1**). Pretexting a study on ergonomic positions, we asked them to greet computerized faces (taken from Oosterhof and Todorov, 2008) while performing different movements. Depending on the block of a within-participants design, participants had to either lean their upper-body forward or backward in order to click the corresponding mouse button (behind vs. in front of the coronal plane). The mouse click triggered the appearance of a speech bubble saying "hello," indicating that participants effectively greeted the character. After this instrumental movement (i.e., greeting), participants returned



to the body's "home" position (i.e., an upright position) and rated the pleasantness of the face (from 1: *very unpleasant* to 7: *very pleasant*).

In Pilot 2 ( $N_{\text{Analyzed}} = 107$ ), we relied on a between-participants design. We further added contextual cues by connecting an upper body to each face and placing them in an office room background. These were projected real size on a wall. We also reduced the distance between the wooden boards to obtain a more ecological movement amplitude. Pretexting a study on impression formation during a job-interview, we asked participants to greet characters verbally while leaning their upper-body either forward or backward depending on condition. In order to circumvent the fact that both approach and avoidance movements were performed before evaluating characters (as this could have been potentially an issue in the case of the manipulation in Pilot 1) participants had to maintain the position while evaluating characters. Instead of asking participants to judge the faces, we asked them to provide their impression of them on a scale anchored at  $-3$ : *I do not like at all* and  $+3$ : *I like very much* (Chen et al., 2004).

In Pilot 3 ( $N_{\text{Analyzed}} = 97$ ), we manipulated approach-avoidance orientations through corresponding postures and relied on the same stimuli as in Pilot 2. Participants were seated in front of a computer screen and were instructed to give their impression of characters verbally, while leaning forward or backward throughout the experimental procedure.

Pilot 4 ( $N_{\text{Analyzed}} = 154$ ) followed the same procedure as Pilot 3 except two changes. To increase reliance on their affective feeling, we led participants to believe that they subliminally received pseudo-individualizing information about each presented target-person (Yzerbyt et al., 1998). To increase ecological validity, we also sampled pictures instead of computerized faces from a distinct database (i.e., the Chicago Face Database, see Ma et al., 2015).

Across the four pilots, we failed to show a positive effect of approach behaviors (as compared to avoidance) on interpersonal evaluations. A random effects mini meta-analysis (with the "metafor" R package) on the standardized regression coefficients (Kim, 2011) revealed a statistically non-significant effect of approach-avoidance behaviors on evaluations,  $z = -0.75$ ,  $p = 0.455$ ,  $\beta_Z = -0.05$ , 95% CI  $(-0.17, 0.07)$ <sup>6</sup>.

Upper-body inclination/postures used in previous research are arguably prototypical and multimodal operationalizations of approach-avoidance orientations, which are also relevant in the context of face evaluation. However, such operationalizations only partially consider the grounded essence of approach-avoidance orientations as they are low in situatedness. The social interaction context and face stimuli may have not been sufficiently interactive to satisfy the situatedness requirement and allow for the re-enactment of approach-avoidance experiences. With an objective of bringing a possible solution with respect to this aspect, we used VR — an immersive and interactive tool — in the two following studies.

<sup>6</sup>For Pilot 1, we only considered the first block of trials in the meta-analysis. Even if this choice affected power, it was done for the sake of comparability with the other pilots that used a between-participants design and also because there was an interaction between movement and block order.

## MAIN STUDIES: A VIRTUAL REALITY SETTING

In Study 1 and 2, we tested the effect of approach-avoidance behaviors on interpersonal evaluations relying on VR and using self-reported evaluations. We expected more positive evaluations in the approach than in the avoidance condition, with the control condition falling in between. Importantly, the inconclusive results of the four pilot studies may also be due to the failure of activating approach-avoidance tendencies. Thus, to directly address this issue in these studies we also included additional measures of approach-avoidance tendencies in order to assess the construct validity of the manipulation. We thus measured action tendencies (with the Visual Approach/Avoidance by the Self Task, VAAST; Rougier et al., 2018, for a similar procedure see Smith and Bargh, 2008) and the activation of approach-avoidance neuropsychological systems (Reinforcement Sensitivity Theory of Personality Questionnaire, RST-PQ; Corr and Cooper, 2016). We expected that our manipulation of approach-avoidance orientations would activate the corresponding action tendency and neuropsychological system. We also took care to measure the feeling of Presence and Cybersickness that could hinder the Virtual Reality experience (see Pan and Hamilton, 2018), as well as the judgment of pleasantness, tiredness and difficulty of the task to control for any potential confounded variables. All hypotheses, measures, instructions and statistical analyses were pre-registered<sup>7,8</sup>.

### Study 1

#### Methods

##### Participants

In total, 211 French-speaking participants took part in the study in exchange of partial credit course or 15€. They were randomly assigned to the approach, avoidance, or control conditions in a between-participants design<sup>9</sup>. We excluded participants that: guessed the hypothesis (5), did not follow the instructions (e.g., using only the head instead of the upper body; 56) and reported having consumed substances (3). Finally, we excluded one participant with excessive missing data (46.67%) due to a

<sup>7</sup>osf.io/sqhwv

<sup>8</sup>After extensive consultation among all authors, we applied exclusion criteria deviating from the pre-registered ones. (1) Because of the absence of explicit approach-avoidance labels, we had a considerable amount of participants that did not understand and correctly perform the requested action. Including those participants would have excessively increased variance in the analyses. (2) We did not exclude participants who reported cognitive troubles as the item did not prove able to detect effective troubles and this exclusion did not change the pattern of obtained results. (3) We did not exclude participants according to their cybersickness score as there is no clear exclusion criterion for cybersickness in the literature and the Simulator Sickness Questionnaire (Kennedy et al., 1993) is not built for cybersickness *per se* and is very sensitive ("merely closing one's eyes for an extended period of time can affect the measurement," Rebenitsch and Owen, 2016). Moreover, we exposed participants to VR for approximately 15 min which induces generally low levels of cybersickness (Stanney et al., 2002; Pan and Hamilton, 2018). Again, excluding those extreme participants (which were outliers on studentized residuals, that is above four, when running a simple regression analysis on cybersickness scores alone; Judd et al., 2011) did not change the pattern of results.

<sup>9</sup>As experimenters have to insert manually the script in the file read by the application, they were not blind to conditions.

technical problem with the VR equipment. We thus analyzed the data of the remaining 162 participants.

### Material

Twelve first names per gender, half of them containing the sound /o/ (e.g., Margaux, Jerome) and the other half containing the sound /i/ (e.g., Emeline, Remy) served as stimuli for the VAAST. We controlled them for frequency based on the national database (Institut National de la Statistique et des Etudes Economiques [INSEE], 2015).

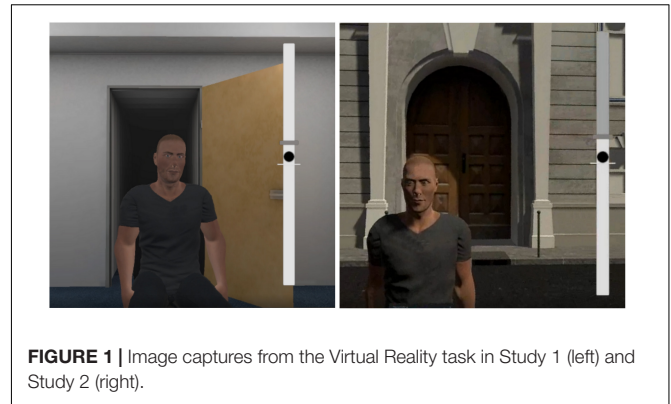
### Procedure

**Virtual reality task.** Upon their arrival, participants received instructions about the VR task on a computer screen. The task was presented as a study on impression formation and administered through a VR headset (HTC Vive®). Participants were seated at a table in a neutral virtual room and had to maintain an upright position. Each virtual character sat in front of them and greeted them by saying “hello.” Depending on the condition, participants had to reply back “hello” and perform a 10-degree forward-lean (approach condition), a 10-degree backward-lean (avoidance condition) or no movement (control condition). A Likert-type scale appeared in the virtual environment 2000 ms after participants performed the correct action. While maintaining their position, participants used the HTC controllers to provide their impression of the character anchored at 1 (negative) and 7 (positive). Once the response was recorded, the virtual character walked away and participants in the approach and avoidance conditions were instructed to go back to the central position. Then, participants waited for the appearance of the next virtual character to repeat the sequence. After five training trials with a test character, participants encountered 30 characters (15 men and 15 women). In line with previous research, we expected more positive evaluations in the approach than in the avoidance condition.

Based on our theoretical rationale, we refrained from explicitly mentioning approach or avoidance labels in the instructions in order to limit potential demand characteristics and the direct influence of these labels on evaluations (Van Dessel et al., 2015). Thus, in order to assist participants in reaching the correct orientation without an explicit mention of the terms “approach” or “avoidance,” we presented them a position bar displaying the onset position (the white mark on **Figure 1**), the requested final position (the gray mark on **Figure 1**) and their tracked position (the black circle on **Figure 1**) on the right side of the screen. Using this position bar, their task was to align their upper-body to the requested position. If participants deviated too much from the requested position, they received an auditory feedback.

### Action tendencies

After the VR task, participants performed the VAAST (Rougier et al., 2018) to check if our manipulation of approach-avoidance orientations activated the corresponding action tendency. They had to categorize first names depending on the sound they contained (i.e., the /o/ vs. /i/ sound) by pressing a “move forward” key (approach response) or a “move backward” key (avoidance response). In one block, participants had to approach first names containing the sound /o/ and avoid those containing



**FIGURE 1** | Image captures from the Virtual Reality task in Study 1 (left) and Study 2 (right).

the sound /i/. In the other block, this was reversed. Each trial began with a white circle displayed in the center of the screen prompting participants to press a “start” button. Then, a fixation cross was displayed (with a random duration of 800–2000 ms) and participants had to keep their finger pressed until a first name appeared. When the target name appeared, participants had to categorize it by pressing the “move forward” or “move backward” key four times, as quickly and as accurately as possible. Depending on keypress, the background image and the target first name was zoomed in (i.e., “move forward” button, approach) or zoomed out (i.e., “move backward” button, avoidance) by 10% after each button press. In each block, participants performed 8 training trials followed by 48 experimental trials. We recorded reaction time (RT) at the onset of the name until the first keypress. At the outcome, participants indicated their age, gender, laterality and if they were fluent in French (in case they were not, they indicated their skills on a scale from 1 = *very low level* to 7 = *very high level*). We expected participants to approach stimuli faster in the approach than in the avoidance condition but to avoid stimuli faster in the avoidance than in the approach condition, or to put it short an interaction between movement and response type.

### Neuropsychological systems

Then, participants completed the French version of the RST-PQ (Corr and Cooper, 2016; L.-C. Vannier, personal communication, December 4, 2017) to check if our manipulation of approach-avoidance orientations activated the corresponding system. Based on the revised reinforcement sensitivity theory (Corr and McNaughton, 2012), this questionnaire measures the Behavioral Approach System (BAS, related to approach behaviors and appetitive stimuli; 29 items), the Fight-Flight-Freeze System (FFFS, related to active avoidance behaviors and aversive stimuli; 10 items) and the Behavioral Inhibition System (BIS, related to passive avoidance behaviors and conflictual stimuli; 15 items). The RST-PQ has the advantage of taking into account the multidimensionality of the BAS and distinguishing the FFFS from the BIS. We expected higher BAS scores in the approach than in the avoidance condition and higher FFFS scores in the avoidance than in the approach condition.

### Complementary measures

Subsequently, participants completed the French versions of the Presence Questionnaire (PQ; Witmer and Singer, 1998; Robillard et al., 2002) and the Simulator Sickness Questionnaire (SSQ; Kennedy et al., 1993; Bouchard et al., 2007). They also indicated to what extent they found the VR task pleasant, difficult and tiring (on a scale from 1 = *not at all* to 7 = *extremely*). All these complementary measures were included to control for any potential confound. Finally, they reported any trouble or substance intake which could have impaired their performance. They were probed for suspicion, debriefed and compensated for their participation.

### Results

We ran several General Linear Model analyses. In order to test the linear effect of movement, we created two contrast codes. In the first, we opposed the approach (+1) to the avoidance condition (-1), ignoring the control condition (0). In the second, we opposed the control condition (+2) to both the approach (-1) and avoidance conditions (-1). As participants judged the task more tiring in the avoidance than in the approach condition ( $M_{\text{Approach}} = 2.60$ ,  $SE_{\text{Approach}} = 0.23$ ;  $M_{\text{Avoidance}} = 3.45$ ,  $SE_{\text{Avoidance}} = 0.21$ ;  $F(1, 155) = 7.47$ ,  $p = 0.007$ ,  $\beta_Z = -0.26$ , 95% IC [-0.45, -0.07]), we included the tiredness judgment in the analysis to control for this potential confound<sup>10</sup>. All reported descriptive statistics were those estimated by the models and the 95% confidence intervals reported hereafter are based on the standardized differences between the tested means.

### Evaluations

We deleted trials where participants performed a wrong movement (1.30%), deviated from the position they had to maintain (6.32%) and/or did not directly reach the correct position (5.13%). On the remaining trials, we estimated a linear mixed-effects model with the linear codes of contrast, tiredness judgment and their interactions terms as fixed factors as well as participants and stimuli as random factors (with the “lmer” R package). Contrary to the tested hypothesis, the first contrast revealed that evaluations did not significantly differ between the approach ( $M = 4.26$ ,  $SE = 0.17$ ) and the avoidance conditions ( $M = 4.34$ ,  $SE = 0.16$ ),  $F(1, 153.09) = 0.39$ ,  $p = 0.534$ ,  $\beta_Z = -0.03$ , 95% IC [-0.12, 0.06]. No other effect was significant,  $F_s < 1.39$ , all  $p_s > 0.239$ .

### Action tendencies

Concerning the VAAST, we examined RTs for experimental trials only and removed incorrect trials (3.29 %). In order to correct a positively skewed distribution, we deleted RTs faster than 200 ms or above 2000 ms (1.06%) and applied a log-transformation on raw RTs. We estimated a linear mixed-effects model with the linear codes of contrast, response type (approach, avoidance), tiredness judgment and their interaction terms as fixed factors,

<sup>10</sup>With four observations deleted due to missing values on task judgment. As pleasantness judgment, difficulty judgment, simulator sickness and presence did not differ between approach and avoidance conditions in both studies, we did not include them in the models. Moreover, unlike the four pilots, the difficulty, pleasantness and tiredness judgment of the task in this study were confounded with judgments of the VR due to item wording problems.

as well as participants and stimuli as random factors (with the “lmer” R package). The analysis first revealed a significant main effect of response type,  $F(1, 14360) = 62.81$ ,  $p < 0.001$ ,  $\beta_Z = -0.11$ , 95% IC [-0.14, -0.08]. Participants were faster to approach ( $M = 719.10$  ms<sup>11</sup>, 95% IC [699.24, 739.52]) than to avoid ( $M = 741.74$  ms, 95% IC [721.26, 762.80]) the first names. However, we did not obtain the expected interaction between the first contrast and response type,  $F(1, 14360) = 0.06$ ,  $p = 0.806$ ,  $\beta_Z = 0.00$ , 95% IC [-0.03, 0.04]: participants were not faster to approach (vs. avoid) first names in the approach than in the avoidance condition (see **Table 1**). The analysis also revealed a marginal interaction between response type and tiredness judgment indicating that the more participants judged the task as tiring, the quicker they were to approach than to avoid,  $F(1, 14360) = 3.24$ ,  $p = 0.02$ ,  $\beta_Z = -0.02$ , 95% IC [-0.03, 0.00].

### Neuropsychological systems

For RST-PQ scores, we estimated a linear regression model with the two contrast codes, tiredness judgment and their interaction terms as predictors. Contrary to what we expected, we did not obtain higher BAS scores in the approach than in the avoidance condition,  $F(1, 151) = 0.46$ ,  $p = 0.499$ ,  $\beta_Z = -0.06$ , 95% IC [-0.25, 0.12]. The results are even in the opposite direction with higher BAS scores in the avoidance ( $M_{\text{BAS}} = 2.89$ ,  $SE_{\text{BAS}} = 0.05$ ) than in the approach condition ( $M_{\text{BAS}} = 2.84$ ,  $SE_{\text{BAS}} = 0.05$ ). Neither we obtained higher FFFS scores in the avoidance ( $M_{\text{FFFS}} = 2.12$ ,  $SE_{\text{FFFS}} = 0.08$ ) than in the approach condition ( $M_{\text{FFFS}} = 2.07$ ,  $SE_{\text{FFFS}} = 0.08$ ),  $F(1, 151) = 0.21$ ,  $p = 0.649$ ,  $\beta_Z = -0.04$ , 95% IC [-0.23, 0.14] although the pattern was in the expected direction. There was no other significant effect, nor for the BAS, neither for the FFFS,  $F_s < 2.68$ ,  $p_s > 0.104$ .

### Discussion

In Study 1, we took advantage of the immersive and interactive nature of VR to implement a grounded operationalization of approach-avoidance orientations and to test their effect on interpersonal evaluations. However, we failed to show the expected positive influence of approach on evaluations. We also did not obtain any indication of an activation of the corresponding action tendencies or neuropsychological systems. Nevertheless, as a relatively substantial part of the sample did not correctly perform the instructed action, it appears that upper-body incline was not very intuitive to participants within this setting. This may have rendered the operationalization of approach-avoidance orientations ambiguous. In Study 2, we pursued the examination and relied on an experimental variation of the foregoing grounded operationalization.

## Study 2

### Methods

#### Participants

Two-hundred and four participants took part in the study in exchange of partial credit course or 15€. They were randomly assigned to the approach, avoidance, or control conditions in a between-participants design. We excluded participants that:

<sup>11</sup>For the sake of clarity, we reported the antilog of log-transformed means.

**TABLE 1** | Estimated means and standard errors (or confidence intervals) for evaluations, neuropsychological systems and action tendencies.

Variable	Avoidance		Control		Approach	
	<i>M</i>	<i>SE (or 95 % CI)</i>	<i>M</i>	<i>SE (or 95 % CI)</i>	<i>M</i>	<i>SE (or 95 % CI)</i>
<b>Evaluations</b>						
Pilot 1 <sup>a</sup>	3.54	0.15	/	/	3.78	0.16
<i>Bloc 1</i>	3.7	0.21	/	/	3.44	0.36
<i>All data</i>	3.54	0.15	/	/	3.78	0.16
Pilot 2 <sup>b</sup>	0.35	0.12	/	/	0.11	0.12
Pilot 3 <sup>b</sup>	0.13	0.2	/	/	0.23	0.19
Pilot 4 <sup>b</sup>	0.45	0.13	0.4	0.13	0.56	0.14
Experiment 1 <sup>a</sup>	4.34	0.16	4.31	0.16	4.26	0.17
Experiment 2 <sup>a</sup>	4.46	0.17	4.41	0.17	4.34	0.17
<b>Neuropsychological Systems</b>						
BAS						
Experiment 1	2.89	0.05	2.92	0.05	2.84	0.05
Experiment 2	2.93	0.05	2.97	0.05	2.96	0.04
FFFS						
Experiment 1	2.12	0.08	2.01	0.07	2.07	0.08
Experiment 2	2.17	0.08	2.18	0.08	2.16	0.07
<b>Action Tendencies</b>						
Approach RT						
Experiment 1	720.54	[689.52, 753.70]	732.89	[702.11, 765.10]	704.16	[672.50, 736.57]
Experiment 2	731.43	[701.35, 762.04]	750.7	[719.82, 782.11]	739.52	[710.52, 769.70]
Avoidance RT						
Experiment 1	744.71	[711.94, 778.99]	755.21	[723.43, 787.61]	725.6	[692.98, 759.76]
Experiment 2	752.95	[722.70, 785.25]	782.9	[750.70, 815.66]	762.04	[732.16, 793.14]

*M*, estimated mean; *SE*, estimated standard error; *CI*, confidence interval; *BAS*, behavioral approach system; *FFFS*, fight, flight and freeze system; *RT*, reaction times. <sup>a</sup>Scale from 1 to 7. <sup>b</sup>Scale from -3 to +3.

guessed the tested hypothesis (2), did not follow the instructions (e.g., steps incompletely done; 7), reported substance intake (4) and declared low French skills (i.e., below 5 on the 1 to 7 scale; 1). Due to an experimenter error, one participant received opposite behavioral instructions from the behavior he had to perform in VR. We excluded this participant and analyzed the data of the remaining 189 participants.

### Procedure

We followed exactly the same procedure as in Study 1, except the approach-avoidance orientations operationalization. This time, participants stood at a bus stop in a virtual street and had to maintain an upright position (**Figure 1**). Virtual characters came across to them and greeted them by saying “hello.” Depending on the condition, participants had to reply back “hello” making one step (approx. 20 cm wide) forward (approach condition), backward (avoidance condition) or standing in place (control condition).

### Results

Again, we ran several General Linear Models to test our predictions. We created the same two contrast codes as in Study 1 in order to test the linear effect of movement. In the first, we opposed the approach (+1) to the avoidance condition (-1), ignoring the control condition (0). In the second, we opposed the

control condition (+2) to both the approach (-1) and avoidance conditions (-1).

### Evaluations

We deleted trials where participants performed a wrong movement (0.20%), deviated from the position they had to maintain (1.85%) and/or did not directly reach the correct position (2.4%). On the remaining trials, we estimated a linear mixed-effects model with the same linear codes of contrast as fixed factors as well as participants and stimuli as random factors (with the “lmer” R package). Again, the analysis revealed that evaluations did not significantly differ between the approach ( $M = 4.34$ ,  $SE = 0.17$ ) and the avoidance condition ( $M = 4.46$ ,  $SE = 0.17$ ),  $F(1, 186.43) = 1.03$ ,  $p = 0.310$ ,  $\beta_Z = -0.04$ , 95% IC [-0.13, 0.04]. The second contrast also was not significant,  $F < 1$ ,  $p = 0.922$ .

### Action tendencies

Concerning the VAAST, we examined RTs for experimental trials only and removed incorrect trials (3.72 %). In order to correct a positively skewed distribution, we deleted RTs faster than 200 ms or above 2000 ms (1.06%) and applied a log-transformation to raw RTs. We estimated a linear mixed-effects model with the linear contrast, response type (approach, avoidance) and their interaction terms as fixed factors as well as participants and stimuli as random factors (with the “lmer” R package). As in



Study 1, participants were faster to approach ( $M = 740.26$  ms, 95% IC [721.26, 759.76]) than to avoid ( $M = 765.86$  ms, 95% IC [746.20, 786.03]) the first names,  $F(1, 17050) = 93.24$ ,  $p < 0.001$ ,  $\beta_Z = -0.12$ , 95% IC [-0.15, -0.10]. We did not obtain the expected interaction between the first contrast and response type,  $F(1, 17050) < 0.01$ ,  $p = 0.962$ ,  $\beta_Z = -0.00$ , 95% IC [-0.03, 0.03] (see **Table 1**).

### Neuropsychological systems

For RST-PQ scores, we estimated a linear regression model with the two contrast codes as predictors. The analysis revealed no effect of the approach-avoidance orientations manipulation on BAS scores ( $M_{\text{Approach}} = 2.96$ ,  $SE_{\text{Approach}} = 0.04$ ;  $M_{\text{Avoidance}} = 2.93$ ,  $SE_{\text{Avoidance}} = 0.05$ ,  $F(1, 182) = 0.14$ ,  $p = 0.705$ ,  $\beta_Z = 0.03$ , 95% IC [-0.14, 0.21]) neither on FFFS scores ( $M_{\text{Approach}} = 2.16$ ,  $SE_{\text{Approach}} = 0.07$ ;  $M_{\text{Avoidance}} = 2.17$ ,  $SE_{\text{Avoidance}} = 0.08$ ,  $F(1, 182) < 0.01$ ,  $p = 0.962$ ,  $\beta_Z = -0.00$ , 95% IC [-0.18, 0.17]).

### Discussion

In Study 2, although we increased the ecological character and situatedness of the operationalization of approach-avoidance orientations, we again failed to confirm the theorized prediction. Approach-avoidance behaviors did not influence evaluations as well as the activation of corresponding action tendencies or neuropsychological systems.

### Complementary Analyses

Although VR is a promising tool to operationalize approach-avoidance as grounded in individual-world experiences, it nevertheless remains a technology-mediated experience. Thus, virtual approach-avoidance interactions might enable to re-enact internal states only when individuals did not consciously perceive such a mediation (Parsons and Rizzo, 2008). That is, in the case the virtual environment successfully supports approach-avoidance interactions while offering the same sensorimotor information as in non-virtual settings and providing individuals the feeling of “being there.” This subjective experience of being in one environment, even when one is physically situated in another, is coined the “feeling of presence” (Witmer and Singer, 1998). Some scholars consider the feeling of presence as reflecting the full integration of every relevant aspect of the situation pertaining to the “here and now” including: movement and perception, actions, representation of the self in the overall situation, possibilities for action, etc. (Carassa et al., 2005; Riva, 2009; Mennecke et al., 2011; Riva and Waterworth, 2014; Willans et al., 2015). In this sense, the notion of presence may gauge the extent to which cognition is grounded in the virtual environment, and may be a necessary condition to re-enact approach-avoidance states through VR.

The overall feeling of presence in the current studies ( $M_{\text{Exp1}} = 95.52$ ,  $SE_{\text{Exp1}} = 1.07$ ;  $M_{\text{Exp2}} = 92.75$ ,  $SE_{\text{Exp2}} = 1.05$ ) was lower than the French speaking norm ( $M = 104.39$ ,  $SE = 1.89$ ; from the Cyberpsychology Lab at University of Quebec in Outaouais, 2013). This moderately low feeling of presence could explain that we failed to obtain the positive effect of approach on evaluations. For this reason, we added the feeling of presence

as a fixed factor in the models previously estimated. For the sake of clarity, we only report results that we deemed relevant for the goal of this paper (the interested reader can refer to **Supplementary Material 2**).

### Complementary Analyses of Study 1

Although not significant, the patterns showed that the more participants felt being present in the situation the more the approach manipulation activated the BAS as compared to the avoidance condition,  $F(1, 144) = 0.36$ ,  $p = 0.549$ ,  $\beta_Z = 0.00$ , 95% IC [-0.01, 0.02]<sup>12</sup>. However, the patterns also showed that the more participants felt being present the less the avoidance manipulation activated the FFFS as compared to the approach condition,  $F(1, 144) = 1.11$ ,  $p = 0.295$ ,  $\beta_Z = 0.01$ , 95% IC [-0.01, 0.02].

A closer inspection of evaluative ratings suggested that the more participants felt being present in the situation, the more they evaluated positively the characters in the avoidance as compared to the approach condition, although this effect was not significant,  $F(1, 146.3) = 0.04$ ,  $p = 0.847$ ,  $\beta_Z = -0.00$ , 95% IC [0.00, 0.01].

### Complementary Analyses of Study 2

The patterns reveal that the more participants felt being present in the situation the more the approach manipulation activated the BAS compared to the avoidance condition,  $F(1, 179) = 3.95$ ,  $p = 0.048$ ,  $\beta_Z = 0.01$ , 95% IC [0.00, 0.02]. Correspondingly, the more participants felt being present in the situation the more the avoidance manipulation activated the FFFS compared to the approach condition,  $F(1, 179) = 1.49$ ,  $p = 0.224$ ,  $\beta_Z = -0.01$ , 95% IC [-0.02, 0.00], although the latter results were not significant.

Interestingly, including presence in the analysis of evaluative ratings revealed that the more participants felt being present in the situation, the less they evaluated positively the characters in the avoidance as compared to the approach condition,  $F(1, 180.9) = 0.20$ ,  $p = 0.66$ ,  $\beta_Z = -0.00$ , 95% IC [-0.00, 0.01].

### Discussion of Complementary Analyses

These exploratory analyses suggest that the approach-avoidance manipulation is contingent on the way participants experience the immersive virtual situation. At least in Study 2, the analyses revealed patterns of interaction between the manipulation of approach-avoidance orientations and the feeling of presence on the activation of the neuropsychological systems. Indeed, the corresponding motivational states seem to be activated by the manipulation when individuals felt being present (in a non-mediated interaction with the environment). Although non-anticipated, we deem these results important as they emphasize the role of ongoing individual-environment interaction in social cognition and arguably fit well with a grounded view of cognition putting subjective sensorimotor experiences at the core of knowledge. However, the results of Study 1 are less clear with patterns of interaction in the opposite direction. As previously mentioned, a large proportion of participants had not correctly performed the requested

<sup>12</sup>We excluded one participant due to missing data on the Presence Questionnaire.

action in Study 1, while this was not the case in Study 2. This may suggest that upper-body incline was a more ambiguous operationalization of approach-avoidance experiences than walking and may explain the mitigated pattern.

## GENERAL DISCUSSION

In this paper, our aim was to capitalize on a grounded view of cognition to develop a thorough and appropriate operational definition of approach and avoidance. According to this view, an optimal operationalization should enable a close matching between ongoing experience and past approach-avoidance traces. To this aim, we relied on prototypical whole-body movements, involving multi-sensory information, in relevant interpersonal contexts. We implemented these operationalizations in the study of the influence of approach and avoidance on interpersonal evaluations. In six studies, we relied on prototypical and multimodal operationalizations previously used in approach-avoidance studies (e.g., evaluative-assimilation, Fayant et al., 2011; cognitive categorization, Price and Harmon-Jones, 2010). In the last two studies, we went a step further and relied on immersive VR in order to fully consider the grounded aspect of approach-avoidance orientations. Doing so, we also satisfied a third (and frequently overlooked) requirement for an optimal grounded operationalization of approach-avoidance: its situatedness. Despite this, the present studies failed to show more positive evaluations in the approach than in the avoidance condition. Including all standardized regression coefficients from VR studies and pilots in a random effects meta-analysis revealed a statistically non-significant effect of approach-avoidance behaviors on evaluations,  $z = -1.06$ ,  $p = 0.2887$ ,  $\beta_Z = -0.03$ , 95% CI  $(-0.07, 0.02)^{13}$ . This estimated effect is even in the opposite direction with more negative evaluations in the approach than in the avoidance condition. Thus, in the present studies, it seems as if approach and avoidance do not influence interpersonal evaluations. This non-finding is puzzling and opposes a wealth of studies that obtained reliable effects of approach-avoidance actions on evaluations (Cacioppo et al., 1993; Slepian et al., 2012; Woud et al., 2013b).

With all cautions taken, the fact that the influence of approach-avoidance on evaluations did not emerge with the use of more ecological behavioral operationalizations raises some questions. First, it may be the case that previous effects were only the fact of unimodal and decontextualized operationalizations of approach-avoidance experiences that activated a very specific and limited pattern of traces. However, social psychologists have the ultimate goal of studying how human social cognition unfolds in daily individual-environment interactions, rather than in (overly) simplistic approximations of those situations (e.g., being seated in front of pictures or words presented on a computer screen in an experimental box). In isolated and simplistic situations, a very narrow and specific pattern of traces may be activated. However, when common sensory surroundings stimulate the

individuals' body and brain, the same pattern may interact with others and become highly context-dependent. In line with this, Varela et al. (1991, p. 94) observed that "the brain is a highly cooperative system: the dense interconnections among its components entail that eventually everything going on will be a function of what all the components are doing." Moreover, the effects of approach-avoidance tendencies on evaluations are often studied for intervention purposes (e.g., addiction treatment, Wiers et al., 2011; prejudice reduction, Kawakami et al., 2007; phobia reduction, Jones et al., 2013). Nevertheless, the effectiveness of interventions would be very limited if daily life experiences differ from the traces involved in these specific intervention phases.

Second, the present studies differed in some aspects from previous work. For instance, we asked participants to evaluate individuals after each encounter while many research involved evaluations only after the presentation of the stimulus set. While the former may be considered as a "priming paradigm," the latter resembles more a learning paradigm (Gast et al., 2012; Laham et al., 2014). Moreover, in previous literature participants are often required to repeatedly approach and avoid specific stimuli/categories, unlike the procedure we relied on in this paper. Thus, extensive behavioral repetition may be necessary to obtain effects of ecological approach-avoidance behaviors on evaluation. It may also be necessary to perform both approach and avoidance behaviors contingent upon specific stimuli/categories. Indeed, according to a grounded perspective, these contingencies could foster the integration of multimodal traces of ongoing experiences (Barsalou, 1999) and/or predictive inferences based on these multimodal representations (Van Dessel et al., 2018b). These observations call for further work along these lines while pursuing the use of ecological operationalizations of approach-avoidance orientations.

Third, in our studies we relied on neutral faces as the effect of approach-avoidance behaviors on evaluations was often studied with neutral stimuli (e.g., neutral ideograms, non-words, fictitious social groups, neutral faces; Cacioppo et al., 1993; Slepian et al., 2012; Van Dessel et al., 2018a). However, the use of such stimuli may have been problematic for two reasons. First, it is possible that neutral expressive faces are not very prototypical of interpersonal approach-avoidance experiences and may thus require more expressive ones. Second, some scholars suggested that approach-avoidance behaviors influence evaluations depending on their motivational compatibility with stimuli: yielding more positive evaluations in the case of compatibility (i.e., approached-positive and avoided-negative), but more negative evaluations in the case of incompatibility (i.e., approached-negative and avoided-positive, Centerbar and Clore, 2006; Krishna and Eder, 2019). This possibility may explain the absence of effects and deserves further investigation. For example, we could add an emotional expression on individuals faces (Dru and Cretenet, 2008; but see Woud et al., 2013a). Current research developments in our lab are specifically dedicated to this issue.

Fourth, as we globally failed to activate approach-avoidance action tendencies and neuropsychological systems, we may have faced a construct validity issue. One or more elements in the situation may have impeded the reactivation of past

<sup>13</sup>Again we considered only data of the first bloc for Pilot 1.

approach-avoidance traces. For instance, if cognition is grounded in multimodal processes relevant for the immediate situation, the pattern of captured traces would differ depending on the task at stake (Barsalou, 1999). We asked participants to perform ecological interpersonal actions without explicitly labeling them as approach-avoidance. This was done in order to avoid potential demand characteristics and the direct influence of these labels on evaluations. In turn, participants may have been overly focused on understanding and correctly performing the requested action rather than on merely interacting with the characters (as reflected by the large proportion of participants in Study 1 that did not perform the action correctly). This may have led to a different pattern of traces than the one associated with usual interpersonal approach-avoidance experiences.

Finally, in two studies we relied on immersive VR to satisfy the requirements of a grounded perspective in the operationalization of approach-avoidance orientations. However, the use of VR is not without challenges and any asynchrony between the visual (virtual) environment and proprioceptive or motor information may impede individuals' experience of having a body in the environment as well as their experience of interacting with elements of it (Pan and Hamilton, 2018). If it is indeed the case, traces of previous approach-avoidance experiences may have not been appropriately activated by the ongoing VR experience. Importantly, the exploratory results of the studies suggested the importance of taking into account the quality of the VR experience in the ecological operationalization of approach-avoidance. Indeed, the more individuals felt present in the virtual environment and the more the ecological approach-avoidance behaviors activated the corresponding neuropsychological systems (at least in Study 2). Thus, following others (Pan and Hamilton, 2018), we agree that increasing the feeling of presence is thus the necessary next step (and challenge) in the avenue of research on the ecological operationalization of approach-avoidance orientations through VR.

Beyond these VR issues, the obtained exploratory results may be of theoretical interest. The feeling of presence is not confined to VR but consists in a more general psychological state – similar to a basic state of consciousness (Loomis, 1992) – accompanying all interactions with the physical and social environment, be it real or virtual (i.e., inner presence, Riva et al., 2004; Carassa et al., 2005; Riva, 2009; Willans et al., 2015). Some consider presence as emerging from the match between simulated sensory predictions (i.e., relevant past experiences traces) and the ongoing sensory consequence of an action (i.e., traces captured from the ongoing interaction, Riva et al., 2011). Others regard presence as a dynamical self-organizing system that emerges from a constant interaction between an organism and its environment and can further combine with emotional dynamical systems (Willans et al., 2015). Due to these potential links between presence, action, emotion, intentionality and embodiment, we deem important to further investigate the role of presence in the operationalization of approach-avoidance orientations and their downstream consequences. For instance, future work could test if the feeling of presence is an experiential

phenomenon that is either necessary and/or sufficient to manipulate approach-avoidance.

## CONCLUSION

We believe that the present findings and non-findings are interesting for the topic of this Special Issue as they suggest that approach and avoidance are much more complex phenomena than basic whole-body movements toward or away from a person (or object). Just as other actions, approach and avoidance are rooted in the subjective experience of the ongoing individual-environment interaction (James, 1904). Hence, we view the present work as a first step and a basis for further discussion and research on proper operationalizations of approach-avoidance experiences considered within the realm of a grounded view of cognition. We also believe that this work stimulates new fundamental questions about the influence of approach-avoidance behaviors on evaluations.

## DATA AVAILABILITY

The datasets analyzed and the corresponding R scripts for the pilots can be found in Open Science Framework ([https://osf.io/quk3j/?view\\_only=acca3acd55284968a935b97debf55828](https://osf.io/quk3j/?view_only=acca3acd55284968a935b97debf55828)). The datasets analyzed and the corresponding R scripts for the two studies can be found in Open Science Framework ([https://osf.io/sqhvww/?view\\_only=9624d0c0d73345029d48a67ea4892e9f](https://osf.io/sqhvww/?view_only=9624d0c0d73345029d48a67ea4892e9f)).

## ETHICS STATEMENT

We collected and analyzed anonymously all data in accordance with the American Psychological Association's ethical principles. However, we did not seek the explicit approbation of an ethics committee for the present studies as there is no law concerning non-interventional research in France.

## AUTHOR CONTRIBUTIONS

All authors contributed to the study concept and design. Data collection was organized by IN. She performed the data analysis and was supported by TA and M-PF in the interpretation of the results. All authors drafted the manuscript and approved the final version of the manuscript.

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## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsyg.2019.01418/full#supplementary-material>



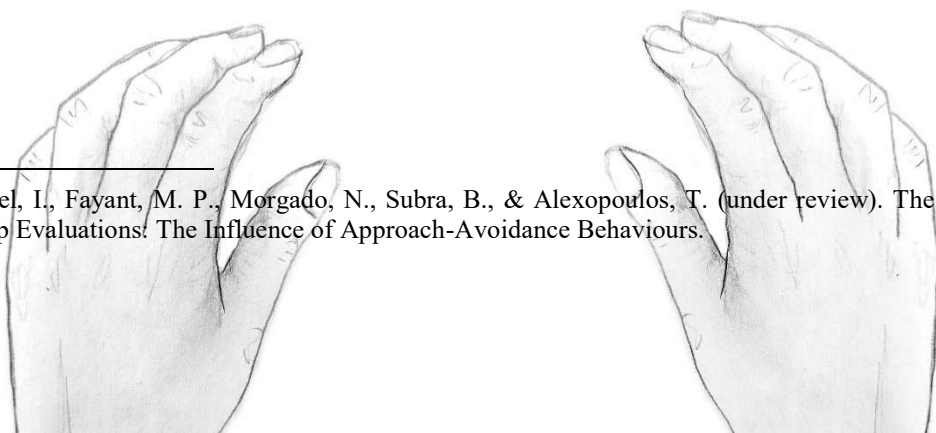
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# Chapter 2<sup>12</sup>



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<sup>12</sup> Based on Nuel, I., Fayant, M. P., Morgado, N., Subra, B., & Alexopoulos, T. (under review). The (Virtual) Reality of Group Evaluations: The Influence of Approach-Avoidance Behaviours.

Through their social interactions, individuals categorise others into social groups on the basis of social or ethnic origins, age, sex but also political, food or musical preferences. The group(s) that the other belongs to is crucial in the process of social interaction regulation because it can be related to a specific evaluation (positive or negative) orienting individuals' behaviour (Neumann et al., 2004; Paladino & Castelli, 2008; Rougier et al., 2019). For instance, individuals are quicker to avoid the elderly, generally associated with a negative valence, than the young persons, generally associated with a positive valence (Paladino & Castelli, 2008). Importantly, this categorical knowledge about the other is not a set of arbitrary symbols disconnected from the body and the environment but the traces of past sensorimotor experiences (Barsalou, 2016). As individuals encounter group members, traces of past sensorimotor experiences with the group are activated and updated by the ongoing experience to assist individuals' behaviour. In other words, the way individuals perceive social groups is grounded in sensorimotor individual-environment interactions.

Therefore, in this chapter, I investigate the role of approach-avoidance behaviours in the regulation of intergroup social interactions (i.e., when the encountered individual belongs to a specific social group). If approach-avoidance behaviours actively participate in the regulation of individuals' social interactions, they should influence group evaluations. Enacting an approach behaviour should lead to more positive group evaluations than enacting an avoidance behaviour. If there is evidence of such an influence in the literature (Kawakami et al., 2007; Phillips et al., 2011; Van Dessel et al., 2020), previous research partly neglected the multiplicity of cues at stake during interpersonal interactions and may offer a limited (or oversimplified) picture of the phenomenon.

Chapter 2 also extends Chapter 1. In Chapter 1, results did not reveal the expected positive effect of approach (vs. avoidance) on evaluations. In our real-life inspired IVR setting, the influence of the approach-avoidance behaviours on individuals' evaluation might have been too small to be detected. By investigating group evaluations (rather than individual ones), one may eventually circumvent this problem. Indeed, if all encountered individuals are members of the same social group, approaching (or avoiding) all individuals means approaching (or avoiding) repeatedly one social group. This repetition of behaviours-target stimulus contingency may increase the chance of revealing the evaluative influence of approach-avoidance by strengthening approach-avoidance sensorimotor traces related to the target stimulus (Versace et al., 2014) or the awareness of this contingency (Van Dessel et al., 2016). Although there is empirical support that approach-avoidance influence evaluations after only

one encounter with a novel stimulus (Cacioppo et al., 1993; Priester et al., 1996; Slepian et al., 2012) there is also evidence that the effect becomes stronger the more often the stimulus has been approached or avoided (Woud et al., 2008). Moreover, Chapter 1 suggests the importance of considering the quality of the IVR experience when operationalising approach-avoidance. Indeed, the more individuals felt present in the virtual environment and the more enacting the behaviours activated the corresponding neuropsychological systems (at least in Study 2). Therefore, we intended to improve the feeling of presence that participants may experience in the virtual environment. First, we reduced the number of encountered individuals from 30 to 16. Indeed, the longer participants are immersed in IVR, the higher is the risk of cybersickness which is negatively correlated with presence (Weech et al., 2019). Second, we changed the sequence of interaction: Participants initiated the interaction and the virtual individuals responded to them rather than the reverse. This was done to increase the control that participants have on the environment and thus the feeling of presence (Weech et al., 2019). Finally, we added a tutorial phase to train participants to correctly perform the required behaviours and smoothen their experience in the experimental phase.

# 1. INTRODUCTION

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Social interactions frequently involve specific interpersonal nonverbal behaviours which help tailor the distance between interaction partners: Approach and avoidance. The literature suggests that during initial social encounters these behaviours influence evaluations of groups that individuals belong to: Approach leads to more positive evaluations as compared to avoidance. However, previous research mainly relied on 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 investigate the effect of interpersonal approach-avoidance behaviours on group evaluations.

## 1.1. THE EVALUATIVE INFLUENCE OF APPROACH-AVOIDANCE BEHAVIOURS: A LITERATURE REVIEW

### 1.1.1. APPROACH-AVOIDANCE BEHAVIOURS AND EVALUATIONS

Approach-avoidance are defined as behaviours enacted in order to reduce or increase the distance between the individual and an aspect of the environment, respectively. These behaviours are supposed to be governed by different neuropsychological systems: The Behavioural Approach System (BAS) governs responses to appetitive stimuli and approach behaviours, while the Fight-Flight-Freeze System (FFFS) governs responses to aversive stimuli and active avoidance behaviours (Gray & McNaughton, 2000). Approach-avoidance enable individuals to efficiently evolve in their environment due to a tight coupling with evaluative processes (Neumann et al., 2003; Strack & Deutsh, 2004). Indeed, positive evaluations generally predispose individuals to approach and negative evaluations predispose them to avoid (Chen & Bargh, 1999; for reviews see Phaf et al., 2014; Laham et al., 2015). For instance, Chen and Bargh (1999) showed that individuals are faster to pull a lever toward themselves (i.e., approach) in response to positive stimuli (i.e., words) and to push a lever away from themselves (i.e., avoidance) in response to negative ones than vice versa.

Research indicates that approach and avoidance behaviours are not mere responses to positive and negative stimuli, but they also actively influence evaluations: Approach leads to

more positive evaluations than avoidance (Cacioppo et al., 1993; Priester et al., 1996). 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.

### **1.1.2. THE INFLUENCE OF APPROACH-AVOIDANCE ON GROUP EVALUATIONS**

When interacting with others, individuals categorise them into social groups on the basis of social or ethnic origins, age, sex but also political, food or musical preferences (to name but a few examples). Depending on their experiences with these social groups, individuals may have evaluative predispositions, or attitudes (Allport, 1935), toward them. The attitudes that individuals have of these groups may be shaped by approach-avoidance behaviours (Kawakami et al., 2007; Van Dessel et al., 2018; 2020; Phills et al., 2011). More specifically, research shows that approach reduces the negative evaluations of certain groups (e.g., Afro-Americans; Kawakami et al., 2007; Phills et al., 2011; Turks; Van Dessel et al., 2020). For instance, repeatedly pulling a joystick toward the body (i.e., approach) in response to pictures of Turkish people leads to less negative evaluations of this group than repeatedly pushing a joystick away from the body (i.e., avoidance; Van Dessel et al., 2020). This finding suggests that approach improves evaluations of existing groups as compared to avoidance. Approach-avoidance may also contribute to the formation of attitudes toward unknown social groups. Repeatedly moving a figure representing the self toward the names of fictitious groups' members (e.g., “Luupites”, “Niffites”) leads to more positive attitudes toward this group than moving the figure away from these names (Van Dessel et al., 2018, Experiment 3).

From this brief review, it follows that in situations where individuals encounter unknown others, enacting specific interpersonal behaviours could differently shape the attitudes toward the groups these strangers belong to. As group attitudes may, in turn, orient the course of the social interaction, a better understanding of how approach-avoidance influence these evaluations represents a crucial step towards a comprehension of intergroup interactions.

### **1.1.3. THE INFLUENCE OF APPROACH-AVOIDANCE ON GROUP EVALUATIONS: LIMITATIONS**

Empirical evidence suggests that approach-avoidance behaviours influence group evaluations (Kawakami et al., 2007; Van Dessel et al., 2020). However, previous research considers an overly restricted window onto the phenomenon as it presents several shortcomings. Past investigations display high experimental control, but this is 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., simple arm movements; Kawakami et al., 2007; Van Dessel et al., 2020) or through their mere symbolic representations (e.g., movement of a figure representing the self; Van Dessel et al., 2018). 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 relevant 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. In a social interaction setting, arm actions may appear ambiguous as well as meaningless and participants would then actively seek ways to generate meaning in the experimental setting (Orne, 1962; Kihlstrom, 2021). For instance, to create meaning they may use reasonings like: “Maybe I have to perform this behaviour because this picture is positive”.

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 group evaluations may appear as a poor approximation of its real-life counterpart. It may take a fairly different form as the elaborateness (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 intergroup interactions (Lewin, 1936). In doing so they do not do justice to a view of cognition as grounded in individual-environment interactions according to which 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 facilitate individuals' interactions with the environment (Smith & Semin, 2004; Versace et al., 2014). As a consequence, previous work may offer a limited or distorted picture of how approach-avoidance behaviours influence attitudes. Some recent methodological attempts laid down the foundations for proposing improved operationalisations based on more ecological whole-body movements (Nuel et al., 2019; Krpan & Fasolo, 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 to test the contribution of approach-avoidance behaviours in group evaluations. Hence, we propose to rely on IVR as a method of choice for addressing the previously neglected criteria of ecologically-bound social interactions and thereby the shortcomings of previous research.

## **1.2. 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 which 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 other interactant is represented as a dynamic virtual

individual, affording specific interpersonal behaviours (e.g., whole body behaviours). In this way, IVR enables us to match the behaviours typically afforded in an interpersonal context to the ones that individuals have to perform and increases the meaningfulness of the situation. Second, contrary to previous paradigms, the immersive nature of the IVR enables us to consider the physical distance between interactants. Third, and finally, by immersing participants in realistic situations with multi-sensory stimulations (including movement, sounds, speech, vision, etc.) IVR allows us to better consider the grounded nature of cognition.

In other words, the use of IVR offers promising perspectives for investigating the contribution of approach-avoidance behaviours on group attitudes. It limits the influence of undesirable variables (e.g., behavioural ambiguity), while taking into account previously neglected variables (e.g., interpersonal distance) and considering the contribution of important features (e.g., sensorimotor and contextual cues). Crucially, in doing so, IVR enables us therefore to better estimate the effect of approach-avoidance on group evaluation.

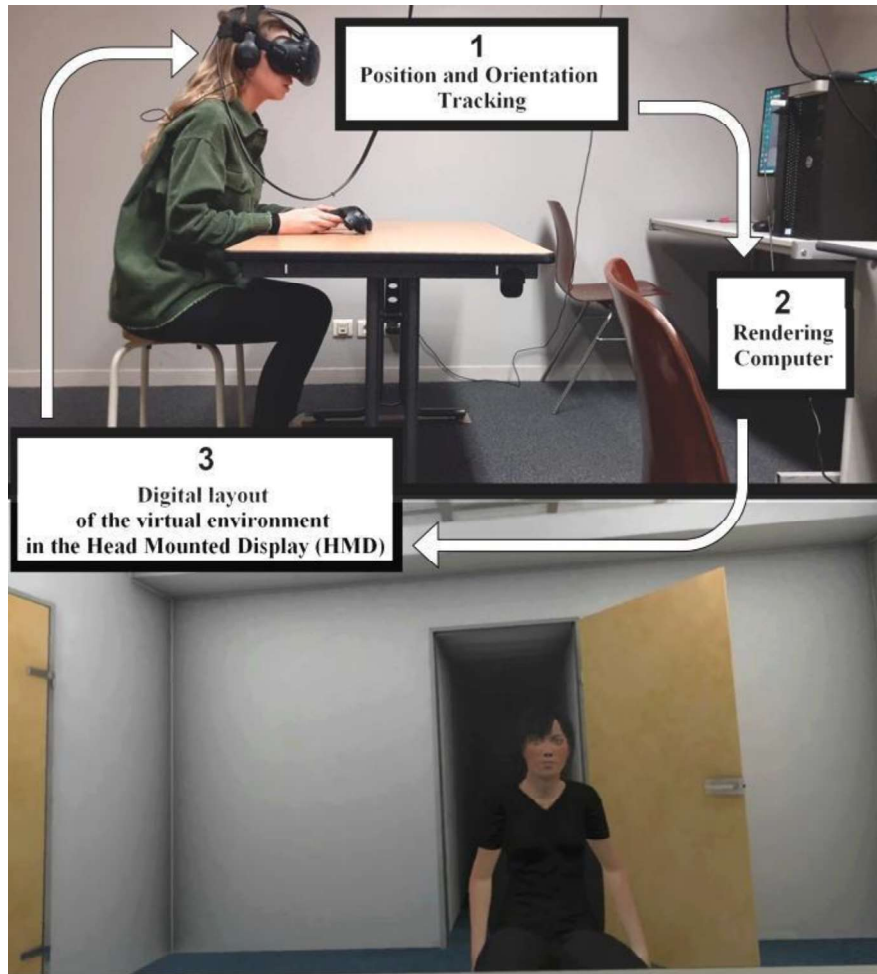
Granting that IVR is highly promising for the study of social interactions and the evaluative influence of approach-avoidance behaviours, its implementation is not without challenges (Pan & Hamilton, 2018). First, when recreating naturalistic interactions, the important feature is not the objective realism per se but rather the maximisation of the subjective experience of realism of this environment. 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 with their eyes but not their body. In IVR experiments, particular care should be taken to ensure that the settings do not provide a poor feeling of presence and/or a high level of sickness that could hinder the IVR experience.

## OVERVIEW

In the present contribution, we investigate whether approaching or avoiding newly encountered persons influences the attitude toward the group they belong to. More specifically, we expect a more positive attitude toward members of the approached group than toward members of the avoided group. If it is the case, approach and avoidance behaviours may be decisive for prospective intergroup interactions from the very onset of social interactions. We argue that IVR is the optimal tool to test this idea as it enables realistic sensorimotor and

contextual settings. We tested the influence of approach-avoidance on group evaluations in two preregistered experiments. Participants were seated in a virtual room and had to approach or avoid virtual individuals representing members of an unknown social group. We relied on fictitious groups rather than on real social groups because individuals may already hold a strong attitude toward existing groups that could reduce the potential influence of approach-avoidance on evaluations (Priester et al., 1996). By presenting a novel and unknown 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 fairly common interpersonal approach-avoidance behaviours: Upper-body forward and backward leaning movements (Nuel et al., 2019; Galton, 1884; Mehrabian, 1968; Word et al., 1974). We then assessed attitudes toward 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).

As the use of IVR to examine approach-avoidance in this way is innovative, we gauged the activation of the neuropsychological systems supposed to underlie approach-avoidance behaviours in order to check the construct validity of our operationalisation (see also Nuel et al., 2019). To do so, we relied on the Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ, Corr & Cooper, 2016) measuring the BAS and FFFS. Finally, the use of IVR prompted us to measure the feeling of presence and sickness symptoms to verify that our settings did not create negative experiences that could interfere with our manipulation. 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 ( $\eta^2$ ) of .038 with a power of 80%. The 90% confidence intervals reported hereafter are based on the partial eta-squared ( $\eta_p^2$ ).



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

## 2. EXPERIMENT 1

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In Experiment 1, we tested the contribution of approach-avoidance behaviour in the attitude toward an unknown group. For this purpose, we used IVR (Figure 1) to operationalise approach-avoidance behaviours (forward and backward leaning). As in previous research, we predicted that enacting approach behaviours toward unknown group members should lead to more positive attitudes toward the group than enacting avoidance behaviours. In order to maintain mundane realism, we introduced the fictitious group as a recently discovered one characterised by a newly discovered 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).

## 2.1.METHOD

### 2.1.1. 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 ( $M_{Age} = 21.62$ ,  $SD_{Age} = 5.59$ ,  $n_{Approach} = 101$ ,  $n_{Avoidance} = 98$ ).

### 2.1.2. 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.

### 2.1.3. PROCEDURE

#### 2.1.3.1. 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.

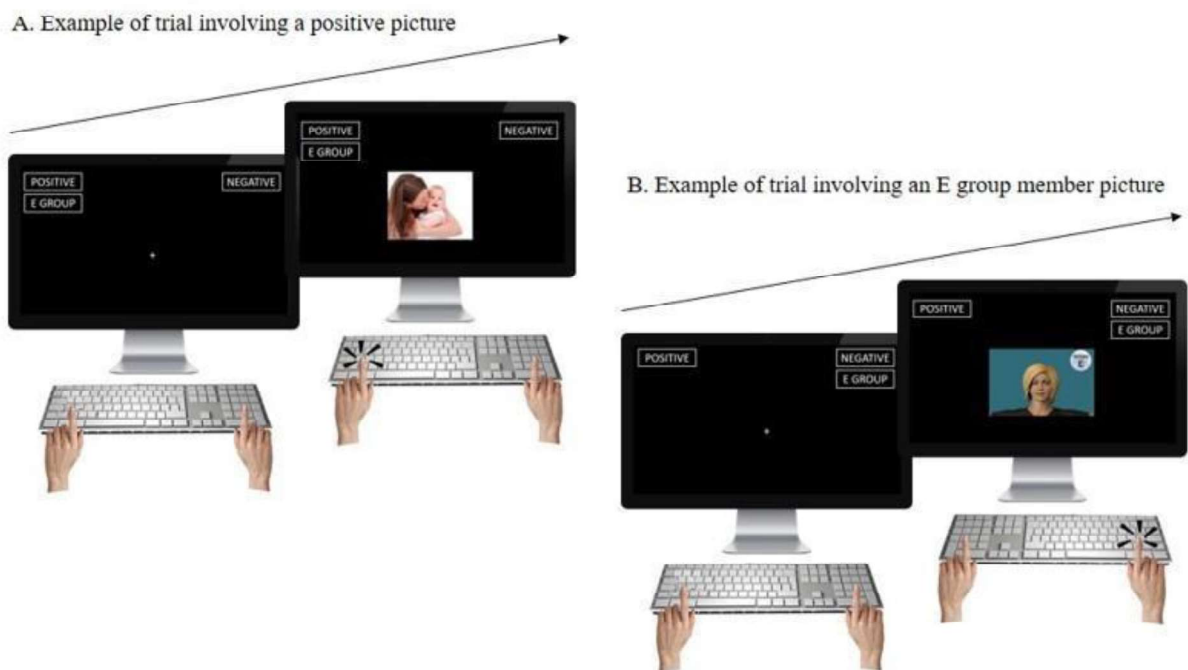
After that, participants saw a short video presenting the general procedure of the task and the two upper-body inclinations (forward and backward, see Figure 1). Then, they were immersed into a virtual room and received all instructions through headphones connected to the headset (HTC Vive © connected 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 should 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 a 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 for each next encountered individual. 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 encountered 16 different virtual individuals (8 men and 8 women). For each encounter, participants had to consider their impression of the target individual. Each virtual individual wore a T-shirt with an “E-group” logo on it in order to help participants to consider them as members of the E-group.

### **2.1.3.2. Evaluations**

After the IVR task, participants were seated in front of a computer screen to evaluate the E-group.

#### **2.1.3.2.1. *SC-RF-IAT***

In the SC-RF-IAT, participants had to categorise stimuli presented on the 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 trials 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 toward the E-group. For the interested reader, a detailed description of the SC-RF-IAT is available in the [OSF project](#).



*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.

### 2.1.3.2.2. *Feeling Thermometer*

Next, participants had to indicate their impression toward 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).<sup>13</sup>

### 2.1.3.3. **Construct Validity Measures: Approach and Avoidance Neuropsychological Systems**

In order to assess the construct validity of the approach-avoidance manipulation, we also gauged the activation of the neuropsychological systems underlying approach and avoidance behaviours with the RST-PQ (Corr & Cooper, 2016). Participants completed the French version of the RST-PQ (obtained from L.-C. Vannier, personal communication, December 4<sup>th</sup>, 2017). 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*. We expected our manipulation of approach-avoidance behaviours to activate the corresponding BAS and FFFS neuropsychological systems.

### 2.1.3.4. **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*.<sup>14</sup> 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 disorder which could have impaired their performance, indicated their age, their gender identification and their ability in French language (i.e., “Are you fluent in

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<sup>13</sup> Three participants indicated group E as their blood type. Excluding these participants from the analyses do not change any of the reported results.

<sup>14</sup> 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).



French?"). Finally, participants were probed for suspicion, debriefed and compensated for their participation.

## 2.1.4. RESULTS

### 2.1.4.1. Confirmatory Analyses

Globally, participants felt present in the virtual environment as the grand mean was greater than the midpoint (3) of the scale ( $M = 3.14$ ,  $SD = 0.71$ ),  $F(1,197) = 7.67$ ,  $p = .006$ ,  $\eta_p^2 = .04$ , 90% CI [.01, .09], Cronbach's  $\alpha = .87$ , 95% CI [.84, .90]. Moreover, they did not report an alarming level of sickness due to VR ( $M = 1.17$ ,  $SD = 0.37$ ). 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  $r(197) = 0.26$ ,  $p < .001$ ]<sup>15</sup>, the feeling about the E-group, the BAS score (Cronbach's  $\alpha = .83$ , 95% CI [.80, .87]), and the FFFS score (Cronbach's  $\alpha = .76$ , 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 have higher BAS (approach system) score or lower FFFS (avoidance system) score than those in the avoidance condition (Table 1).

	Avoidance <i>n</i> = 98		Approach <i>n</i> = 101		Comparison
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
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 <sup>a</sup>	5.03	16.53	4.99	14.42	$F(1,195) = 0.00$ , $p = .99$ , $\eta_p^2 = .000$ , 90% CI [.00, .00]
BAS	2.85	0.37	2.92	0.38	$F(1,197) = 1.59$ , $p = .21$ , $\eta_p^2 = .008$ , 90% CI [.00, .04]
FFFS	2.19	0.62	2.22	0.59	$F(1,197) = 0.14$ , $p = .71$ , $\eta_p^2 = .001$ , 90% CI [.00, .03]

<sup>a</sup> Two supplementary participants in the approach condition were excluded from the Feeling-Thermometer due to missing data.

SC-RF-IAT = Single Category Recoding Free Implicit Association Test, BAS = Behavioural Approach System, FFFS = Fight-Flight-Freeze System.

Feeling Thermometer scores could vary from - 50 to + 50. BAS and FFFS scores could vary from 1 to 4.

Table 1. Preregistered analyses in Experiment 1

<sup>15</sup> 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.

#### 2.1.4.2. Complementary Analyses

The neuropsychological system guiding approach behaviours (BAS) is composed of 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  $\alpha = .84$ , 95% CI [.80, .87],  $n_{\text{item}} = 9$ , Supplementary Material of Corr & Cooper, 2016). Interestingly, the analysis revealed that participants in the approach condition scored higher on the GDP ( $M_{\text{Approach}} = 3.23$ ,  $SD_{\text{Approach}} = 0.45$ ) than in the avoidance condition ( $M_{\text{Avoidance}} = 2.99$ ,  $SD_{\text{Avoidance}} = 0.59$ ),  $F(1, 197) = 10.56$ ,  $p = .001$ ,  $\eta_p^2 = .05$ , 90% CI [.01, .11] (see the [OSF project](#) for the analyses of the other components).

#### 2.1.5. DISCUSSION

In Experiment 1, we capitalised on IVR to ecologically operationalise approach-avoidance behaviours (upper-body forward and backward leaning) and tested their effect on evaluations vis-à-vis a novel group. The presence and sickness level revealed that we managed to provide a realistic experience of social interaction in the virtual environment. However, contrary to what was predicted, participants did not evaluate the novel group any more positively in the approach than in the avoidance condition. However, complementary analyses revealed that approach-avoidance behaviours 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 indicates that participants in the approach condition reported higher motivation to persist in reaching their desired end-state. Although not predicted, this result suggests that approach and avoidance behaviour have been successfully manipulated. Indeed, approach-avoidance behaviours are enacted in the first and anticipatory stage of motivation (Berridge, 1996), stage 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, a higher threshold level of GDP activation may be necessary to influence group evaluations (Krpan & Fasolo, 2019). Third, 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 and 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 did, these inferences may have led to essentialist appraisals due to their biological substrate (Dar-Nirmod & Heine, 2011).

### 3. EXPERIMENT 2

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In Experiment 2, we aimed to address the limits of Experiment 1 to investigate the contribution of approach-avoidance behaviours in the attitude toward an unknown group. Again, we predicted that enacting approach towards unknown group members should lead to more positive attitude toward the group than enacting avoidance. 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; Rougier et al., 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 toward the group, as well as a greater willingness to interact with a member of this group.

#### 2.2.METHOD

### 2.2.1. 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 ( $M_{Age} = 20.62$ ,  $SD_{Age} = 4.47$ ,  $n_{Approach} = 107$ ,  $n_{Avoidance} = 98$ ).

### 2.2.2. PROCEDURE

#### 2.2.2.1. 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 “UDESOS” logo depending on the encountered group.

#### 2.2.2.2. 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 the other group is avoided) indexes a more positive attitude toward 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](#).



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

#### 2.2.2.3. Traits-Rating Task

Then, using a pencil and paper questionnaire, participants evaluated the group encountered in the IVR setting on six positive and six negative traits (i.e., “According to you, to what extent the Alesophiles/Udesophiles are ...”) on a 10-points response scale ranging from 1: *not at all* to 10: *extremely* (see the [OSF project](#) for the material).

#### 2.2.2.4. Willingness to Interact

As an index of the attitude toward 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.

#### 2.2.2.5. Construct Validity Measures: Approach and Avoidance Neuropsychological Systems

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

#### 2.2.2.6. Supplementary Measures

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

### 2.3.RESULTS

#### 2.3.1. CONFIRMATORY ANALYSES

Globally, participants felt relatively present in the virtual environment with the grand mean being descriptively slightly above the midpoint (3) of the scale,  $M = 3.05$ ,  $SD = 0.72$ ,  $F(1, 203) = 0.99$ ,  $p = .32$ ,  $\eta_p^2 = .01$ , 90% CI [.00, .03], Cronbach's  $\alpha = .87$ , 95% CI [.85, .90]. Moreover, they did not report an alarming level of sickness due to VR ( $M = 1.14$ ,  $SD = 0.38$ ). All results of Experiment 2 were presented in Table 2.

##### 2.3.1.1. 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 & Andrew, 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 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,  $t = 1.51$ , Likelihood ratio test:  $\chi^2(1) = 0.34$ ,  $p = .56$ .<sup>16</sup> 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 statistically significant,  $b = -5.17$ ,  $SE = 2.06$ ,  $t = -2.39$ , Likelihood ratio test:  $\chi^2(1) = 5.64$ ,  $p = .018$ .

The expected interaction between block type and behaviour was not statistically significant,  $b = 6.65$ ,  $SE = 3.38$ ,  $t = 1.83$ , Likelihood ratio test:  $\chi^2(1) = 2.33$ ,  $p = .127$ . Contrary to what was expected, the interaction pattern revealed that the approach bias toward 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<sub>Avoidance</sub> = -8.49,  $SE_{Avoidance} = 2.86$ ) than for those who enacted approach (Approach bias<sub>Approach</sub> = -1.85,  $SE_{Approach} = 2.76$ ).

### 2.3.1.2. Traits Rating

We computed an evaluation score by averaging the six reversed negative traits with the six positive ones in the traits-ratings task. This score could vary between 1 and 10, with higher scores indicating a more positive evaluation of the encountered group, Cronbach's  $\alpha = .78$ , 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]. More importantly, 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 ( $M_{Avoidance} = 5.70$ ,  $SD_{Avoidance} = 1.08$ ). However, this effect missed conventional levels of statistical significance,  $F(1, 203) = 3.13$ ,  $p = .08$ ,  $\eta_p^2 = .02$ , 90% CI [.00, .05].

### 2.3.1.3. 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

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<sup>16</sup> 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. Whenever possible, we report unstandardized effect sizes in line with general recommendations of reporting effect sizes (e.g., Pek & Flora, 2018).

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  $\chi^2(1) = 1.06, p = .30, OR = 0.70, 95\% CI [0.35, 1.37]$ .

#### 2.3.1.4. Construct Validity Measures: 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  $\alpha = .81, 95\% CI [.77, .85]; M_{Approach} = 2.89, SD_{Approach} = 0.34$  and  $M_{Avoidance} = 2.90, SD_{Avoidance} = 0.39, F(1, 202) = 0.13, p = .72, \eta_p^2 = .00, 90\% CI [.00, .02]$ , nor on the FFFS score (Cronbach's  $\alpha = .71, 95\% CI [.65, .77]; M_{Approach} = 2.21, SD_{Approach} = 0.56$  and  $M_{Avoidance} = 2.22, SD_{Avoidance} = 0.57, F(1, 202) = 0.01, p = .93, \eta_p^2 = .00, 90\% CI [.00, .00]$ .<sup>17</sup> Also, we did not replicate the Experiment 1 results on the GDP score (Cronbach's  $\alpha = .84, 95\% CI [.81, .87]; M_{Approach} = 3.13, SD_{Approach} = 0.53$  and  $M_{Avoidance} = 3.24, SD_{Avoidance} = 0.54, F(1, 202) = 2.04, p = .16, \eta_p^2 = .01, 90\% CI [.00, .04]$ ).

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<sup>17</sup> One participant (in the approach condition) was excluded because of reporting having confounded the anchors in the RST-PQ completion.



	Avoidance <i>n</i> = 98		Approach <i>n</i> = 107		Comparison				
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>					
Traits-ratings	5,7	1,08	5,98	1,14	$F(1,203) = 3.13, p = .08, \eta^2_p = .02, 90\% \text{ CI } [.00, .05]$				
BAS <sup>a</sup>	2,9	0,39	2,89	0,34	$F(1,202) = 0.13, p = .72, \eta^2_p = .00, 90\% \text{ CI } [.00, .02]$				
FFFS <sup>a</sup>	2,22	0,57	2,21	0,56	$F(1,202) = 0.01, p = .93, \eta^2_p = .00, 90\% \text{ CI } [.00, .00]$				
Willingness to interact	81,63%		75,70%		$\chi^2(1) = 1.06, p = .30, OR = 0.70, 95\% \text{ CI } [0.35, 1.37]$				
VAAST <sup>b</sup>	RT <sub>to avoid</sub>		RT <sub>to avoid</sub>		RT <sub>to approach</sub>				
	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>	<i>M</i>	<i>SE</i>			
	853.10	6.29	844.61	6.07	864.2	5.42	862.4	8.03	$b = 6.65, SE = 3.38, t = 1.83, \chi^2(1) = 2.33, p = .127$

<sup>a</sup> One participant (in the approach condition) was excluded because of reporting having confounded the anchors in the RST-PQ completion.

<sup>b</sup> 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 ( $n_{\text{Approach}} = 105, n_{\text{Avoidance}} = 96$ ).

VAAST = Visual Approach-Avoidance by the Self Task, BAS = Behavioural Approach System,

FFFS = Fight-Flight-Freeze System.

Traits-ratings scores could vary from 1 to 10. BAS and FFFS scores could vary from 1 to 4.

Table 2. Preregistered analyses in Experiment 2

### 2.3.2. COMPLEMENTARY ANALYSES

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 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  $\alpha = .78$ , 95% CI [.72, .83]) and a competence (Cronbach's  $\alpha = .77$ , 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. 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 ( $M_{Avoidance} = 4.81$ ,  $SD_{Avoidance} = 1.73$ ),  $F(1, 203) = 4.18$ ,  $p = .04$ ,  $\eta_p^2 = .02$ , 90% CI [.00, .06] and descriptively more competent in the approach condition ( $M_{Approach} = 5.85$ ,  $SD_{Approach} = 1.23$ ) than in the avoidance condition ( $M_{Avoidance} = 5.60$ ,  $SD_{Avoidance} = 1.27$ ),  $F(1, 203) = 2.20$ ,  $p = .14$ ,  $\eta_p^2 = .01$ , 90% CI [.00, .05].

## 2.4. DISCUSSION

In Experiment 2, we tested the effect of approach (leaning forward) and avoidance (leaning backward) behaviours on the evaluation of a newly discovered (but fictitious) social group. 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. Following our reasoning, we showed in highly ecological settings that approach-avoidance behaviours account for 2% of the variance in one measure of group evaluations (i.e., trait ratings): Participants in the approach condition tended to evaluate the encountered group more positively than those in the avoidance condition. This positive effect of approach is significant on the warmth dimension, which is considered to be the primary dimension in social judgment (i.e., see the primacy-of-warmth, Abele and Wojciszke, 2007; Fiske et al., 2018). These results are important as they replicate past research showing that approach and avoidance influence evaluative processes.

Overall, the present findings are somewhat mitigated when considering action tendencies toward the encountered group. Indeed, participants who enacted approach toward

the group in IVR were then descriptively faster to initiate avoidance (vs. approach) toward members of the target group than those who avoided the group in the IVR. A tentative explanation might stem from the fact that measurements are not process-pure (Jacoby, 1991; Sherman, 2009). Indeed, although approach-avoidance tendencies are sensitive to group attitudes (for a 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, 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 behaviours (Heuer et al., 2007) and anger-related stimuli trigger approach behaviours (Alexopoulos & Ric, 2007). Moreover, as IVR reproduces interpersonal distances, participants may have felt too close to the virtual individuals in the approach condition. Subsequently, this may have activated avoidance tendencies (Bailenson et al., 2003).

#### **4. GENERAL DISCUSSION**

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In the present research, we investigated if and how approach and avoidance behaviours toward unknown others influence individuals' attitudes toward the encountered group. For this purpose, we advocated the use of IVR to operationalise approach-avoidance behaviours appropriately because of IVR's capacity for recreating realistic individual-environment interactions. With the use of IVR we were able to test, in ecological settings and with sufficient experimental control, the reasoning that approach behaviours should positively influence group attitudes as compared to avoidance. Globally, results were mitigated with regard to our hypotheses. Experiment 1 did not reveal the expected positive effect of approach on social group evaluations but revealed an effect of approach-avoidance behaviours on one specific sub-dimension of the BAS (i.e., the GDP component). Experiment 2 showed the expected approach-avoidance effect on traits ratings, and the effect on action tendencies was opposite to what was expected.

The current work constitutes a non-negligible contribution to the field of approach and avoidance behaviours. By immersing individuals in a meaningful virtual environment and

manipulating whole-body movements we went beyond previous paradigms that rely on minimalist and decontextualised settings. The obtained results suggest that the IVR operationalisation of approach-avoidance could influence the motivational state of individuals (i.e., the GDP component of the BAS in Experiment 1). This effect should be taken with caution as not replicated. Nevertheless, they are encouraging in regard with the novel approach-avoidance operationalisation and future research should pursue the issue. Interestingly, although some findings pointed in the expected direction they are not as straightforward as would be predicted based on the literature. These mixed results might question those of the literature and again, call for further investigation of approach-avoidance influences in IVR settings.

One could consider the advantages of IVR to be limited if it is unable to straightforwardly replicate the effects obtained with more minimalist paradigms. There are several, admittedly post hoc, possible explanations for not replicating the effect of approach-avoidance on evaluations. First, it is possible that portions of the effect obtained in previous studies were driven by specific experimental settings: A too decontextualised setting may give more weight to instructions in the production of the effect (Van Dessel et al., 2015) than in IVR settings. Second, it is possible that features of the IVR procedure or aspects of the implemented environment hindered the effect by surreptitiously cueing situation-specific psychological states or perceptions. For example, our settings may have activated different goals (e.g., affiliation, aggression, dominance, submission; Bossuyt et al., 2014) or emotional states (e.g., happiness, anger; Maayan & Meiran, 2011; Yan & Dillard, 2011) functionally linked to approach (and avoidance) behaviours that could have jointly contributed to the effect. This possibility may explain: a) the unsettled results on the neuropsychological systems across the two experiments as well as b) the reverse pattern in the VAAST. As another example, due to the immersive settings, the avoidance of virtual individuals may have been negatively experienced and have subsequently triggered compensatory approach tendencies (e.g., due to loss of social connection or guilt, for an example see Schmader and Lickel, 2006). These tendencies may have been captured by the VAAST independently of self-reported group evaluations. The ecological setting offered by IVR is well suited to reveal such complexity.

None of these potential explanations justifies dampening mundane realism in the study of approach-avoidance influence on evaluation. If one or more potential moderators of the effect exist, these should be eventually investigated by considering the multiplicity of sensory and contextual cues emerging during a social interaction. Metaphorically speaking, keeping up with

impoverished or minimalist paradigms to study human behaviour would be like observing fishes taken out of the water to draw general inferences about their swim 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 way to investigate human behaviour in situations as close to those in which they are supposed to occur. Future research on approach-avoidance behaviours should benefit from IVR technologies to increase their realism. The current experiments represent a first step in this direction: Due to mixed results this work questions the boundary conditions as well as the underlying mechanisms of approach-avoidance effects.

One limitation of the current work resides in the number of behaviour repetitions. Indeed, 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. This limitation should be addressed in further studies. 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).

Finally, the evaluative influence of approach-avoidance has been proposed as a possible intervention for prejudice reduction (Van Dessel et al., 2020). As the current findings did not replicate previous work in a straightforward way, the interventional perspectives of the effect may be premature. Further research in IVR settings must be conducted to look for potential new boundary conditions before concluding that approach-avoidance behaviours constitute a viable intervention for prejudice reduction.

## CONCLUSION

To conclude, in the present contribution we advocated the use of IVR as an appropriate and insightful tool to expand the scope of investigation concerning the influence of approach-avoidance behaviours on group evaluations. Future research will certainly benefit from using IVR to reveal the full complexity of the psychological determinants of social behaviour.

## SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at:  
[https://osf.io/9jb8a/?view\\_only=eb885e8942654089ba7cff2fd880ed98](https://osf.io/9jb8a/?view_only=eb885e8942654089ba7cff2fd880ed98)

## OPEN PRACTICES

All materials, analysed datasets with the corresponding R scripts for the two experiments can be found in Open Science Framework ([here](#)). Preregistration for Experiment 1: <https://osf.io/426f7>. Preregistration for Experiment 2: <https://osf.io/nyzke>.

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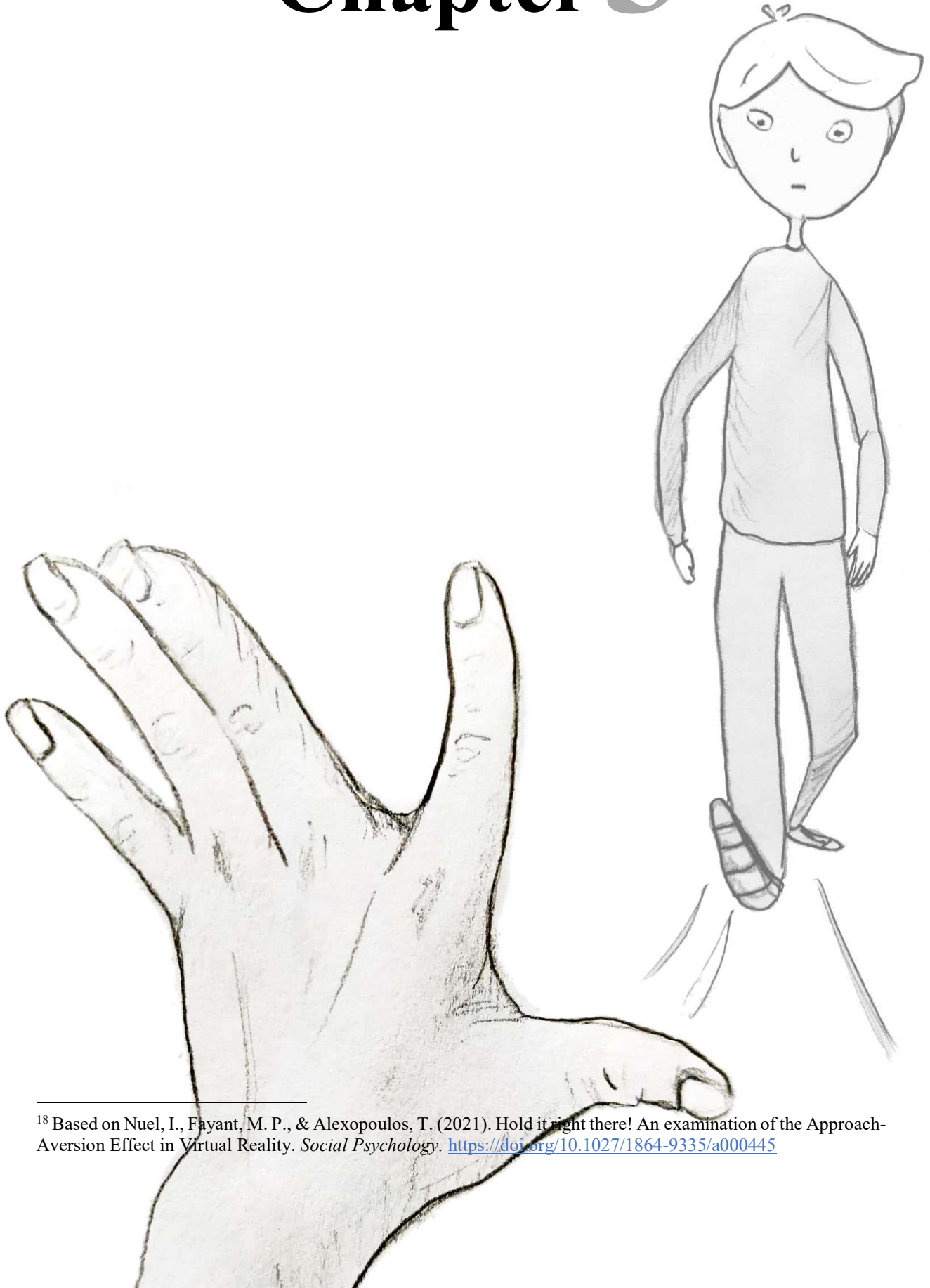
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# Chapter 3<sup>13</sup>



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In the two previous chapters, we investigated if during a social interaction, the enactment of approach-avoidance behaviours influences the evaluation of the interaction partner. In the literature, enacting approach behaviours produces more positive evaluations of the partner than enacting avoidance behaviours (Slepian et al., 2012; Woud et al., 2008). However, by focusing on the individual who enacts the behaviours, previous research may not tell us the whole story about the contribution of approach-avoidance in the process of social interaction regulation. Indeed, if approach-avoidance behaviours actively contribute to the regulation of individuals' social interactions, they should integrate any modification in the social interaction situation in order to flexibly adapt to changing demands (Balcetis & Cole, 2009; Semin & Cacioppo, 2008). As an element of the environment in which the social interaction occurs, the other should also be considered as an integral part of the process of social interaction regulation. Importantly, the interaction partner constitutes another autonomous cognitive system and is thus dynamic. If the ultimate fate of the strawberries tart that attract you is relatively fixed (i.e., to be devoured), the interaction partner could react to your approach or avoidance behaviour and orient the course of the interaction in a different way than what you originally planned (e.g., running away when approaching them). Depending on how the other would react, the evaluative effect of approach and avoidance behaviour could take a different turn than the original one. Therefore, to understand the role of approach-avoidance behaviour in the regulation of social interaction, one must not only consider their influence on the individual who enacts them. It is also necessary to understand 1) how these enacted behaviours are perceived from the perspective of the one who is approached or avoided and 2) how, in return, this could affect the evaluative influence of approach-avoidance from the perspective of the one who enacts them.

In this chapter, as a first step for a more complete comprehension of how approach-avoidance behaviours regulate individuals' social interaction, I focus on the first point (i.e., how these enacted behaviours are perceived from the perspective of the one who is approached or avoided). More specifically, I investigate if and how, trying to interact with someone through approach behaviours could be negatively perceived by the other. Indeed, when a distance reduction stems from the social environment rather than from the bodily self (as in Chapter 1 and 2), it may be perceived as threatening. If it is the case, this could ironically have a negative effect on the unfolding social interaction (e.g., the approached individual may avoid the approaching one or attack them). Importantly, being rejected while intending to initiate a social



interaction may have a negative impact on (approaching) individuals such as threatening their fundamental need for social interactions (Gerber & Wheeler, 2009; Molden et al., 2009).



# Hold It Right There!

## An Examination of the Approach-Aversion Effect in Virtual Reality

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**Abstract:** The approach-aversion effect refers to a devaluation of approaching (vs. static) stimuli and is attributable to the fact that being approached is threatening. However, the explanation and the generalizability of this effect still remain unclear. To fill this gap, we provide a powerful test of the approach-aversion effect using Virtual Reality. Participants evaluated approaching and static virtual individuals for which we manipulated the threatening nature via their emotional facial expressions (Experiment 1), their group membership (Experiment 2), and the agency of their movements (Experiment 3). The results suggest a general approach-aversion effect which is attenuated when the self (vs. the target) initiates the movement. We thus bring convergent evidence that being approached is threatening.

**Keywords:** agency, approach-avoidance, threat, virtual reality, grounded cognition

As social beings, individuals are constantly engaging in social interactions infused with a broad range of interpersonal behaviors that shape their course. For instance, proximity behaviors such as distance reduction are picked up and reciprocated during an interaction (Word et al., 1974). This distance reduction may serve an affiliative purpose and create social bonds. Evidence shows that enacting an approach behavior leads individuals to evaluate the approached person more positively (Slepian et al., 2012; Woud et al., 2008). Granting the positive evaluative effect of approach behaviors, previous research may not tell us the whole story as the social interaction relies on a dyadic sequence, embedded in a physical and social environment. In fact, from the perspective of the one who is approached, the approach may be threatening and bear negative evaluative consequences, an effect termed approach-aversion (Hsee et al., 2014). Nevertheless, previous research reveals contradictory findings (Hsee et al., 2014; Mühlberger et al., 2008) and has some methodological issues (i.e., movement ambiguity, lack of mundane realism) questioning the explanation as well as the generalizability of this effect. The present contribution fills the gap of equivocal findings by adequately addressing these issues. Across three well-powered preregistered experiments conducted in Virtual Reality (VR), we tested the reasoning that, in the context of everyday social interactions, facing an approaching individual may be threatening and thus yield *an approach-aversion effect*.

### Interpersonal Approach Behaviors: Always Positive?

The bulk of research suggests that approach behaviors, hereafter defined as behaviors enacted in order to reduce the distance between the self and the surrounding stimuli, yield more positive evaluations of those stimuli as compared to avoidance behaviors, enacted to increase this distance (Cacioppo et al., 1993; Slepian et al., 2012; Van Dessel et al., 2018; Woud et al., 2008). During social interactions, when approaching others, individuals perceive them as more positive (Woud et al., 2008, but see Vandenbosch & De Houwer, 2011) and trustworthy (Slepian et al., 2012), and could contribute to prejudice reduction when performed repeatedly (Kawakami et al., 2007; Phillips et al., 2011; Van Dessel et al., 2016, 2020).

In these studies, the influence of approach behaviors on evaluations was investigated solely from the perspective of the interaction partner displaying these behaviors (but see Hütter & Genschow, 2020; Van Dessel et al., 2018). The fact that the literature focuses mainly on the behavior emitter may be due to the core idea that the self is the steering force behind the enactment of approach-avoidance behaviors (Robinson et al., 2014). However, the course of social interaction depends mutually on all parties involved. Taking this notion into account, one could easily conceive cases in which the social situation may be perceived in a diametrically opposite way from the perspective of the person being

approached. In the present paper we seriously consider this idea: Taking up the social interaction as a whole-bodied dynamic sequence, we investigate the evaluative consequences of a distance reduction on the part of the perceiver.

## Approach Behaviors From the Receiver's Side: A Potential Looming Threat

When a distance reduction occurs from the social environment rather than from the bodily self it may be perceived as threatening. In the face of approaching stimuli, one may need to promptly defend oneself (Franconeri & Simons, 2003). It is therefore crucial to quickly detect approaching stimuli in order to prepare adaptive responses (Skarratt et al., 2014). Research shows that individuals' sensory systems are especially attuned to movement perception and more specifically to approach movements (for a review, see Riskind & Rector, 2018): Approaching stimuli benefit from attentional prioritization (Judd et al., 2004) and speed up behavioral reaction times (Spaccasassi et al., 2019). These stimuli trigger a state of defensive action preparedness, eliciting eyeblink responses (Schmuckler et al., 2007) and backward head movements (King et al., 1992). This approach sensitivity is heightened for trajectories directed straight toward the self as compared to trajectories getting close but bypassing the self (Lin et al., 2009).

In a nutshell, while approaching a target leads to more favorable evaluations of the target, the same behavior could be perceived as threatening from the target's standpoint, having ironically a deleterious effect on the unfolding of social interactions.

## The Approach-Aversion Effect

Some research directly illustrates the negative evaluative consequences of being approached by revealing an approach-aversion effect (Davis et al., 2011; Hsee et al., 2014; Mühlberger et al., 2008). For instance, Hsee and colleagues (2014) showed that participants felt more negatively vis-à-vis approaching social stimuli (e.g., schematic face icons) as compared to receding or static ones. This approach-aversion effect supposedly occurs because of the threatening nature of approach movements (*the threat hypothesis*). Indeed, Hsee and colleagues (2014) found that measured fear mediated the negative effect of approach on evaluation. However, although these seminal studies have the merit to highlight the potential negative consequences of being approached, there are still open questions.

First, previous studies mostly manipulated the approach movement ambiguously by creating a zoom effect through changes in stimulus size (Hsee et al., 2014, Studies 1–4; Mühlberger et al., 2008). This induction is ambiguous as the size of a stimulus may increase as a result of (a) the self-performing an approach movement toward the stimulus, or (b) the stimulus itself approaching the self (Hsee et al., 2014, Study 4). Perceptual cues stemming from the surrounding environment could disambiguate between these two cases. Indeed, performing an approach movement during a social interaction generally involves concurrent changes in visual angles of both the surrounding environment and the other (Rougier et al., 2018),<sup>1</sup> while this is not the case when one is being approached by another individual. We, therefore, need to fine-tune the approach movement by including surrounding cues.

Second, previous research presented dynamic stimuli on a computer screen (but see Hsee et al., 2014, Study 6). In doing so, researchers adopted a too passive conception of social cognition and missed its interactive nature (Neisser, 1980). Indeed, the way individuals perceive a social situation is grounded in individual-environment interactions (Smith & Semin, 2004) and depends on a multiplicity of multimodal cues, on the representation of oneself in the environment and on action possibilities offered by the environment (e.g., Grade et al., 2015). Therefore, one could object that previous research lacked *mundane realism* (i.e., the extent to which an experiment is close to situations encountered in everyday life; Aronson & Carlsmith, 1969). It is, therefore, crucial to fill this gap in order to generalize the approach-aversion effect.

Third, it is not clear whether the approach-aversion effect concerns either: All stimuli unrestrictedly, only specific types of stimuli, or whether it is stronger for some stimuli than others. From a threat hypothesis perspective, one expects that even non-negative stimuli would trigger an approach-aversion effect, but that this effect should be stronger for negative ones. Indeed, as they generally entail beneficial consequences, positive approaching stimuli should appear as less threatening than negative approaching ones. There is tentative evidence for a generalized approach-aversion effect, suggesting that approaching stimuli lead to negative evaluations independently of their initial valence (e.g., frowning or smiling faces; Hsee et al., 2014). Other research instead shows more negative evaluations only for approaching negative stimuli, but not for neutral or positive ones (see Mühlberger et al., 2008 for real; Davis et al., 2011 for imagined stimuli), and therefore questions the scope of the threat hypothesis. Because of these contradictory results,

<sup>1</sup> Concurrent changes in visual angles of both the surrounding environment and the stimulus do not apply to arm approach behaviors. Indeed, bringing an object toward the self through an arm movement (e.g., bringing a cup of coffee to the mouth) is often considered as an approach behavior (Phills et al., 2011; Woud et al., 2008) but does not involve changes in the surrounding environment.

it is unclear whether this approach-aversion effect applies to all valenced stimuli, and whether the threatening nature of the approach is responsible for the approach-aversion effect. It is possible that this inconsistency is just a matter of too small an effect size to be detected, and therefore calls for a thorough examination of this approach-aversion effect with sufficient power.

To recapitulate, researchers have intensively investigated the (positive) consequences of enacted approach behaviors on interpersonal evaluations (Slepian et al., 2012; Woud et al., 2008). However, when one considers the social interaction as a whole dynamic process, the necessity emerges to take into account the effect of the approach on all individuals enmeshed in the behavioral episode. Here, we gauge the potential negative consequences of an approach movement on the part of the perceiver (i.e., the approach-aversion effect). Crucially, to date, it is unclear whether this approach-aversion effect: (a) generalizes to non-ambiguous manipulations, (b) generalizes to everyday settings, and (c) depends on stimulus valence. If the effect indeed exists, the positive intention accompanying the enactment of approach behaviors could translate negatively to the perceiver facing these behaviors, with deleterious consequences in the unfolding of social interactions (but see Harmon-Jones et al., 2013, for the case of anger).

## Overview of the Experiments

Here, we tested the hypothesis that during social interaction, an (unknown) approaching person is generally threatening. If it is the case, one should observe an approach-aversion effect independently of idiosyncratic valence (see Hsee et al., 2014). Furthermore, if the threat hypothesis holds, the threatening nature of the individual should moderate the effect. We tested this rationale across three experiments. Participants had to evaluate approaching and static individuals displaying different levels of threat (based on their emotional facial expression, their group membership, and the agency of their movements). We focused our investigation on a common situation, namely the encounter of unknown people at a bus stop. We relied on VR settings to increase the mundane realism of the experiments while maintaining a high level of experimental control (Pan & Hamilton, 2018). We are aware that VR cannot be equated with reality itself. Nevertheless, in VR, a realistic and natural behavior is more important than photographic realism

to create a genuine experience of social interactions (Blascovich et al., 2002). With the use of VR, we were able to test the approach-aversion effect by manipulating the approach unambiguously, taking into account both visual information about the individual and its surroundings. If being approached is threatening, approaching individuals should be evaluated more negatively than static ones, and this effect should be stronger for menacing target individuals. Therefore, we expect an interaction between movement and target threat level. We preregistered all hypotheses, the sampling plan, the materials, the procedure, as well as the exclusion criteria and analyses for all three experiments of this paper (corresponding links are provided in each experiment section).<sup>2</sup> For each experiment, all measures, manipulations, and exclusions were reported. We collected and analyzed anonymously all data in accordance with the American Psychological Association's ethical principles. However, we did not seek explicit ethics approval as it was not required for the present studies as per the University's guidelines. The 90% confidence intervals reported hereafter are based on the estimated percent reduction in error index (PRE; Judd et al., 2011).<sup>3</sup>

## Experiment 1

In Experiment 1, we aimed to replicate the approach-aversion effect in a setting derived from a real-life situation. To manipulate the target threat level, we relied on smiling and frowning facial expressions as was done in the seminal study of Hsee and colleagues (2014; Study 3). During social interactions, individuals may manifest various facial emotional expressions to convey specific communicative intentions (Frijda, 1997) which may thus represent various threat levels. By relying on a VR setting and securing sufficient statistical power, we predicted more negative evaluations for approaching virtual individuals than for those staying on spot, and this effect should be more important for frowning than for smiling individuals. As the effect has never been investigated in VR before, it was difficult to estimate the anticipated effect size. Therefore, we conducted a sensitivity analysis based on the available resources and preregistered to sample at least 100 participants which met our inclusion criteria. This sample size enabled us to detect an effect size  $\eta^2$  of at least .008 with a power of 80% (see the preregistration at OSF, [https://osf.io/zydjk?view\\_only=b21f58d1db4e48f48b443780e28689c0](https://osf.io/zydjk?view_only=b21f58d1db4e48f48b443780e28689c0)).

<sup>2</sup> Experiment 2 was the first of the series but we decided to reverse the presentation order as the underlying reasoning was similar and starting with the close replication should ease the reading. Moreover, we conducted a fourth experiment in which we manipulated the movement in two counterbalanced blocks. This experiment is not reported here as we obtained a block order effect precluding the clear interpretation of the results (although they pointed in the expected direction).

<sup>3</sup> The PRE index is an estimation of the true effect size in the population ( $\eta$ ) based on the experimental sample. In keeping with the statistical formalization norms, we used the PRE index rather than the Greek notation.

## Method

### Participants

One hundred sixty-five participants took part in the experiment in exchange for 5€ or partial credit course. They were assigned to a 2 (movement: approach, static)  $\times$  2 (facial expression: smiling, frowning) within-participants design. Here, as well as in all experiments, we applied a conservative exclusion criterion concerning hypothesis suspicion: We excluded 32 participants who spontaneously mentioned anything about evaluations or bodily movements in their broadest sense (e.g., distance, position). We thus analyzed the data of the remaining 133 participants ( $M_{\text{Age}} = 19.61$ ,  $SD_{\text{Age}} = 2.56$ ).

### Procedure

Participants initially signed a consent form. The experiment was presented as a development phase of a VR application in which users were offered the possibility to interact with others via their avatar. Participants were informed that the goal of the experiment was to test whether the avatars supposedly created by previous participants were able to faithfully represent their real-human counterparts. Then, participants were immersed in a virtual bus stop environment (see Figure 1) and received all instructions via headphones connected to the headset (Vive™, HTC). After one training encounter with a virtual individual (staying on spot), participants encountered the 16 critical ones (four smiling men, four smiling women, four frowning men, and four frowning women) one by one. Each virtual individual entered the virtual scene from the left and stood in front of the participants at a distance of 85 cm. This distance corresponds to the optimal comfortable distance that participants wish to maintain between them and the virtual individual as revealed by a pretest ( $N = 10$ ,  $M = 84.1$ ,  $SD = 14.82$ ). Then, half of them performed an approach movement toward the participant (one step), while the other half stayed on spot. Participants gave their impression of the virtual individual verbally on a scale ranging from  $-3$  (= very negative) to  $+3$  (= very positive). After each evaluation, the virtual individual left the scene on the right side. For each participant, the order of trials, as well as the assignment of virtual individuals to the experimental conditions, were randomly generated with R before the session. After the VR task, we measured 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) with the Multimodal Presence Scale by Makransky and colleagues (2017).<sup>4</sup> Then, participants indicated any



**Figure 1.** Illustration of the virtual bus stop environment from the participant's perspective.

consequent sickness symptoms (i.e., oculomotor disorders, disorientation, and/or nausea due to the VR; 0 = not at all, 1 = slightly, 2 = a lot, 3 = severely) and reported any pre-existing cognitive impairment and/or substance intake. They also indicated their age, gender, and their French language ability. Finally, participants were probed for suspicion and debriefed.

## Results

Evaluations of virtual individuals were submitted to a 2 (movement: approach, static)  $\times$  2 (facial expression: smiling, frowning) within-participants analysis of variance (ANOVA). The results showed the expected approach-aversion effect with more negative evaluations for approaching individuals ( $M_{\text{Approach}} = -0.08$ ,  $SE_{\text{Approach}} = 0.08$ ) than static ones ( $M_{\text{Static}} = 0.52$ ,  $SE_{\text{Static}} = 0.05$ ),  $F(1, 132) = 61.71$ ,  $p < .0001$ ,  $PRE = .32$ , 90% CI [.21, .41]. We also obtained a main facial expression effect. Participants evaluated frowning individuals more negatively ( $M_{\text{Frowning}} = -0.90$ ,  $SE_{\text{Frowning}} = 0.10$ ) than smiling ones ( $M_{\text{Smiling}} = 1.34$ ,  $SE_{\text{Smiling}} = 0.07$ ),  $F(1, 132) = 366.72$ ,  $p < .001$ ,  $PRE = .74$ , 90% CI [.67, .78]. Finally, we obtained an interaction between movement and facial expression,  $F(1, 132) = 11.26$ ,  $p = .001$ ,  $PRE = .08$ , 90% CI [.02, .16]. However, contrary to what was expected, the approach-aversion effect was larger for smiling individuals ( $M_{\text{Smiling-Approach}} = 0.96$ ,  $SE_{\text{Smiling-Approach}} = 0.10$  and  $M_{\text{Smiling-Static}} = 1.73$ ,  $SE_{\text{Smiling-Static}} = 0.07$ ) than for frowning ones ( $M_{\text{Frowning-Approach}} = -1.11$ ,  $SE_{\text{Frowning-Approach}} = 0.11$  and  $M_{\text{Frowning-Static}} = -0.68$ ,  $SE_{\text{Frowning-Static}} = 0.10$ ).

## Discussion

In Experiment 1, relying on an innovative VR setting and sufficient statistical power, we replicated the approach-aversion effect: Participants evaluated more negatively

<sup>4</sup> In the preregistration, we planned to explore whether the feeling of presence moderated the obtained effects. Across the three experiments, these exploratory analyses revealed that the feeling of presence did not persistently moderate the effects, and crucially when it did, the effects remained unchanged. Therefore, we did not report these analyses which are available in the supplementary material available at [https://osf.io/q5ybx/?view\\_only=773e613c7f6c449895cdb8f672958fd5](https://osf.io/q5ybx/?view_only=773e613c7f6c449895cdb8f672958fd5)



virtual individuals who approached them as compared to those who stayed on spot. We also predicted that perceiving an approaching individual would be less threatening when this individual is smiling (vs. frowning) due to the general positive social meaning of this expression (Niedenthal et al., 2010). However, contrary to expectations, the approach-aversion effect was greater for smiling than for frowning individuals. This unexpected interaction could result from the fact that virtual individuals' expressions faded away as soon as they approached participants. The resulting emotional shift may have created an aversive feeling in the smiling condition which eventually increased the approach-aversion effect. Indeed, research shows that evaluations of emotional expressions are highly flexible with documented evidence for a recency effect for dynamic expressions (Fang et al., 2018). This emotional shift may also have added an inconsistency in the behavioral realism of virtual individuals which contributed to creating a feeling of eeriness and potentially increased the approach-aversion effect (MacDorman & Chattopadhyay, 2016). As facial expressions represent much more complex stimuli than originally thought (e.g., Cowen et al., 2019) and may trigger somewhat unexpected reactions, in Experiment 2 we relied on a more straightforward manipulation of threat, namely group membership.

## Experiment 2

Research shows that outgroups may elicit threat reactions (Cottrell & Neuberg, 2005). For instance, compared to their ingroup, European Americans feel fear toward African Americans and perceive them as threatening their physical safety and health. We, therefore, expected more negative evaluations for approaching virtual individuals than for those staying on spot, and this effect should be more important for outgroup than for ingroup members. We relied on Caucasian versus Maghrebian group membership because in France Maghrebian people are generally negatively perceived and even more so in the context of recent terrorist attacks (Cohu et al., 2016). We preregistered to run 100 participants that met our inclusion criteria in order to be able to detect an effect size  $\eta^2$  of at least .008 with a power of 80% (see preregistration at OSF, [https://osf.io/wgu6c?view\\_only=c608627f0deb4d36974ff14acf28b5e7](https://osf.io/wgu6c?view_only=c608627f0deb4d36974ff14acf28b5e7)).

## Method

### Participants

One hundred fifty-four participants took part in the experiment in exchange for 5€. They were assigned to a 2 (movement: approach, static)  $\times$  2 (group membership: Caucasian, Maghrebian) within-participants design. In order to ensure

that Caucasian was the participants' ingroup, we excluded participants who declared a mother tongue other than French for at least one of their parents ( $N = 28$ ). We also excluded participants who guessed the research hypothesis ( $N = 29$ ) or who reported substance use ( $N = 2$ ). We thus analyzed the data of the remaining 100 participants ( $M_{\text{Age}} = 24.12$ ,  $SD_{\text{Age}} = 8.10$ ).

### Procedure

The procedure for Experiment 2 was similar to that of Experiment 1 except that participants encountered Caucasian (ingroup) and Maghrebian (outgroup) virtual individuals instead of smiling and frowning ones. In order to heighten the salience of group membership, we also added French and Maghrebian prototypical names on the virtual individuals' T-shirts. At the end of the experiment, participants also indicated the mother tongue of their parents in order to ensure the ingroup versus outgroup manipulation.

## Results

Evaluations of virtual individuals were submitted to a 2 (movement: approach, static)  $\times$  2 (group membership: Caucasian, Maghrebian) within-participants ANOVA. The results yielded the expected approach-aversion effect with more negative evaluations for approaching individuals ( $M_{\text{Approach}} = 0.51$ ,  $SE_{\text{Approach}} = 0.10$ ) than static ones ( $M_{\text{Static}} = 1.03$ ,  $SE_{\text{Static}} = 0.08$ ),  $F(1, 99) = 30.47$ ,  $p < .0001$ ,  $PRE = .24$ , 90% CI [.12, .34]. There was also a main effect of group membership. Participants evaluated outgroup members more negatively ( $M_{\text{Outgroup}} = 0.66$ ,  $SE_{\text{Outgroup}} = 0.09$ ) than ingroup members ( $M_{\text{Ingroup}} = 0.89$ ,  $SE_{\text{Ingroup}} = 0.08$ ),  $F(1, 99) = 8.73$ ,  $p = .004$ ,  $PRE = .08$ , 90% CI [.02, .17]. However, we did not obtain the expected interaction between movement and group membership,  $F(1, 99) = 0.3$ ,  $p = .59$ ,  $PRE = .003$ , 90% CI [.00, .04]. The approach-aversion effect occurred equally for outgroup ( $M_{\text{Outgroup-Approach}} = 0.41$ ,  $SE_{\text{Outgroup-Approach}} = 0.10$  vs.  $M_{\text{Outgroup-Static}} = 0.90$ ,  $SE_{\text{Outgroup-Static}} = 0.10$ ) than for ingroup members ( $M_{\text{Ingroup-Approach}} = 0.61$ ,  $SE_{\text{Ingroup-Approach}} = 0.11$  vs.  $M_{\text{Ingroup-Static}} = 1.16$ ,  $SE_{\text{Ingroup-Static}} = 0.09$ ).

## Discussion

The results of Experiment 2 further corroborate the existence of an approach-aversion effect: Participants evaluated approaching virtual individuals more negatively than those staying on spot. These findings highlight the threatening nature of the approach from the perspective of the one who faces it. Although participants manifested ingroup favoritism, the approach-aversion effect was not stronger for outgroup members, as predicted. It is thus possible that the group membership manipulation was not optimal to

modulate the threatening nature of the movement. Indeed, an important number of participants in our initial sample reported a mother tongue other than French which suggests that the participants of our sample pool are used to interact with members of different groups, including Maghrebians individuals. Because of this diversity characteristic of our pool of participants and the resulting exclusion rate, we decided to change the way to manipulate the threat level rather than replicating Experiment 2 with more power.

Experiments 1 and 2 established the approach-aversion effect in settings derived from real-life situations. However, one limitation to these conclusions is that they are restricted to a specific interpersonal distance reduction implying a penetration of the virtual individuals into the participants' peripersonal space (i.e., the space surrounding the body which specifies the private and protective area of individuals; Coello et al., 2012). Indeed, while static individuals stood at a distance of 85 cm from the participants, approaching ones came closer at an approximate distance of 60 cm from them. Such a distance is somewhat below the average distance at which people feel comfortable with others based on our pretest (see also Iachini et al., 2014), although one should note that this distance of 60 cm remains within the acceptable personal distance bounds (i.e., 45–120 cm; Hall, 1966). Consequently, the effect obtained in Experiments 1 and 2 may not illustrate an approach-aversion effect but rather a “peripersonal space invasion effect.” We addressed this limitation in Experiment 3.

## Experiment 3

In Experiment 3 we tested the threat hypothesis by manipulating the agency of the movement, that is whether the approach movement was initiated by the virtual agent her/himself (as in Experiments 1 and 2) or by the participant via a verbal approach instruction. Hsee and colleagues (2014) had similar reasoning concerning agency but asked participants to imagine whether the self or the other enacted the movement. In doing so, they actually compared two different perspectives instead of manipulating the agency of the same movement. Importantly, by manipulating agency in terms of the initiator of the other's movement we maintained the perspective constant across situations and proposed a more stringent test than Hsee and colleagues (2014). When the other approaches following a request, the movement may be perceived as more predictable and controllable which thus reduces its threatening nature (Wood et al., 2015). Participants should therefore perceive approaching individuals as less threatening when asking them to come. In line with this idea, research shows

that people tend to allow more interpersonal spatial proximity the more they are susceptible to control the other (e.g., influence their behavior; Strube & Werner, 1984). Also, Riskind and Maddux (1993) showed that an approaching (vs. receding or motionless) spider elicited greater fear, but only when individuals imagined having no control in the situation (e.g., being unable to escape from, or defend themselves against the spider). Therefore, we predicted more negative evaluations for approaching virtual individuals than for those staying on spot but expected this effect to decrease when these movements were self-initiated.

In this experiment, we increased the interpersonal distance in order to address the aforementioned limitation in terms of peripersonal space invasion. If peripersonal space invasion partly contributes to the obtained effects in Experiments 1 and 2, the approach-aversion effect could be somewhat overestimated. Therefore, with such a modification, we decided to further increase the sample size in Experiment 3. We preregistered to run a minimum of 200 participants which allowed us to detect a minimum effect size  $\eta^2$  of .004 with a power of 80% (see the preregistration OSF, [https://osf.io/qm9ac?view\\_only=13066e87eb99431684549157d7940719](https://osf.io/qm9ac?view_only=13066e87eb99431684549157d7940719)). In Experiment 3, we deviated from the preregistration on two points: (1) we included participants who declared not speaking French fluently. Indeed, a minor error has crept in the preregistration as we did not specify this criterion in the two previous experiments and there is no obvious theoretical reason to expect an influence of French fluency on the approach-aversion effect. The experimenter noticed a smooth verbal interaction with two participants who reported being non-fluent. (2) We excluded trials for which participants did not utter an instruction as required due to a microphone (0.61%) or headset issue (0.03%). None of these exclusions change the results in any way.

## Method

### Participants

Two hundred fifty-six participants took part in the experiment in exchange for 5€ or partial credit course. They were assigned to a 2 (movement: approach, static)  $\times$  2 (other's movement agency: self, other) within-participants design. We excluded 39 participants because of hypothesis guessing ( $N = 37$ ) or because they did not follow instructions ( $N = 2$ ). We thus analyzed the data of the remaining 217 participants ( $M_{Age} = 20.19$ ,  $SD_{Age} = 3.27$ ).

### Procedure

The procedure was similar to Experiment 1 and 2 except for the threat operationalization as well as the interpersonal distance between participants and individuals. We informed participants that, in addition to evaluating impressions

about virtual individuals we also wished to adjust the audio settings of the device. To this aim, they were asked to instruct the virtual individuals on which movement to execute in some trials (but not others) by asking them to “Come over here” or “Stay on spot” depending on condition. After two training virtual individuals (one per instruction type), participants encountered the 16 critical ones (two men and two women in each of the four conditions). Half of the virtual individuals performed an approach movement toward the participants (one step, arriving at 85 cm from the participants), while the other half stayed on spot (at a distance of 110 cm from participants). In each movement condition (approach, static), participants had to give an instruction to half of the virtual individuals to execute the movement – to come toward them (after a sound signal) or to stay on spot (after a distinct sound signal) – whereas they did not have to give any instruction to the remaining half. Unlike the previous experiments, a Likert-type scale appeared in the virtual environment after each encounter, and participants used the VR controllers to provide their impression toward him/her anchored at 1 (= *very negative*) and 7 (= *very positive*). The Likert-scale anchors were different from the previous experiments as we used a default scale type included in our VR application instead of oral evaluations. After performing the VR task, participants underwent the Presence questionnaire (Makransky et al., 2017), follow-up questions, and debriefing.

## Results

As preregistered, we excluded trials for which participants erroneously gave an instruction to the virtual individuals (0.06%). The evaluations of virtual individuals were submitted to a 2 (movement: approach, static)  $\times$  2 (other’s movement agency: self, other) ANOVA with all factors manipulated within-participants. The results showed the expected approach-aversion effect with more negative evaluations for approaching individuals ( $M_{\text{Approach}} = 4.24$ ,  $SE_{\text{Approach}} = 0.05$ ) as compared to static ones ( $M_{\text{Static}} = 4.53$ ,  $SE_{\text{Static}} = 0.05$ ),  $F(1, 216) = 43.66$ ,  $p < .0001$ ,  $PRE = .17$ , 90% CI [.10, .24]. The main effect of movement agency was not statistically significant ( $M_{\text{Self}} = 4.40$ ,  $SE_{\text{Self}} = 0.05$ ;  $M_{\text{Other}} = 4.37$ ,  $SE_{\text{Other}} = 0.05$ ),  $F(1, 216) = 0.51$ ,  $p = .48$ ,  $PRE = .00$ , 90% CI [.00, .02]. Crucially, we obtained an interaction between movement and movement agency,  $F(1, 216) = 7.95$ ,  $p = .005$ ,  $PRE = .04$ , 90% CI [.01, .08]. As predicted, the approach-aversion effect ( $M_{\text{Other-Approach}} = 4.16$ ,  $SE_{\text{Other-Approach}} = 0.06$  vs.  $M_{\text{Other-Static}} = 4.58$ ,  $SE_{\text{Other-Static}} = 0.06$ ) observed when the virtual agent initiated its own movement was mitigated when the individuals’ movement was initiated by the participants ( $M_{\text{Self-Approach}} = 4.32$ ,  $SE_{\text{Self-Approach}} = 0.06$  and  $M_{\text{Self-Static}} = 4.49$ ,  $SE_{\text{Self-Static}} = 0.06$ ; see Figure 2).

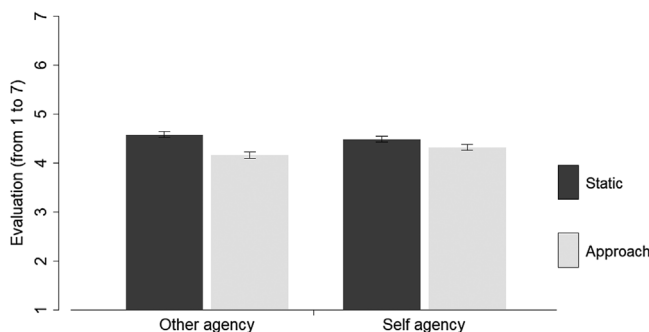
## Discussion

In Experiment 3, we replicated the approach-aversion effect: Participants evaluated virtual individuals approaching them more negatively as compared to those staying on spot. Importantly, as we reduced the possibility that the virtual individuals entered the peripersonal space, this approach-aversion effect occurs beyond space invasion. However, one should mention that the magnitude of the approach-aversion effect is smaller than in the first two experiments (even in the critical condition where the movement is initiated by the virtual agent). This may suggest that peripersonal space intrusion could have contributed, to some extent, to the results observed in Experiments 1 and 2. Importantly, we observed the expected interaction by the initiator of the movement: The approach-aversion effect is less important when participants initiated the movement of virtual individuals (by inviting them to approach) as compared to when individuals approached by themselves which lends support to the threat hypothesis.

## Reliability of the Approach-Aversion Effect

In order to assess the reliability of the approach-aversion effect, we performed an integrative data analysis (IDA; Curran & Hussong, 2009) of the three experiments. First, we standardized the data by recoding those of Experiment 3 in such a way that they fit the scale range of Experiments 1 and 2. Second, the smiling versus frowning (Experiment 1), Caucasian versus Maghrebian (Experiment 2), and self-initiated versus other-initiated (Experiment 3) conditions were respectively coded as low-threat versus high-threat conditions. Then, we submitted the overall dataset to a 2 (movement: approach, static)  $\times$  2 (threat level: low, high)  $\times$  3 (Experiment: 1, 2, 3) ANOVA with the first two factors manipulated within participants and the last manipulated between (C1: -1, 0, 1; C2: -1, 2, -1). Two participants were excluded from being outliers on the studentized residual index (i.e., above four; Judd et al., 2011). The results of this analysis further establish the approach-aversion effect showing more negative evaluations for approaching individuals ( $M_{\text{Approach}} = 0.21$ ,  $SE_{\text{Approach}} = 0.04$ ) than static ones ( $M_{\text{Static}} = 0.64$ ,  $SE_{\text{Static}} = 0.04$ ) across the three experiments,  $F(1, 445) = 141.56$ ,  $p < .0001$ ,  $PRE = .24$ , 90% CI [.19, .29] (we did not obtain the movement by threat level interaction, see the supplementary material on OSF, [https://osf.io/q5ybx/?view\\_only=773e613c7f6c449895c8b8f672958fd5](https://osf.io/q5ybx/?view_only=773e613c7f6c449895c8b8f672958fd5)). Importantly, we obtained the same estimation of the approach-aversion effect size by conducting a random-effects mini





**Figure 2.** Mean evaluations (and standard errors) according to movement and other's movement agency in Experiment 3.

meta-analysis on the three experiments ( $PRE = .24$ ,  $z = 5.05$ ,  $p < .0001$ , 90% CI [.16, .31]).<sup>5</sup>

## General Discussion

In the present work, we investigated the evaluative consequences of approaching (unknown) individuals and tested the idea that those individuals are perceived as threatening. To this purpose, we aimed to: (a) replicate the approach-aversion effect in everyday settings, and (b) test its moderation by the threatening nature of approaching individuals. Across three experiments, we reliably obtained the approach-aversion effect: Participants evaluated approaching individuals more negatively than static ones. Regarding the moderation by the individuals' threatening nature, results were somewhat mitigated.

In order to investigate the approach-aversion effect in more realistic situations than previous paradigms, we relied on a VR setting. The obtained approach-aversion effect is rather important as it explains 24% of the variance in the evaluation of others on average. Such an effect size suggests that being approached by others could have deleterious consequences at the outset of an interaction. This seems to be the case beyond situations of close proximity as the effect of approach-aversion was found independently of peripersonal space invasion (Experiment 3). Noteworthy, as in both conditions virtual individuals are actually moving to place themselves in front of participants, the eventuality that the obtained approach-aversion effect reflects a mere movement effect seems highly unlikely. The current work is important from a cumulative science perspective and represents a first important step toward establishing the generalizability of the approach-aversion effect.

To test the idea that approaching individuals are threatening, we examined whether the approach-aversion effect could be moderated by threat. To do so, we manipulated either the features of the approaching individual or the control participants exerted on the movement. Contrary to expectations, the approach-aversion effect was less pronounced for frowning than for smiling individuals (Experiment 1) and was not moderated by group membership (Experiment 2). Experiment 3 supports our reasoning by showing that the approach-aversion effect is mitigated when participants (vs. the virtual individuals) initiated the movements. This moderation by the other's movement agency is in line with a threat explanation as being the agent of others' movements dampens perceived threat (Wood et al., 2015). Moreover, the obtained interaction between movement and agency enables to discard a mere perceptual alternative explanation. Indeed, as virtual individuals came closer, participants could perceive an increasing amount of unrealistic details about them as compared to when they stood on spot. However, agency manipulation does not affect in any way the perceptual features of individuals. Therefore, this purely perceptual explanation does not hold for the present approach-aversion effect.

We discussed potential explanations for the unexpected results concerning the threat by movement interaction in the first two experiments: A contrast effect for the facial emotional expression manipulation and a lack of relevance for the group membership manipulation. Another potential explanation could reside in the threat manipulation itself: While in Experiments 1 and 2, we manipulated threat through the features of approaching individuals (i.e., group membership, facial expression), in Experiment 3 we manipulated the control over the other's movement (i.e., agency). It is possible that, as soon as individuals approach the self, they elicit the same relevance and preparedness to react

<sup>5</sup> Male individuals could be perceived as more threatening than female ones. Therefore, based on the threat hypothesis, the gender of virtual individuals could also moderate the approach-aversion effect. Indeed, an exploratory mixed model integrative analysis revealed that the effect is larger for male than for female virtual individuals. For details see the supplementary material on OSF, [https://osf.io/q5ybx/?view\\_only=773e613c7f6c449895cdb8f672958fd5](https://osf.io/q5ybx/?view_only=773e613c7f6c449895cdb8f672958fd5)

independently of their a priori features (Spaccasassi et al., 2019) and thus trigger the same level of perceived threat in participants. With the control manipulation, we may have more directly manipulated the level of the perceived threat of approaching individuals. These potential explanations could be investigated in further research by examining the reasons why being approached is threatening and which type of threat underlies the approach-aversion effect.

The current work presents some limitations, especially considering the ecological validity and generalizability of the effect. First, the improvement in mundane realism comes with downsides as the richer becomes the experience of a situation, the greater the necessity to consider several multi-modal features and their consistency in order to warrant realism. Any inconsistency in the situation as compared to its real-world counterpart may produce a disfluent perception and create a negative impression (Reber et al., 1998) which pollutes the investigated effect. Second, we restricted our investigation to a relatively common, but specific, situation of social interaction (i.e., encountering an unknown person at a bus stop). Future research should investigate the approach-aversion effect with different, and maybe even more realistic, combinations of features as well as different situations and stimuli to increase generalizability.<sup>6</sup>

As asking others to come closer could be reinterpreted as a form of approach, one may have expected that the self-agency condition (Experiment 3) would reverse the approach-aversion effect. There are several potential (admittedly post hoc) explanations for that such as the potential injunctive nature of the request, or the lack of specific modal information involved when enacting an approach behavior (e.g., visual flow). Further research should address this point. Nevertheless, it is worth noting that the current findings are consistent with recent ones showing that the positive influence of approach is not clear when individuals perform an action (i.e., moving a joystick) that brings the stimulus closer (Hütter & Genschow, 2020). Moreover, the replicated approach-aversion effect should alert researchers not to use feedback suggesting that others are moving toward participants in approach-avoidance trainings (see also Krishna & Eder, 2018; Van Dessel et al., 2018). Finally, this work qualifies the perspectives for intervention suggested by previous research on approach behaviors (e.g., prejudice reduction, Kawakami et al., 2007; Van Dessel et al., 2020), at least if one wants to transpose them in real-life situations.

This contribution illustrates the importance of considering the interactional aspects of the social situation in the

study of human behavior. Indeed, while the literature showed that approach behaviors improve evaluations of others as compared to avoidance, the present research confirms that, on the part of the perceiver, those performing the approach behavior could be negatively evaluated. Indeed, social interaction is a dynamic process and the negative consequences of approach behaviors from an observer's standpoint may cancel out the initial positive interactional intention.

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<sup>6</sup> Nevertheless, a non preregistered mixed model integrative analysis suggests that the effect did not vary across our stimulus subset (see the supplementary material on OSF, [https://osf.io/q5ybx/?view\\_only=773e613c7f6c449895cdb8f672958fd5](https://osf.io/q5ybx/?view_only=773e613c7f6c449895cdb8f672958fd5)).

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### Authorship

All authors contributed to the study concept and design. Data collection was organized by I. Nuel. I. Nuel performed the data analysis and was supported by M. P. Fayant and T. Alexopoulos in the interpretation of the results. All authors drafted the paper and approved the final version for submission.

### Open Data

All materials analyzed datasets with the corresponding R scripts can be found in Open Science Framework ([https://osf.io/mgbxz/?view\\_only=7532cd112a25414c8e6ca254bd72ada1](https://osf.io/mgbxz/?view_only=7532cd112a25414c8e6ca254bd72ada1)).

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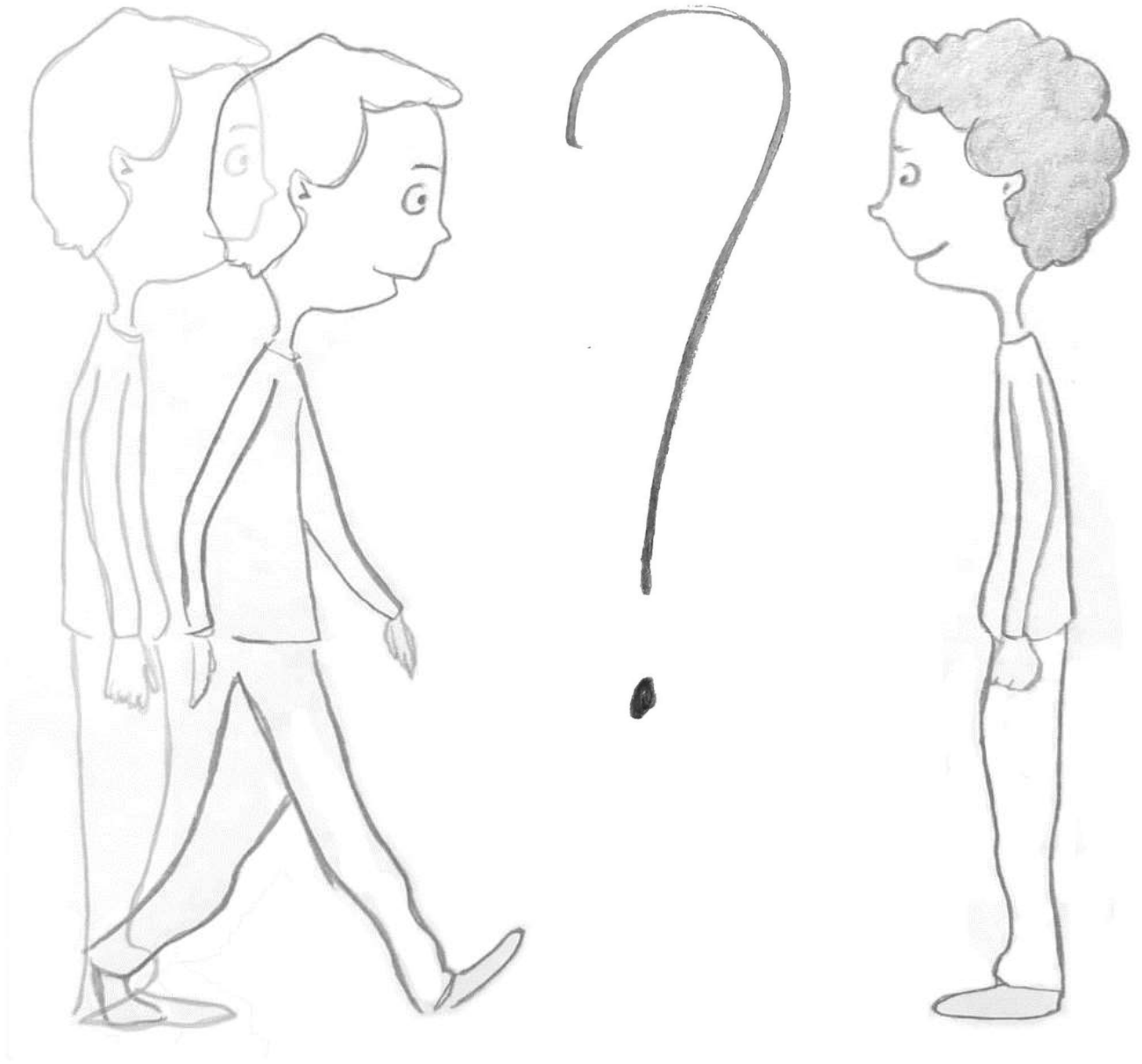
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# General Discussion



From early childhood, social interactions have a major place in the life of human beings: Individuals need to create and maintain social interactions. Therefore, the question of how individuals regulate their social interactions is a crucial one. In the current work, the question of social interactions regulation has been investigated by considering cognition as grounded in sensorimotor individual-environment interactions. More specifically, I proposed that approach and avoidance behaviours are not mere passive responses in the regulation process but play an active role. I argued that if it is the case, approach and avoidance behaviours should 1) influence how individuals perceive their environment so as to facilitate appropriate behaviours and 2) integrate any modification in the social interaction situation in order to flexibly adapt to changing demands (Balcetis & Cole, 2009; Semin & Cacioppo, 2008). To fully appreciate the sensorimotor and interactive nature of cognition, I capitalised on IVR to operationalise whole-body approach-avoidance behaviours in an interpersonal context.

In Chapter 1, I tested the reasoning that if approach-avoidance behaviours actively contribute to regulation via their evaluative influence, they should influence the ongoing process of interpersonal individual evaluations. To assist regulation, performing interpersonal approach and avoidance behaviours should echo traces of past experiences in which individuals generally approached stimuli evaluated as positive and avoided those evaluated as negative (Barsalou, 1999; Papiés et al., 2020; Versace et al., 2014). In this way, and in line with the literature, I hypothesised that enacting an approach behaviour towards someone should lead to more positive interpersonal evaluations than enacting an avoidance behaviour. Across six studies, we varied the approach-avoidance operationalisations (upper-body incline, upper-body posture and walking steps) but failed to obtain the theorised positive effect of approach (as compared to avoidance) on evaluations. Interestingly, further exploratory analyses on two studies conducted in the VR settings suggested that the more participants felt being present (i.e., have a subjective experience of being there) in the situation, the more the approach-avoidance ecological actions activated the corresponding neuropsychological systems. This suggests the importance of considering approach and avoidance as rooted in the subjective experience of the ongoing individual-environment interaction.

In Chapter 2, I extended the study of the evaluative influence of approach-avoidance behaviours to the group level. Indeed, individuals partly categorise others into social groups on the basis of their sensorimotor experiences (Barsalou, 2016) and a specific evaluation may be associated with this group membership. Therefore, if approach-avoidance behaviours are sensorimotor individuals-environment interactions which actively participate in the regulation



of social interactions they should influence group evaluations. In two experiments, we tested whether approach behaviours lead to more positive group evaluations than avoidance. Overall, some findings went in the expected direction but were not as straightforward as predicted. Approach-avoidance behaviours influenced a sub-dimension of the BAS (Experiment 1) and social trait ratings of the group (Experiment 2). Other findings are less consistent with the general hypothesis (e.g., RT-based evaluative measures, action tendencies) and seem to nuance the influence of approach-avoidance behaviours.

If approach-avoidance behaviours actively contribute to the regulation process, they should flexibly adapt to changing demands by integrating the continuous modifications at stake during the social interaction (Balcetis & Cole, 2009; Semin & Cacioppo, 2008). Because social interactions are dyadic sequences, any change in the other's behaviour must be considered to fully appreciate the role of approach-avoidance in the regulation of social interactions. In Chapter 3, I investigated how enacted approach behaviours are negatively perceived from the perspective of the one who is approached. The results of three experiments suggest that approach is threatening from the perspective of the one who is approached. Indeed, participants evaluated approaching virtual individuals more negatively than static ones (i.e., the approach-aversion effect, Hsee et al., 2014). This approach-aversion effect is mitigated when participants compared to virtual individuals initiated the movements (Experiment 3). These latter results are in line with a threat explanation because being the agent of others' movements attenuates perceived threat (Wood et al., 2015). Manipulating the menacing nature of virtual individuals via their facial expression (Experiment 1) or their group membership (Experiment 2) offer less support to this explanation. This contribution illustrates the importance of considering the interactional aspects of the social situation in the study of human behaviour. Focusing on only one individual may not tell us the whole story about a phenomenon.

Independently of the results, the current work is important in its own right. Indeed, it represents a first step towards a more ecological investigation of the approach-avoidance evaluative influence, and more broadly, of social cognition. As already argued, if one considers cognition as grounded in sensorimotor individual-environment interactions, it is crucial to consider these interactions when studying cognition experimentally. However, taken together, the results offer weak support to the idea that approach-avoidance behaviours actively participate in how individuals regulate their social interactions by influencing evaluations. Compared to previous research, enacting an approach behaviour does not lead to more positive evaluations of the other than enacting an avoidance one (excepted in Chapter 2, Experiment 2).

With these results, it is not possible to conclude that approach-avoidance behaviours exert an evaluative influence that fosters their own enactment. Why approach-avoidance behaviours do not influence evaluations in this thesis while they do in the literature with more minimalist settings? Should we conclude that approach-avoidance behaviours do not actively contribute to regulation via their evaluative influence? In the following sections, I will examine and discuss different possible (but non-exhaustive) answers to these questions. As a foretaste, research about the evaluative influence of approach-avoidance still has many years ahead of it.

## 1. LIMITATIONS OF THE CURRENT WORK

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Before going further, I would like to clarify one point. In the current work, overall, the manipulated behaviours did not influence the construct validity indexes we relied on (i.e., BAS/FFFS, action tendencies). This absence of results might question the manipulation of approach-avoidance behaviours. However, I do not consider these null results to represent a strong limitation to the current thesis. First, it is possible that the measures used as indexes of construct validity were not adequate to the behaviours manipulation. For instance, the RST-PQ is initially intended to capture traits or dispositional sensitivities to the BAS and FFFS (Corr & Cooper, 2016; Corr & McNaughton, 2012). These traits “reflect long-term stabilities in the operation of state systems responsible for basic here-and-now appetitive (or attractor) and aversive (or repulsor) goals, which lead to corresponding approach and avoidance behaviours” (Corr & Krupić, 2017, p. 15). On this reasoning, the BAS and FFFS scales may also capture variations at the state level and be sensitive to contextual influences. In line with this idea, the literature offers evidence for such a contextual sensitivity (Bargh & Smith, 2008; Haefffel, 2011). However, these previous studies relied on different scales than the RST-PQ ones, namely the BIS/BAS scales of Carver and White (1994). The choice of the RST-PQ in this thesis was theoretically driven. Indeed, the previously used BIS/BAS scales are based on Gray's (1982) Reinforcement Sensitivity Theory which has been substantially revised since the development of these scales (e.g., the separation between the FFFS and the BIS; Gray & McNaughton, 2000). Nevertheless, to date, I am not aware of any research relying on the RST-PQ scales as measures of state BAS and FFFS. Therefore, it is possible that the BAS and FFFS scales of RST-PQ have not been able to capture variations in the state BAS and FFSS systems due to the behaviours manipulation. Second, the influence of behaviours on the construct validity indexes may have dissipated as participants completed the measures a certain time after having enacted the



behaviours. Third and finally, it is also possible that the operationalised behaviours did not enable the re-enactment of these specific motivational states which impel individuals to move towards or away.

Nevertheless, the null results on the construct validity indexes do not invalidate the reasoning that enacting approach-avoidance behaviours influences evaluations (Fayant et al., 2017; Sigall & Mills, 1998). Actually, Chapter 1 and Chapter 2 studies were initially the pilots of a larger research project. The approach-avoidance evaluative influence investigated in this thesis was considered as one indicator of the grounded operationalisation of approach-avoidance among others. Finally, because evaluations and BAS/FFFS are two different constructs, it would have been a better solution to investigate them in separate studies (Fayant et al., 2017; Hauser et al., 2018). That being said, I will now discuss some potential limitations of the present work.

### **1.1.ON THE PITFALLS OF VIRTUAL REALITY**

In this thesis, I proposed to rely on the IVR technology to better consider the sensorimotor and interactive nature of cognition in the study of approach-avoidance behaviours. However, if IVR enables individuals to experience more realistic social interactions than in previous paradigms, it nevertheless remains a technology-mediated experience. IVR comes with its downsides and may ironically, have reduced the realism of the situation. Indeed, the more complex and the richer the virtual situation is, the more its constitutive elements should be consistent with each other. Any inconsistency in the situation may interfere with the investigated effect.

First, participants may have more or less the illusion of being there, in the IVR environment. This subjective experience of being there (notwithstanding that individuals know for sure that they are not) is called the feeling of presence (Slater, 2018; Witmer and Singer, 1998). As mentioned in Chapter 1, this feeling may reflect the full integration of every relevant aspect of the situation pertaining to the “here and now” including: Movement and perception, actions, representation of the self in the overall situation, possibilities for action, etc. (Carassa et al., 2005; Riva, 2009; Mennecke et al., 2011; Riva and Waterworth, 2014; Willans et al., 2015). On this reading, the notion of presence may gauge the extent to which cognition is grounded in the ongoing interaction between individuals and the virtual environment, and may be a necessary condition to obtain the evaluative influence of approach-avoidance in IVR. In

line with this idea, studies in Chapter 1 suggest that the influence of enacted approach-avoidance behaviours on the corresponding neuropsychological systems activation depends on the feeling of presence. However, we never obtained this moderation pattern again in the subsequent studies.<sup>19</sup> Therefore, any interpretation of these results would be premature until empirical studies are specifically designed for this purpose.

Second, in the VR literature, it is well known that virtual individuals may sometimes evoke a negative affective state: The uncanny valley effect (Mori, 1970). Users may experience a feeling of eeriness towards virtual individuals resulting from inconsistency in the realism of their human-like features (MacDorman & Chattopadhyay, 2016). This inconsistency could activate a motivation to avoid the virtual agents (Shin et al., 2019). The more virtual individuals' realism increases (both in terms of appearance and movements), the more the uncanny valley effect should occur (Mori, 1970). Indeed, with higher levels of realism, any inconsistency would appear eerie. In the current work, although virtual individuals are globally evaluated positively by the participants, we cannot unequivocally discard the eventuality of an uncanny valley effect. If virtual individuals induced an uncanny valley effect, this could have impeded the positive evaluative influence of enacting an approach behaviour and increased the negative consequences of being approached. It would be worthy to test these effects by filming 360° videos with real individuals.

## 1.2. WHAT ABOUT THE INDIVIDUAL'S INTERNAL STATE?

In the introduction of this thesis, I raised the importance of considering the individual-environment interaction when investigating human behaviour. However, in the current work, the emphasis has been put on the sensorimotor and contextual aspect of individual-environment interaction. The individuals' internal state (e.g., emotional state, motivational state) has not been considered.

First, in the current work, the motivational state of individuals has not been considered. I assumed that individuals are fundamentally motivated to create and maintain social interactions (Baumeister & Leary 1995; Deci & Ryan, 2000). If the literature supports such a need, in the current work, it remains an assumption that we did not manipulate or activate. Indeed, the need may fluctuate among individuals (Leary et al., 2013) and across situations

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<sup>19</sup> It is worth mentioning that in the subsequent studies of this thesis (in Chapter 2 and Chapter 3) we tried to incrementally improve the feeling of presence and relied on a more recent measure of the feeling of presence. These changes limit the comparison between the studies.

(Newman & Smith, 2016; Pickett et al., 2004). Therefore, it would have been worthy to prime this need in participants before experiments or to control for its interindividual variability (Fitzsimons & Shah, 2008).

Moreover, participants may have been driven by different social motivations. Indeed, I introduced this manuscript with the general idea that individuals need to create and maintain social interactions (Baumeister & Leary, 1995; Deci & Ryan, 2000). However, this need may translate into different motivations depending on individuals' past experiences and the current one: Hope for affiliation and fear of rejection (Atkinson et al., 1954; Boyatzis, 1973; DeCharms, 1957; Gable, 2006; Mehrabian, 1976). Hope for affiliation is considered as an approach-related social motivation as it energises and directs behaviour towards positive outcomes. When this motivation is high, individuals would be motivated to have pleasing interactions with funny and understanding people. Conversely, fear of rejection is an avoidance-related social motivation as it energises and directs behaviour away from negative outcomes. When this motivation is high, individuals would be motivated to avoid rejection and conflict.

As we did not manipulate or control for the type of social motivation in the reported experiments, it is possible that participants differed in their ongoing social motivation. If it is the case, this may have created some noise in the results. Indeed, research shows that in daily social life approach and avoidance social motivations are associated with different social outcomes. Elliot and colleagues (2006) showed that the higher the individuals' level of approach social motivation is, the more they report frequent positive social events (e.g., having good interactions with others). On the contrary, the higher the individuals' level of avoidance social motivation is, the more they report frequent negative social events (e.g., feeling left out or rejected by others). If individuals had not the same social interactions experiences depending on their social motivation, enacting approach and avoidance behaviours should have echoed different sensorimotor traces and influence ongoing cognition differently. In line with this idea, there is evidence that whether individuals have an approach or an avoidance social motivation influences their cognitive activity (Gable, 2006; Strachman & Gable, 2006; for a review see Gable, 2015). For instance, when individuals have to remember an essay about a social situation, the more they hope for affiliation and the more they remember neutral statements positively (Strachman & Gable, 2006). Conversely, the more they fear of rejection and the more they remember neutral statements negatively. Further research should consider individuals' motivational states when investigating the evaluative influence of approach-avoidance behaviours.

Second, in the current work, the emotional state of individuals has not been considered. Emotions may be broadly defined as episodic, relatively short-term, biologically based patterns of perception, experience, physiology, action, and communication that occur in response to specific physical and social challenges and opportunities (Keltner & Gross, 1999). They are sets of coordinated processes including appraisal patterns, bodily reactions, feelings, action tendencies, motivation, etc. rather than unitary categories (Coppin & Sander, 2016; Frijda, 2016; Scherer, 2005; Scherer & Moors, 2019). Importantly, emotions serve behaviour regulatory functions to initiate, alter or maintain a functional link with aspects of the environment (Barrett & Campos, 1987; Frijda & Parrott, 2011). Therefore, the ongoing emotional state of individuals may orient how approach-avoidance behaviours would be interpreted in regard with the environment and individuals' needs or goals. For instance, approaching someone may be interpreted as an attempt to affiliate with someone or to dominate someone depending on the ongoing emotional state. In this case, it is possible that the approached individual would not be evaluated in the same way: Trustworthy and attractive in the first case but as interfering with individuals' needs or goals, and thus negative, in the latter (Frijda & Parrott, 2011). In this case, the link between approach-avoidance behaviours and valence thought to be at the core of their evaluative influence in the literature (i.e., approach-positive and avoidance-negative) would be subject to boundary conditions. Further research should extend the current attempt to consider the individual-environment interaction by integrating the emotional states of individuals. Our research team has begun to work along this line.

### 1.3.POTENTIAL MEASUREMENTS ISSUES

Beyond the IVR and internal states issues, it is possible that the behaviours do regulate social interactions via their evaluative influence but that we have not investigated evaluations appropriately. First, some of the used evaluative measures may have been insufficiently reliable or sensitive to detect the evaluative influence of approach-avoidance behaviours. For instance, the single item employed to sound immediate evaluations in Chapter 1 (i.e., “Your impression about this individual?” from 1 = *negative* to 7 = *positive*) may have not been sufficiently sensitive to capture the evaluative influence of approach-avoidance behaviours. The measure based on multiple traits evaluations in Chapter 2 may have been better suited to capture this effect. Moreover, the version of the IAT used in Chapter 2 (Experiment 1) used to measure evaluations showed low reliability. If this version of the IAT is supposed to circumvent limits

of the original version (Karpinski & Steinman, 2006; Rothermund et al., 2009), its low reliability may have impeded us to reveal the effect of approach-avoidance.

Second, the way we measured evaluations in the current empirical work may seem rather un-ecological. Indeed, in the current work, efforts have been focused on operationalising approach-avoidance behaviours more in line with the idea that cognition is grounded in sensorimotor interactions. Evaluations were measured in less realistic manner via computer-based tasks or Likert scales. When measured outside IVR, the context of the laboratory may remind participants of the experimental situation and influence their evaluations. As already said, the grounded view of cognition suggests that the ongoing experience is as much as important as past ones: The way individuals perceive their environment emerges from their interaction with the environment. Moreover, evaluations are constructed on the spot in regard with what is relevant now, in the ongoing situation (Schwarz, 2007). Therefore, the mismatch between the decontextualised setting at the time of measuring evaluations and the more realistic setting at the time of encountering (approaching or avoiding) individuals may have impeded us to capture an influence of the behaviours on evaluations. Measuring evaluations in IVR, with concrete social situations, would be a better option to detect an influence of evaluations in IVR. If we measured evaluations in IVR in the experiments of Chapter 1 and 2, we relied on self-reported evaluations via Likert scales, which is not quite ecological. After all, you do not give a number from one to seven or from minus three to plus three to each newly encountered person. Further research should be conducted with more realistic or psychophysiological measures of interpersonal evaluations. For instance, one could observe face orientation and gaze behaviour in IVR (Lahnakoski et al., 2020; McCall & Singer, 2015), chair-to-chair distance for a planned future interaction (Goff et al., 2008; Kawakami et al., 2007; Macrae et al., 1994), electromyographic (EMG) activity of the corrugator supercilii and of the zygomaticus major in response to individuals (Cacioppo et al., 1986; Vanman et al., 1997; 2004) or even the voice tone of the “hi” utterance after the behaviour (Weitz, 1972).

## **2. QUESTIONING THE EVALUATIVE INFLUENCE OF APPROACH-AVOIDANCE BEHAVIOURS?**

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From the obtained results, we could not discard the eventuality that enacting approach and avoidance behaviours do not actively participate in the regulation of individuals’ social

interactions. At least not by influencing interpersonal evaluations. Indeed, it is possible that approach-avoidance behaviours per se do not influence evaluations.

### **2.1.THE EVALUATIVE INFLUENCE OF APPROACH-AVOIDANCE: AN EXPERIMENTAL ARTEFACT?**

Due to the decontextualised and minimalist settings of previous research, it is possible that the influence of approach-avoidance behaviours on evaluation was an experimental artefact. Indeed, these experimental settings may represent a quite meaningless situation for participants compared to daily life situations and goad them to look for meaning (Orne, 1962). Why on earth do they have to push or pull a joystick in response to this word or picture? This could force them to rely on specific experimental features not present in the everyday life situations in which the phenomena that one would really like to explain occurs. For example, participants could rely on task instructions or any other information to render the situation meaningful and to infer that the stimulus is positive or negative (Bem, 1972; Van Dessel et al., 2016; 2019; but see Van Dessel et al., 2020). In this case the active contribution of approach-avoidance behaviours in regulation may be questioned as enacting the behaviours per se does not influence evaluation. If previous evidence of the effect is due to experimental settings, the current findings should warn researchers about the conclusions that can be drawn from the literature. They emphasise the necessity to consider the sensorimotor individual-environment interaction as a whole when investigating human cognition. This is not to invalidate all previous studies about the evaluative influence of approach-avoidance, after all, the effect is generally replicated. But what is known from the literature about human functioning (e.g., that moving a joystick influences evaluation of static and decontextualised stimuli) could be quite different from what is going on in everyday situations, outside of the laboratory context.

### **2.2.THE COMPATIBILITY HYPOTHESIS**

In the current thesis, I hypothesised that if approach-avoidance behaviours actively participate in social interactions regulation, they should influence interpersonal evaluations in such a way that facilitate their own enactment (Balci et al., 2009). More specifically, I predicted that performing an approach behaviour leads to more positive evaluation of the interaction partner than performing an avoidance one. This reasoning fits a view of cognition as grounded in sensorimotor individual-environment interactions. Enacting approach-avoidance behaviours echoes sensorimotor traces of past experiences in which individuals

approached positive others and avoided negative ones. In doing so approach behaviours orient the evaluation process towards more positive evaluation than avoidance behaviours. In this way, the evaluative influence of approach-avoidance comes from their past co-occurrence with valenced stimuli or events. A lot of empirical evidence is in line with this prediction (Cacioppo et al., 1993; Kawakami et al., 2007; Slepian et al., 2012; Van Dessel et al., 2020; Woud et al., 2008, 2013). However, some researchers consider that approach and avoidance behaviours do not influence evaluations by themselves. Rather, it is the motivational compatibility between the enacted behaviours and the a priori valence of the stimulus which orient evaluations (i.e., compatibility hypothesis, Centerbar & Clore, 2006; see also Dru & Cretenet, 2008; Krishna & Eder, 2019). From this perspective, if the other is already perceived positively, approaching them should create more positive evaluations than avoiding them because it is compatible with the approach tendency that the positive valence of the other affords while avoidance is not. On the contrary, from such a position, the reverse pattern is expected if the other is a priori perceived negatively. Approaching them would create more negative evaluations than avoiding them because it is incompatible with the avoidance tendency that their negative valence affords while avoidance is not. In other words, from this perspective, the valence at the origin of the evaluative influence does not come from the type of stimuli generally approached or avoided. The valence comes from the felt experience of doing well or bad in regards with the need to create and maintain social interaction. In this case, rather than approach and avoidance behaviours per se it is the felt experience of appropriateness that contribute to how individuals regulate their social interactions: The feeling of doing well should maintain the ongoing behaviour compared to the feeling of doing bad (Isbell et al., 2013; Schwarz, 2012).

This alternative hypothesis could explain why we failed to obtain the evaluative influence of approach and avoidance behaviours in the present work. Predictions of the compatibility hypothesis require a certain range of variability in the a priori valence of stimuli. As it was not our goal to test this hypothesis, we have neither manipulated nor included a priori valence in our analyses. We even tried to reduce the variability of these evaluations around neutrality (see Pilot 1, 2 and 3 in Chapter 1). It is possible that we did not obtain the expected effect precisely because we did not consider a priori valence. To assist the comprehension of the current findings, we ran exploratory analyses including the a priori positivity of evaluated individuals when possible (see [Appendix](#)). With all caution taken, the results do not support the compatibility hypothesis and limit an explanation in terms of compatibility effects. However,

further research should be specifically designed to investigate the compatibility hypothesis by fully considering the sensorimotor and interactive nature of cognition.

### **3. REINTEGRATING THE OTHER IN THE STUDY OF SOCIAL INTERACTION REGULATION**

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The current findings suggest that approaching someone is threatening from the side of the other: The approaching (unknown) individual is evaluated more negatively than the static one. Negative evaluations generally predispose to avoidance behaviours (Chen & Bargh, 1999). It follows that the person who is approached may finally move away. In other words, enacting an approach behaviour in order to interact with someone could have two distinct and paradoxical effects: A positive evaluative influence from the side of the actor and a negative one on the side of the target (or only the negative one as we did not find evidence for the positive influence in the current work). An interaction attempt through approach behaviours may ironically, jeopardise the satisfaction of the need to create and maintain a social interaction. Indeed, you would easily agree that any attempt to create an interaction with someone running away from you is unfruitful. The social interaction may even take a negative turn if the other comes to be aggressive in response to this perceived threat. Therefore, by replicating the effect of approach-aversion in real-life inspired settings, Chapter 3 emphasises the importance of considering the situation of social interaction, really as an *inter*-action when studying human behaviour. This approach-aversion effect may qualify the hypothesised positive influence of enacting an approach behaviour in social interaction. If approach and avoidance behaviours regulate how an individual interacts with another one, they should flexibly adapt to changing demands including the other's reactions (Balcetis & Cole, 2009; Semin & Cacioppo, 2008). Therefore, further research must be conducted to understand how the reactions of the other would be integrated in this process. For instance, one may both manipulate the behaviour enacted by individuals (approach vs. avoidance) and the reaction of this behaviour on the other (e.g., smile vs. frown). Such a procedure has been used in the study of approach-avoidance facilitation (see Wilkowski & Meier, 2010) but never for the study of their evaluative influence.



#### 4. A FINAL THOUGHT

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At the end of this manuscript, I would like to open the discussion with some epistemological considerations. When considering human cognition as grounded in sensorimotor individual-environment interactions, things may quickly appear circular. Cognition, how people make sense of their environment in order to interact with it, depends on these very interactions. This also applies when investigating how individuals regulate their social interactions through approach-avoidance behaviours. Social interactions that individuals have to regulate also serve as a basis for human cognition and thus, the regulation process itself. In experimental social psychology, researchers intend to identify processes by isolating causes and effects. Causality is frequently considered in a linear way: A cause X has an effect Y that could not be its own cause. In this way of thinking, the circularity above mentioned is not allowed. However, because we tend to think and create experiments in a linear way does not mean that cognitive processes function linearly. When we acknowledge this, nothing prevents us to include some circularity in social cognition. Actually, doing that, like when viewing social cognition as an emergent and self-sustaining system (De Jaegher & Di Paolo, 2007; Froese & Gallagher, 2012; Varela et al., 1991), could open new questions in the field of approach-avoidance.

For instance, the current work aims at pursuing and extending previous research about the evaluative influence of approach-avoidance behaviours. All along this thesis, a view of human cognition as grounded in sensorimotor individual-environment interactions has been adopted. In the empirical part of this work, efforts have been made in order to investigate how individuals regulate their social interactions through approach-avoidance behaviours in line with this view. Indeed, we distinguish our work from previous ones by relying on whole body behaviours performed in real-life inspired IVR settings and by beginning to reintegrate the other interactant in the study of the phenomenon. But, by considering circularity, one could go further and wonder whether it makes sense to study the effect of approach-avoidance on interpersonal evaluation as an isolated sequence. Could we really investigate this effect without considering that, in daily life, humans rarely perform approach-avoidance behaviours without any reason, or in other words, that these behaviours are motivated behaviours? Researchers should always keep in mind that when investigating an effect as an isolated sequence they only capture a fixed picture of a dynamic and functional individual-environment relation (Nuttin, 1980).

When introducing circularity in social cognition, the study of psychological phenomena and processes is becoming more complex. One potential and encouraging solution resides in the theory of dynamical systems devoted to the study of emerging and self-organised systems composed of multiple interacting components (Richardson et al., 2014). Dynamical systems could help to modelise the dynamism of the social interaction in which approach-avoidance behaviours occur (Nowak & Vallacher, 1998; Nowak et al., 2000; Richardson et al., 2014).

To conclude, the current work intended to better consider the implications of a grounded view of cognition when investigating the evaluative influence of approach-avoidance behaviour (compared to previous work). If the results are mitigated they pave the way for new avenues of research and new questions concerning this effect. In other words, the current work constitutes a first step toward more ecological and epistemological considerations in the study of approach-avoidance and social cognition in general.

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## Links of online appendices

### Chapter 1

**Details of pilots:**

[https://osf.io/m2svz/?view\\_only=acca3acd55284968a935b97debf55828](https://osf.io/m2svz/?view_only=acca3acd55284968a935b97debf55828)

**Material, data and R scripts for pilots:**

[https://osf.io/quk3j/?view\\_only=acca3acd55284968a935b97debf55828](https://osf.io/quk3j/?view_only=acca3acd55284968a935b97debf55828)

**Preregistration of Study 1 and 2:**

[https://osf.io/7wh48?view\\_only=b6af44ee54164c86ba88099fce128e8c](https://osf.io/7wh48?view_only=b6af44ee54164c86ba88099fce128e8c)

**Material, data and R scripts for Study 1 and 2:**

[https://osf.io/sqhvz/?view\\_only=9624d0c0d73345029d48a67ea4892e9f](https://osf.io/sqhvz/?view_only=9624d0c0d73345029d48a67ea4892e9f)

**Complementary analyses for Study 1 and 2:**

[https://osf.io/fvwbz/?view\\_only=9624d0c0d73345029d48a67ea4892e9f](https://osf.io/fvwbz/?view_only=9624d0c0d73345029d48a67ea4892e9f)

### Chapter 2

**Preregistration of Experiment 1:**

[https://osf.io/426f7?view\\_only=7ac61b6a1b434724ab8efec483fcfa60](https://osf.io/426f7?view_only=7ac61b6a1b434724ab8efec483fcfa60)

**Preregistration of Experiment 2:**

[https://osf.io/nyzke?view\\_only=3cc0e390743e415fa4a38b7114433298](https://osf.io/nyzke?view_only=3cc0e390743e415fa4a38b7114433298)

**Procedure details (for the SC-RF-IAT and for the VAAST):**

[https://osf.io/hnywj/?view\\_only=eb885e8942654089ba7cff2fd880ed98](https://osf.io/hnywj/?view_only=eb885e8942654089ba7cff2fd880ed98)

**Material, data and R scripts:**

[https://osf.io/9jb8a/?view\\_only=eb885e8942654089ba7cff2fd880ed98](https://osf.io/9jb8a/?view_only=eb885e8942654089ba7cff2fd880ed98)

**Confirmatory and complementary analyses:**

[https://osf.io/xyn8e/?view\\_only=eb885e8942654089ba7cff2fd880ed98](https://osf.io/xyn8e/?view_only=eb885e8942654089ba7cff2fd880ed98)

### Chapter 3

**Preregistration for Experiment 1:**

[https://osf.io/zydjz?view\\_only=b21f58d1db4e48f48b443780e28689c0](https://osf.io/zydjz?view_only=b21f58d1db4e48f48b443780e28689c0)

**Preregistration for Experiment 2:**

[https://osf.io/wgu6c?view\\_only=c608627f0deb4d36974ff14acf28b5e7](https://osf.io/wgu6c?view_only=c608627f0deb4d36974ff14acf28b5e7)

**Preregistration for Experiment 3:**

[https://osf.io/qm9ac?view\\_only=13066e87eb99431684549157d7940719](https://osf.io/qm9ac?view_only=13066e87eb99431684549157d7940719)

**Material, data and R scripts:**

[https://osf.io/mgbxz/?view\\_only=7532cd112a25414c8e6ca254bd72ada1](https://osf.io/mgbxz/?view_only=7532cd112a25414c8e6ca254bd72ada1)

**Discussion**

**Compatibility hypothesis exploratory analyses**

[https://osf.io/jup7h/?view\\_only=773e613c7f6c449895cdb8f672958fd5](https://osf.io/jup7h/?view_only=773e613c7f6c449895cdb8f672958fd5)

**Unpublished experiment**

- **Details**

[https://osf.io/w4f5x/?view\\_only=773e613c7f6c449895cdb8f672958fd5](https://osf.io/w4f5x/?view_only=773e613c7f6c449895cdb8f672958fd5)

- **Analysis outputs**

[https://osf.io/pgmz4/?view\\_only=773e613c7f6c449895cdb8f672958fd5](https://osf.io/pgmz4/?view_only=773e613c7f6c449895cdb8f672958fd5)

Résumé substantiel de la thèse en français



# Vers une perspective grounded de la régulation des interactions sociales

*La contribution des comportements d'approche-évitement aux évaluations interpersonnelles*

## **1. Introduction**

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### **1.1. L'importance des interactions sociales dans la vie des individus**

L'être humain est un animal social. En tant que tel, il a besoin de créer et maintenir des interactions sociales satisfaisantes avec autrui (Baumeister & Leary 1995 ; Deci & Ryan, 2000). Ainsi, les interactions sociales occupent une place centrale dans la vie des individus. Elles contribueraient à leur santé et leur bien-être, à la manière dont ils se perçoivent ainsi qu'au développement de nouvelles connaissances à propos de leur environnement (Bandura, 1962 ; Barrett & Campos, 1987 ; Cohen et al., 2000 ; Leary, 2006 ; Mikulincer, 1995). Par conséquent, il est crucial de comprendre comment les individus créent et maintiennent leurs interactions, comment ils les régulent, afin de satisfaire leur besoin. C'est l'objectif de la présente thèse. Plus précisément, dans ce travail, j'étudie comment les comportements interpersonnels participent eux-mêmes de manière active à ce processus de régulation.

### **1.2. Attraction et répulsion : De l'évaluation aux comportements**

Dans le processus de régulation, tant l'évaluation que l'action sont impliquées. Les individus évaluent leur environnement en fonction de la capacité de celui-ci à satisfaire (évaluation positive) ou non (évaluation négative) leurs besoins et objectifs (Brendl & Higgins, 1996 ; Frijda, 2016). Cette évaluation orienterait les individus vers certains comportements vis-à-vis de leur environnement : Une évaluation positive orienterait les individus vers l'environnement alors qu'une évaluation négative les orienterait loin de celui-ci (Chen & Bargh,



1999). Les individus mettraient alors en place des comportements d'approche et d'évitement, visant à réduire et augmenter la distance entre soi et l'environnement (Strack & Deutsch, 2004 ; Van Dantzig et al., 2008), pour satisfaire leurs besoins.

Ainsi, les individus seraient capables de réguler leurs interactions sociales de manière efficace 1) en évaluant si les individus rencontrés peuvent faciliter ou gêner la satisfaction de leur besoin de connexions sociales et 2) en les approchant ou en les évitant en conséquence. Toutefois, réduire la manière dont les individus régulent leurs interactions sociales à cette relation entre évaluation et comportement, dans laquelle les comportements ne sont que de simples réactions, serait trop fixiste au regard de la cognition humaine.

### **1.3. La contribution active des comportements d'approche-évitement dans la régulation des interactions sociales**

Afin de réguler leurs interactions sociales, les individus doivent donner du sens à leur environnement, l'évaluer, de manière à agir en conséquence. Ce processus de création de sens est au cœur de la cognition. En effet, la cognition est un processus régulateur adaptatif permettant aux individus de donner du sens à leur environnement et d'agir de manière adaptée (Fiske & Taylor, 2013 ; Pecher & Zwaan, 2005 ; Smith & Semin, 2004 ; Wilson, 2002). Par conséquent, comprendre comment les individus régulent leurs interactions sociales ne peut se faire sans considérer la nature de la cognition.

Aujourd'hui, il est relativement accepté que la cognition est ancrée, nous dirons également *grounded*, dans les interactions sensorimotrices entre l'individu et son environnement (Barsalou, 2008 ; Overmann & Malafouris, 2018 ; Robbins & Aydede, 2009 ; Smith & Semin, 2004 ; Wilson, 2002). Tant les systèmes neuronaux spécifiques à chaque modalité sensorielle, le corps, l'environnement (physique et social) ainsi que leurs interactions participent conjointement à la cognition. Ainsi la manière dont les individus interagissent avec leur environnement contribue à donner du sens à celui-ci pour agir de manière appropriée. Autrement dit, tous les changements qui ont lieu dans les systèmes neuronaux, le corps et l'environnement lors de la réalisation de comportements d'approche et d'évitement devraient contribuer à la perception de l'environnement. Plus que de simples réactions à des valences positives et négatives, ces comportements participeraient de manière active au processus de régulation.

Les comportements d'approche-évitement pourraient contribuer de manière active au processus de régulation grâce à une influence évaluative (Balctis & Cole, 2009 ; Neumann et

al., 2003 ; Strack & Deutsch, 2004). Lors de la réalisation des comportements, l'ensemble de la situation en cours devrait faire écho aux traces sensorimotrices d'expériences passées (Barsalou, 1999 ; Papiés et al., 2020 ; Versace et al., 2014). Puisque les individus approchent généralement des individus positifs et évitent ceux négatifs, ces traces, couplées à la situation actuelle, devraient orienter l'évaluation de l'environnement : De manière plus positive lors de la réalisation d'un comportement d'approche que d'évitement. En effet, dans la littérature de nombreuses évidences empiriques montrent un tel effet sur tout type de stimuli (Cacioppo et al., 1993 ; Hütter & Genschow, 2020 ; Krishna & Eder, 2018 ; Laham et al., 2014 ; Streicher & Estes, 2016) y compris des stimuli sociaux comme des individus (Mertens et al., 2020; Slepian et al., 2012 ; Woud et al., 2008 ; Woud et al., 2013) ou leur groupe d'appartenance (Kawakami et al., 2007 ; Phills et al., 2011 ; Van Dessel et al., 2018 ; Van Dessel et al., 2020). Toutefois, si l'effet des comportements d'approche-évitement sur les évaluations est en accord avec une vision de la cognition comme ancrée dans les interactions sensorimotrices individus-environnement, c'est moins le cas pour ce qui est de la manière dont cet effet a été étudié.

#### **1.4. Etat de l'art de la littérature : De l'incapacité de rendre compte de la contribution active des comportements d'approche-évitement dans le processus de régulation**

Dans la littérature, les comportements d'approche-évitement sont souvent opérationnalisés à travers la contraction de muscles spécifiques ou la variation de distance effective entre soi et l'environnement. Dans le premier cas, les participants doivent alors contracter les muscles des bras généralement impliqués dans les comportements d'approche (fléchisseurs) ou d'évitement (extenseurs). Par exemple, cela peut se faire en exerçant une pression de la main sur une surface (Cacioppo et al., 1993 ; Slepian et al., 2012) ou par le mouvement d'un joystick (Kawakami et al., 2007 ; Woud et al., 2008). Dans le cas d'une opérationnalisation par variation de distance effective, les mouvements du bras impliquant un rapprochement vers le soi ou un éloignement (e.g., joystick) peuvent aussi être utilisés. Mais il est également possible de créer l'illusion visuelle d'un changement de distance à la première perspective (Rougier et al., 2018 ; Woud et al., 2008) ou même de manipuler le changement de distance à la troisième perspective (e.g., déplacement d'une silhouette représentant le participant ; Van Dessel et al., 2018 ; Woud et al., 2013). Par ailleurs, peu importe le type d'opérationnalisation, les situations expérimentales utilisées pour étudier l'influence des comportements sur les évaluations se limitent bien souvent à des stimuli décontextualisés présentés sur un écran d'ordinateur.

Autrement dit, l'influence évaluative des comportements d'approche-évitement n'est pas suffisamment étudiée dans des configurations en accord avec une vision *grounded* de la cognition. Plus précisément, les paradigmes existants négligent 1) le rôle du corps et des systèmes multisensoriels, 2) le rôle de l'environnement et 3) le rôle de l'action dans la cognition. Tout d'abord, les opérationnalisations utilisées reposent souvent sur la modalité motrice et/ou visuelle alors que les comportements interpersonnels d'approche-évitement impliquent une multitude d'indices multisensoriels (e.g., moteurs, proprioceptifs, intéroceptifs, visuels, auditifs). Ensuite, les recherches antérieures se focalisent essentiellement sur l'individu et sous-estime le rôle de l'environnement alentour dans les processus psychologiques (Brunswik, 1957 ; Lewin, 1935). Enfin, les opérationnalisations utilisées négligent le fait que dans une situation d'interaction sociale l'environnement, principalement autrui, est dynamique. Or, ce dynamisme prédispose les individus à certains comportements et leur offre des possibilités d'action spécifiques (Kockler et al., 2010 ; Valenti & Gold, 1991). Bien sûr, il existe quelques exceptions dans la littérature. Certains ont tenté de pallier ces problèmes en ayant recours à des mouvements du corps entier (Krpan & Fasolo, 2019) ou en contextualisant la situation (Laham et al., 2014 ; Zogmaister et al., 2016). Toutefois, il semble qu'aucune recherche sur l'influence évaluative de l'approche-évitement ne considère à la fois le rôle du corps et des systèmes multisensoriels, de l'environnement et de l'action dans la cognition.

### **1.5. La présente thèse**

Au vu de cette analyse, il semble donc que les comportements d'approche-évitement puissent avoir un rôle actif dans le processus de régulation des interactions sociales en influençant les évaluations interpersonnelles. Mais on s'aperçoit également que les travaux précédents ont négligé le poids du corps, de l'environnement et de leur interaction dans l'étude de cet effet. Ce faisant, ils n'ont pas suffisamment considéré la cognition comme *grounded* dans les interactions sensorimotrices individu-environnement. Puisque la cognition sert la régulation du comportement humain, ce manque offre une vision trop limitée et simplifiée de la potentielle nature régulatrice des comportements d'approche-évitement. Il est donc crucial de pallier ce manque si l'on veut pleinement appréhender comment les individus régulent leurs interactions sociales.

Dans ce travail, je défends la thèse selon laquelle les comportements d'approche-évitement, en tant qu'interactions sensorimotrices individu-environnement, contribuent de manière active à la régulation des interactions sociales en influençant les évaluations interpersonnelles. Si tel est le cas, 1) l'approche et l'évitement devraient influencer comment

les individus perçoivent leur environnement de manière à faciliter les comportements appropriés et 2) ce processus devrait s'adapter de manière flexible aux variations de l'environnement en intégrant les modifications de la situation actuelle (Balcetis & Cole, 2009 ; Semin & Cacioppo, 2008). Plus important encore, l'étude de ce phénomène doit se faire en appréciant pleinement le fait que la cognition est ancrée dans les interactions sensorimotrices entre l'individu et son environnement. Pour ce faire, dans la présente recherche je capitalise sur l'utilisation de la réalité virtuelle immersive (RVI) pour opérationnaliser les comportements interpersonnels d'approche et d'évitement.

En RVI, un environnement virtuel est présenté aux individus en fonction du suivi de leurs mouvements ce qui permet de simuler leur présence physique dans ce même environnement (Fox et al., 2009). La RVI semble particulièrement bien adaptée pour étudier la contribution des comportements d'approche-évitement dans le processus de régulation : Elle permet de considérer à la fois le rôle du corps, de l'environnement et de l'action dans la cognition. En effet, les utilisateurs reçoivent des feedbacks sensoriels en temps réels et à la première personne selon leurs mouvements dans un environnement social en trois-dimensions, riche et complexe (pour une vision d'ensemble voir Pan & Hamilton, 2018). Dans le cadre d'une expérience, les participants peuvent ainsi être immergés dans une situation d'interaction sociale certes virtuelle mais réaliste (e.g., un arrêt de bus ; Dotsch & Wigboldus, 2008 ; Gillath et al., 2008). Plus important encore, la RVI offre une situation réaliste tout en maintenant le contrôle expérimental élevé (Pan & Hamilton, 2018). Pour les besoins de cette thèse, deux environnements virtuels ont été utilisés—un arrêt de bus en zone urbaine et une pièce neutre—dans lesquels les comportements d'approche-évitement étaient opérationnalisés par la réalisation d'un pas (dans la rue) ou par des inclinaisons de buste (dans la pièce).

Ce travail de thèse s'articule autour de trois chapitres empiriques. Dans le Chapitre 1, il s'agit de tester l'influence évaluative des comportements d'approche-évitement au cours d'une interaction sociale à l'aide d'opérationnalisations plus en accord avec une vision *grounded* de la cognition. Dans le Chapitre 2, il s'agit de tester la contribution des comportements d'approche-évitement dans les évaluations intergroupes. Enfin, dans le Chapitre 3, il s'agit de mettre en évidence que si l'on souhaite étudier le rôle de l'approche-évitement dans le processus de régulation, il faut considérer la situation d'interaction sociale dans sa globalité. Plus précisément, il s'agit de montrer que la réalisation de comportements d'approche peut avoir des conséquences sur autrui, et que par conséquent l'étude de leur influence évaluative doit être abordée de manière dynamique.

## **2. Chapitre 1 - “Science Manipulates the Things and Lives in Them”: Reconsidering Approach-Avoidance Operationalization Through a Grounded Cognition Perspective**

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### **2.1. Introduction**

Dans cet article, nous argumentons qu’une approche de la cognition comme étant ancrée dans les interactions sensorimotrices entre l’individu et son environnement—dite *grounded* cognition—peut permettre de mieux comprendre les processus évaluatifs. Une telle approche implique des opérationnalisations spécifiques au niveau empirique. En effet, une manipulation optimale de l’approche-évitement doit permettre une adéquation étroite entre l’expérience en cours et les expériences d’approche-évitement passées. Cette adéquation dépend du potentiel de la situation actuelle à réactiver des traces d’expériences passées qui soient à la fois 1) prototypiques (i.e., les plus représentatives en termes de traces mnésiques), 2) multimodales et 3) situées (Barsalou, 2003, 2005, 2015 ; Versace et al., 2014 ; Papies & Barsalou, 2015). Or, les opérationnalisations d’approche-évitement issues des paradigmes de la littérature n’ont pas systématiquement et conjointement intégré ces trois aspects. Ce faisant, elles ne reflètent pas suffisamment la nature *grounded* de la cognition.

Tout d’abord, les études antérieures manipulent fréquemment l’approche-évitement à travers la contraction de muscles spécifiques comme les muscles fléchisseurs et extenseurs du bras (Cacioppo et al., 1993 ; Wentura et al., 2000 ; Kawakami et al., 2007 ; Laham et al., 2014). De telles opérationnalisations couvrent un nombre relativement limité d’expériences impliquant l’approche et l’évitement. Des opérationnalisations mobilisant le corps entier seraient plus prototypiques (Rougier et al., 2018).

Ensuite, les opérationnalisations utilisées se restreignent bien souvent à une seule modalité sensorielle (e.g., information motrice, Cacioppo et al., 1993 ; Topolinski et al., 2014 ; information visuelle, De Houwer et al., 2001 ; Rougier et al., 2018). Or, une opérationnalisation efficace de l’approche -évitement devrait combiner plusieurs traces sensorimotrices dans diverses modalités afin faciliter la réactivation des traces passées. Encore ici, les opérationnalisations impliquant le corps entier seraient plus adaptées car elles engageraient à la fois des changements du flux visuel tout en engageant les composantes motrices.

Enfin, la majorité des travaux antérieurs réduisent la situation d’approche-évitement à des rencontres minimales et isolées avec des stimuli. De telles opérationnalisations ne prennent pas en compte le fait que les traces des expériences d’approche-évitement passées concernent également le contexte dans lequel les expériences ont eu lieu (Barsalou, 2003 ; Papies and

Barsalou, 2015). Ce manque peut mener à des opérationnalisations non-satisfaisantes et/ou ambiguës puisque, selon la situation, la même contraction musculaire peut être considérée comme de l’approche ou de l’évitement. Par ailleurs, la situation expérimentale peut offrir certaines possibilités d’actions aux participants qui peuvent gêner la réactivation des traces visées par l’opérationnalisation (Cesario et al., 2010). Une opérationnalisation de l’approche-évitement optimale devrait donc être contextualisée.

Par conséquent, il apparaît qu’une opérationnalisation de l’approche et de l’évitement reposant sur des mouvements du corps entier, interactifs et contextualisés, qui sollicitent plusieurs modalités sensorielles satisfait le besoin de prototypicalité, de multimodalité et de contextualisation inhérents à une approche *grounded* de la cognition. Dans ce papier, notre objectif était de développer une telle opérationnalisation afin d’étudier l’influence de l’approche-évitement sur les évaluations. En accord avec la littérature, nous faisons l’hypothèse que réaliser des comportements d’approche envers autrui devrait mener à des évaluations plus positives de celui-ci que réaliser des comportements d’évitement. Nous avons testé cette hypothèse à travers six études dans lesquelles nous avons pris en compte les présupposés de la *grounded* cognition de manière incrémentielle.

## **2.2. Etudes pilotes**

### **2.2.1. Procédure**

Dans quatre études pilotes ( $N_{\text{Total}} = 408$ ) nous nous sommes focalisés sur les aspects prototypiques et multimodaux de l’opérationnalisation de l’approche et l’évitement. Plus précisément, nous avons adapté des opérationnalisations existantes basées sur l’inclinaison et la posture du haut du corps. Les participants devaient réaliser des comportements d’approche-évitement face à des visages en inclinant ou en maintenant le haut du corps vers l’avant ou vers l’arrière et les évaluer (pour plus de détails sur ces études pilotes, voir [ici](#)).

### **2.2.2. Résultats**

Les résultats de ces quatre études pilotes ne montrent pas l’effet positif des comportements d’approche (vs. des comportements d’évitement) attendu sur les évaluations (voir Tableau 1). Nous avons réalisé une mini meta-analyse de ces études en utilisant un modèle à effets aléatoires sur les coefficients de régression standardisés (Kim, 2011). Cette dernière ne révèle pas d’effet des comportements d’approche-évitement sur les évaluations qui soit statistiquement significatif,  $z = -0.75$ ,  $p = 0.455$ ,  $\beta_Z = -0.05$ , 95% CI (-0.17, 0.07).

## 2.3. Expériences en Réalité Virtuelle

Si dans les études pilotes, nous avons opérationnalisé l'approche et l'évitement de manière prototypique et multimodale, nous n'avons pas suffisamment considéré l'aspect contextualisé. Pour pallier cela, nous avons conduit deux expériences en RVI ( $N_{\text{Total}} = 351$ , pré-enregistrement et matériel supplémentaire : [ici](#)). La RVI permet d'étudier les situations sociales de manière réaliste, en considérant l'interaction sensorimotrice individu-environnement en cours tout en garantissant un contrôle expérimental élevé (Pan and Hamilton, 2018). Ce faisant, la RVI nous permettait d'opérationnaliser l'approche et l'évitement en satisfaisant le besoin de prototypicalité, de multimodalité et de contextualisation inhérents à une approche *grounded* de la cognition.

### 2.3.1. Procédure

Les participants devaient saluer des individus virtuels en les approchant ou en les évitant à l'aide de leur buste (Expérience 1) ou d'un pas (Expérience 2). La Figure 1 illustre les environnements virtuels utilisés. Pour chaque rencontre, les participants devaient donner leur première impression à propos de l'individu en utilisant une échelle allant de 1 (négative) à 7 (positive). Nous prédisions que les participants réalisant un comportement d'approche évalueraient plus positivement les individus que ceux réalisant un comportement d'évitement. Afin de s'assurer de la validité de construit de notre opérationnalisation nous avons également mesuré les tendances à l'action activées par notre opérationnalisation à l'aide de la Visual Approach-Avoidance by the Self Task (VAAST ; Rougier et al., 2018) ainsi que les systèmes neuropsychologiques d'approche (i.e., Behavioral Approach System ; BAS) et d'évitement (i.e., Fight-Flight-Freeze System ; FFFS) à l'aide du Reinforcement Sensitivity Personality Questionnaire (RST-PQ ; Corr & Cooper, 2016).

### Figure 1

*Illustrations des environnements virtuels utilisés dans le Chapitre 1*



### 2.3.2. Résultats

Les résultats de ces deux études ne supportent pas l'hypothèse avancée. Comme présenté dans le Tableau 1, les participants n'évaluent pas plus positivement les individus virtuels en condition d'approche qu'en condition d'évitement. Qui plus est, notre opérationnalisation ne semble pas non plus avoir activé les tendances à l'action et les systèmes neuropsychologiques associés à l'approche-évitement.

**Tableau 1**

*Statistiques descriptives et inférentielles des expériences présentées dans le Chapitre 1*

Variable	Évitement		Contrôle		Approche		Comparaison Approche vs. Évitement
	M	ES (ou 95 % IC)	M	ES (ou 95 % IC)	M	ES (ou 95 % IC)	
<b>Evaluations</b>							
Pilote 1 <sup>a</sup>	3.54	0.15	/	/	3.78	0.16	$F(1, 2333) = 9.11, p = .003, \beta_2 = 0.16, 95\% \text{ CI } [0.05, 0.26]$
Bloc 1	3.7	0.21	/	/	3.44	0.36	$F(1, 33.98) < 1, p = .518, \beta_2 = -0.18, 95\% \text{ CI } [-0.65, 0.28]$
Pilote 2 <sup>b</sup>	0.35	0.12	/	/	0.11	0.12	$F(1, 90.15) = 2.81, p = .097, \beta_2 = -0.18, 95\% \text{ CI } [-0.36, 0.01]$
Pilote 3 <sup>b</sup>	0.13	0.2	/	/	0.23	0.19	$F(1, 81) = 0.62, p = .434, \beta_2 = -0.08, 95\% \text{ CI } [-0.26, 0.10]$
Pilote 4 <sup>b</sup>	0.45	0.13	0.4	0.13	0.56	0.14	$F(1, 130) = 0.70, p = .406, \beta_2 = 0.04, 95\% \text{ CI } [-0.04, 0.12]$
Expérience 1 <sup>a</sup>	4.34	0.16	4.31	0.16	4.26	0.17	$F(1, 153.09) = 0.39, p = 0.534, \beta_2 = -0.03, 95\% \text{ CI } [-0.12, 0.06]$
Expérience 2 <sup>a</sup>	4.46	0.17	4.41	0.17	4.34	0.17	$F(1, 186.43) = 1.03, p = 0.310, \beta_2 = -0.04, 95\% \text{ CI } [-0.13, 0.04]$
<b>Systèmes neuropsychologiques</b>							
<b>BAS</b>							
Expérience 1	2.89	0.05	2.92	0.05	2.84	0.05	$F(1, 151) = 0.46, p = 0.499, \beta_2 = -0.06, 95\% \text{ CI } [-0.25, 0.12]$
Expérience 2	2.93	0.05	2.97	0.05	2.96	0.04	$F(1, 182) = 0.14, p = 0.705, \beta_2 = 0.03, 95\% \text{ CI } [-0.14, 0.21]$
<b>FFFS</b>							
Expérience 1	2.12	0.08	2.01	0.07	2.07	0.08	$F(1, 151) = 0.21, p = 0.649, \beta_2 = -0.04, 95\% \text{ CI } [-0.23, 0.14]$
Expérience 2	2.17	0.08	2.18	0.08	2.16	0.07	$F(1, 182) < 0.01, p = 0.962, \beta_2 = -0.00, 95\% \text{ CI } [-0.18, 0.17]$
<b>Tendances à l'action</b>							
<b>Expérience 1</b>							
TR Approche	720.54	[689.52, 753.70]	732.89	[702.11, 765.10]	704.16	[672.50, 736.57]	$F(1, 14360) = 0.06, p = 0.806, \beta_2 = 0.00, 95\% \text{ CI } [-0.03, 0.04]$
TR Évitement	744.71	[711.94, 778.99]	755.21	[723.43, 787.61]	725.6	[692.98, 759.76]	
<b>Expérience 2</b>							
TR Approche	731.43	[701.35, 762.04]	750.7	[719.82, 782.11]	739.52	[710.52, 769.70]	$F(1, 17050) < 0.01, p = 0.962, \beta_2 = -0.00, 95\% \text{ CI } [-0.03, 0.03]$
TR Évitement	752.95	[722.70, 785.25]	782.9	[750.70, 815.66]	762.04	[732.16, 793.14]	

Note . M = Moyenne estimée; ES = Erreur standard estimée; IC = Intervalle de confiance; BAS = Behavioral Approach System; FFFS = Fight, Flight and Freeze System; TR = Temps de réaction.

<sup>a</sup> Echelle de 1 à 7. <sup>b</sup> Echelle de -3 à +3



### 2.3.3. Analyses exploratoires

Toutefois, des analyses exploratoires suggèrent que l'efficacité de notre opérationnalisation pourrait dépendre de comment les participants ressentent la situation virtuelle: Plus les participants se sentent *présents* dans la situation—c'est-à-dire plus ils font l'expérience subjective d'être dans l'environnement virtuel alors qu'ils sont physiquement ailleurs (Witmer & Singer, 1998)—plus notre opérationnalisation écologique d'approche-évitement tend à activer les systèmes neuropsychologiques correspondant.

### 2.4. Discussion

Dans ce travail de recherche, nous cherchions à développer une opérationnalisation des comportements d'approche-évitement en capitalisant sur une approche *grounded* de la cognition. Pour cela nous nous sommes basés sur des comportements du corps entier qui soient prototypiques, qui sollicitent plusieurs modalités sensorielles et qui soient intégrés dans un contexte interpersonnel. Nous avons implémenté ces opérationnalisations dans l'étude de l'influence évaluative des comportements d'approche-évitement et nous attendions à des évaluations interpersonnelles plus positive en approche qu'en évitement. Les résultats des six études menées ne soutiennent pas cette hypothèse.

Le fait que nous ne répliquions pas les travaux précédents avec des opérationnalisations de l'approche-évitement plus écologiques soulèvent certaines questions. Premièrement, il est possible que l'influence évaluative des comportements d'approche et d'évitement obtenue par le passé ne soit due qu'à la réactivation par des opérationnalisations unimodales et décontextualisées de traces sensorimotrices très spécifiques et isolées. Si tel est le cas, cela n'offrirait qu'une approximation simpliste de la cognition sociale humaine puisque dans leur vie quotidienne les individus évoluent dans des situations bien plus riches et variées. Deuxièmement, notre procédure générale diffère des études précédentes en certains points (e.g., moment de l'évaluation juste après vs. un certain temps après la rencontre, une seule présentation vs. des présentations répétées du stimulus) qui pourraient expliquer la différence de résultats. Troisièmement, il est également possible que l'utilisation de la RVI ait interféré avec la réactivation de traces d'expérience d'approche-évitement passées. En effet, les patterns d'interaction entre les comportements et le sentiment de présence sur l'activation des systèmes suggèrent que l'expérience en RVI pourrait influencer l'opérationnalisation de l'approche-évitement et donc potentiellement leur effet sur les évaluations.

### **3. Chapitre 2 - The (Virtual) Reality of Intergroup Interactions: Approach-Avoidance Behaviours and Group Evaluations**

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#### **3.1. Introduction**

Au cours de leurs interactions sociales, les individus catégorisent les autres dans des groupes sociaux sur la base de leurs origines ethniques ou sociales, de leur âge, leur sexe ou même leurs préférences politiques, musicales ou culinaires. Les groupes d'appartenance sont cruciaux dans le processus de régulation des interactions sociales car ils sont associés à une valence particulière (positive ou négative) et orientent donc le comportement des individus (Neumann et al., 2004 ; Paladino & Castelli, 2008 ; Rougier et al., 2019). Par exemple, des travaux montrent que les individus sont plus rapides pour éviter le groupe des personnes âgées, généralement associé à une valence négative, que celui des jeunes, généralement associé à une valence positive (Paladino & Castelli, 2008).

La cognition est ancrée dans les interactions sensorimotrices individu-environnement (Barsalou, 1999 ; 2008 ; Pecher & Zwaan, 2005 ; Smith & Semin, 2004 ; Varela et al., 1991 ; Versace et al., 2014 ; Wilson, 2002). Dans une telle perspective, les connaissances que nous avons des groupes sociaux ne sont pas déconnectées du corps et de l'environnement. Au contraire, elles résultent des traces d'expériences sensorimotrices passées (Barsalou, 2015). Au fur et à mesure que les individus rencontrent les membres d'un groupe, les traces des rencontres précédentes sont activées et mises à jour par l'expérience en cours pour orienter le comportement de l'individu dans son interaction avec autrui. En d'autres termes, la manière dont les individus perçoivent les groupes sociaux est ancrée, ou *grounded*, dans leurs interactions sensorimotrices et donc dans les comportements d'approche-évitement.

L'objectif de cet article est donc d'étudier comment les comportements d'approche-évitement pourraient contribuer à la régulation des interactions sociales en influençant l'évaluation du (ou des) groupe(s) d'appartenance d'autrui. Les recherches à ce sujet montrent que la réalisation de comportements d'approche envers les membres d'un groupe mène à des évaluations plus positives du groupe que la réalisation de comportements d'évitement (Kawakami et al., 2007 ; Phills et al., 2011 ; Van Dessel et al., 2020). Toutefois, les travaux antérieurs négligent la richesse des interactions sociales et pourraient n'offrir qu'une vision limitée (ou du moins simplifiée) du phénomène. En effet, les recherches passées négligent la multiplicité des indices sensorimoteurs, perceptuels et intéroceptifs présents lors d'une interaction avec l'environnement (y compris autrui). Tout d'abord, en mettant l'accent sur le

contrôle expérimental, les travaux antérieurs négligent le réalisme de la situation expérimentale en manipulant les comportements de manière simpliste ou abstraite. Ce faisant, ils ne permettent de prendre en considération ni les possibilités d'actions amorcées par autrui (Valenti & Gold, 1991) ni les distances interpersonnelles réelles au cours de l'interaction sociale. Ensuite, le manque de réalisme dans cette littérature n'est pas vraiment en accord avec les conceptions actuelles des attitudes : C'est-à-dire comme étant ancrées dans les modalités sensorimotrices, le corps et les interactions avec l'environnement présent (Niedenthal et al., 2005) et comme construites sur le moment, pour la situation présente (Schwarz, 2007). Afin de pallier ces problèmes, la RVI semble une option prometteuse pour tester la contribution des comportements d'approche-évitement dans les évaluations de groupe. En effet, la RVI permet 1) de donner des feedbacks sensorimoteurs aux individus en réponse à leurs mouvements dans l'environnement, 2) de reproduire la richesse de la situation d'interaction sociale et 3) de maintenir le contrôle expérimental à un niveau élevé (Pan & Hamilton, 2018). Ainsi l'utilisation de la RVI permettrait une meilleure estimation de l'effet de l'approche-évitement sur les évaluations de groupe. En accord avec la littérature, les comportements d'approche devraient mener à des évaluations plus positives du groupe auquel appartient autrui comparé aux comportements d'évitement. Nous avons testé cette hypothèse en RVI à travers deux expériences ( $N_{\text{Total}} = 404$ , pré-enregistrements : [Expérience 1](#), [Expérience 2](#) ; Matériel supplémentaire : [ici](#)).

## **3.2. Expériences**

### **3.2.1. Procédure**

Dans les deux expériences, la procédure était relativement similaire. Les participants étaient d'abord informés que dans le cadre d'une étude sur la formation d'impression, ils allaient rencontrer les avatars d'individus appartenant un groupe nouvellement découvert (mais en réalité fictif). Dans l'Expérience 1, il s'agissait d'un nouveau groupe sanguin tandis que dans l'Expérience 2, il s'agissait d'un groupe partageant certains goûts et préférences. Les participants étaient ensuite immergés dans une pièce virtuelle neutre, assis à une table. Seize individus virtuels (huit hommes et huit femmes) venaient alors à leur rencontre, les uns après les autres en s'asseyant en face d'eux. Pour chaque individu rencontré, les participants devaient dire « salut » en s'inclinant vers l'avant (approche) ou vers l'arrière (évitement) et en pensant à la première impression qu'ils avaient vis-à-vis de cet individu. L'individu virtuel répondait alors « salut » à son tour avant de repartir. Après avoir rencontré les 16 individus, les participants retiraient le casque.

Après la phase en RVI, nous mesurons l'évaluation du groupe rencontré à l'aide de différentes mesures. Dans l'Expérience 1, les participants réalisaient d'abord un Single Category Implicit Association Test avec une procédure en recoding free (SC-RF-IAT, Haynes et al., 2016 ; Karpinski & Steinman, 2006 ; Rothermund et al., 2009) afin de mesurer l'évaluation du groupe de manière indirecte. Puis ils devaient donner leur impression générale vis-à-vis du groupe sur un Feeling-Thermometer. Dans l'Expérience 2, les participants réalisaient d'abord la VAAST (Rougier et al., 2018) afin de mesurer l'évaluation du groupe rencontré à travers les tendances à l'action associées à celui-ci (Rougier et al., 2019). Ensuite, ils devaient évaluer le groupe sur différents traits avant d'indiquer leur intention d'échanger par mail avec un membre du groupe (réponse en oui ou non).

Par ailleurs, du fait du caractère novateur de la RVI dans la manipulation de l'approche-évitement, nous avons mesuré l'activation des systèmes neuropsychologiques qui sous-tendent les comportements d'approche (BAS) et d'évitement (FFFS) comme indicateur de validité de construit. Pour cela, nous avons utilisé le RST-PQ (Corr & Cooper, 2016). Enfin, nous avons mesuré le sentiment de présence (i.e., expérience subjective d'être dans l'environnement, Witmer & Singer, 1998) et les maux liés à la RVI (e.g., nausées, troubles oculomoteurs) qui peuvent gêner l'induction.

### **3.2.2. Résultats**

Les résultats de ces deux expériences ne soutiennent pas l'hypothèse avancée. Comme présenté dans le Tableau 2, les participants en condition d'approche n'évaluent pas plus positivement le groupe rencontré que ceux en condition d'évitement (excepté un effet tendanciel sur l'évaluation des traits). Les résultats sur les tendances à l'action montrent même un pattern inverse à celui attendu. Qui plus est, notre opérationnalisation ne semble pas non plus avoir activé les systèmes neuropsychologiques associés à l'approche-évitement comme ce attendu.

### **3.2.3. Analyses complémentaires**

Le RST-PQ distingue plusieurs sous-dimensions dans l'échelle du BAS. Si la réalisation des comportements d'approche-évitement n'influence pas le score au BAS, l'Expérience 1 révèle que réaliser des comportements d'approche (vs. évitement) mène à des scores significativement plus élevés sur la sous-dimension Goal-Drive Persistence (GDP : la motivation à mettre en place et maintenir des buts et sous-buts pour atteindre les états désirés,

Corr & Cooper, 2016) du BAS. Toutefois, nous ne répliquons pas ces résultats dans l'Expérience 2.

Dans l'Expérience 2, une analyse factorielle conduite sur l'évaluation des traits révèle un facteur regroupant les items liés à la compétence et un facteur regroupant ceux liés à la chaleur, deux dimensions centrales dans la perception sociale (Fiske et al., 2018). Les analyses de variance conduites sur ces deux facteurs, montrent que réaliser des comportements d'approche (vs. évitement) mène à une évaluation plus positive du groupe de manière significative sur la dimension de chaleur et de manière descriptive sur celle de compétence.

**Tableau 2**

*Statistiques descriptives et inférentielles des expériences présentées dans le Chapitre 2*

	Evitement		Approche		Comparaison
	<i>M</i>	<i>ET</i>	<i>M</i>	<i>ET</i>	
<b>Expérience 1</b>	<i>n</i> = 98		<i>n</i> = 101		
SC-RF-IAT-D4	0.08	0.24	0.10	0.24	$F(1,197) = 0.48, p = .49, \eta_p^2 = .002, 90\% \text{ IC } [.00, .03]$
Feeling-Thermometer <sup>a</sup>	5.03	16.53	4.99	14.42	$F(1,195) = 0.00, p = .99, \eta_p^2 = .000, 90\% \text{ IC } [.00, .00]$
BAS	2.85	0.37	2.92	0.38	$F(1,197) = 1.59, p = .21, \eta_p^2 = .008, 90\% \text{ IC } [.00, .04]$
FFFS	2.19	0.62	2.22	0.59	$F(1,197) = 0.14, p = .71, \eta_p^2 = .001, 90\% \text{ IC } [.00, .03]$
<b>Expérience 2</b>	<i>n</i> = 98		<i>n</i> = 107		
VAAST ( $\text{TR}_{\text{Approche}} - \text{TR}_{\text{Evitement}}$ ) <sup>b</sup>	-8.49	( <i>ES</i> ) 2.86	-1.85	( <i>ES</i> ) 2.76	$b = 6.65, SE = 3.38, t = 1.83, \chi^2(1) = 2.33, p = .127$
Traits	5.70	1.08	5.98	1.14	$F(1,203) = 3.13, p = .08, \eta_p^2 = .02, 90\% \text{ IC } [.00, .05]$
Intention de contact	81.63%		75.70%		$\chi^2(1) = 1.06, p = .30, OR = 0.70, 95\% \text{ IC } [0.35, 1.37]$
BAS	2.90	0.39	2.89	0.34	$F(1,202) = 0.13, p = .72, \eta_p^2 = .00, 90\% \text{ IC } [.00, .02]$
FFFS	2.22	0.56	2.21	0.57	$F(1, 202) = 0.01, p = .93, \eta_p^2 = .00, 90\% \text{ IC } [.00, .00]$

<sup>a</sup> Deux participants supplémentaires ont été exclus dans la condition Approche en raison de données manquantes sur le Feeling-Thermometer.

<sup>b</sup> Un score négatif indique un biais d'approche envers le groupe rencontré en Réalité Virtuelle

*M* = Moyenne, *ET* = Ecart type, *ES* = Erreur standard, *IC* = Intervalle de confiance, SC-RF-IAT = Single Category Re-coding Free Implicit Association Test, BAS = Behavioural Approach System,

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

Les scores au Feeling Thermometer pouvaient varier de - 50 à + 50. Les scores sur les échelles du BAS et du FFFS pouvaient varier de 1 à 4.

Les scores d'évaluation des traits pouvaient varier de 1 à 10.

### 3.3. Discussion

Dans cet article, il s'agissait de mettre à profit les avantages de la RVI afin de tester la contribution des comportements d'approche-évitement dans les évaluations intergroupes de manière plus écologique. Plus précisément, en accord avec la littérature, nous prédisions des évaluations groupales plus positives après avoir approché (vs. évité) les membres du groupe. Les résultats obtenus sont mitigés. L'Expérience 1 ne révèle pas l'effet positif de l'approche sur les évaluations du groupe mais révèle un effet sur une sous-dimension du BAS (i.e., GDP). L'Expérience 2 révèle l'effet attendu des comportements d'approche-évitement sur les évaluations de traits mais un pattern inverse à celui attendu sur les tendances à l'action.

Du fait de ces résultats mitigés, certains pourraient conclure que la RVI n'est pas si prometteuse puisqu'elle ne permet pas de répliquer clairement l'effet des comportements d'approche-évitement sur les évaluations. Toutefois, il est possible qu'une portion de l'effet habituellement observé dans la littérature soit due à des configurations expérimentales spécifiques : L'absence de contexte pourrait donner plus de poids aux instructions par exemple (Van Dessel et al., 2015). Il est aussi possible que la situation en RVI ait activé des buts (e.g., affiliation, agression, domination, soumission ; Bossuyt et al., 2014) ou des états émotionnels (e.g., joie, colère ; Maayan & Meiran, 2011 ; Yan & Dillard, 2011) particuliers chez les participants qui soient fonctionnellement associés aux comportements d'approche-évitement. Si c'est le cas, cela pourrait avoir interféré avec notre manipulation. Néanmoins aucune de ces raisons ne justifie de réduire le réalisme dans l'étude de l'influence évaluative des comportements d'approche-évitement.

Par ailleurs, les expériences présentées dans cet article ont certaines limites qui pourraient expliquer l'absence de résultats cohérents. Tout d'abord, le nombre de répétition des comportements d'approche-évitement (16 rencontres) est bien moindre que celui généralement appliqué dans les études précédentes (Kawakami et al., 2017 ; Phillips et al., 2011 ; Van Dessel et al., 2016 ; 2018 ; 2020). Il est donc possible qu'un nombre de répétition plus important soit nécessaire pour observer l'effet. Ensuite, l'état interne des individus n'est pas pris en compte dans les expériences que nous avons réalisées, alors qu'ils constituent une partie intégrante de la situation (Lewin, 1936). Des travaux supplémentaires restent donc à mener.

## **4. Chapitre 3 - Hold it right there! An Ecological examination of the Approach-Aversion Effect in Virtual Reality**

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### **4.1. Introduction**

La littérature suggère que lors d'une interaction sociale, le fait de réaliser des comportements d'approche envers autrui améliore les évaluations vis-à-vis de ce dernier. Ce faisant, les comportements d'approche faciliteraient la création de liens avec autrui et le bon déroulement de l'interaction. Toutefois, il ne faut pas oublier qu'une interaction sociale est une séquence *dyadique* et dynamique intégrée dans un environnement physique et social. Autrement dit, en se focalisant sur l'individu qui réalise le comportement, l'effet positif des comportements d'approche sur les évaluations ne brosserait pas un portrait complet de ce qu'il se passe au cours de l'interaction. Dans cet article, nous changeons de perspective par rapport aux études précédentes en nous plaçant du côté d'autrui, du côté de celui qui est approché. Nous argumentons que du point de vue d'autrui, être approché serait menaçant et mènerait de manière ironique à des évaluations plus négatives de celui qui approche.

En effet, lorsqu'ils perçoivent un mouvement d'approche, les individus doivent pouvoir réagir rapidement en cas de danger (Franconeri & Simons, 2003). Ils seraient alors particulièrement sensibles au mouvement d'approche (Riskind & Rector, 2018) tant au niveau attentionnel (Judd et al., 2004) qu'en termes de réactions comportementales (Spaccasassi et al., 2019). Par ailleurs, la perception d'un mouvement d'approche menace le besoin fondamental de contrôler et de prédire l'environnement (Bandura, 1988 ; White, 1959). Par conséquent, si percevoir un mouvement d'approche est menaçant, cela devrait mener à des évaluations négatives vis-à-vis de la personne qui effectue le mouvement.

En accord avec ce raisonnement, des travaux montrent que le fait d'être approché entraîne des évaluations d'autrui plus négatives que lorsque celui-ci reste statique : Un effet d'aversion à l'approche (Davis et al., 2011 ; Hsee et al., 2014 ; Mühlberger et al., 2008). Si tel est le cas, cela pourrait considérablement changer le cours de l'interaction. Celle-ci prendrait une direction opposée à celle initialement attendue si l'on considère l'effet positif des comportements d'approche du point de vue de celui qui approche.

Toutefois, à ce jour des incertitudes persistent. Nous ne savons pas a) si cet effet d'aversion à l'approche est vraiment fiable puisque les études antérieures utilisent des manipulations du mouvement ambiguës (e.g., effet de zoom) et manquent de réalisme (e.g., stimuli présentés sur un écran d'ordinateur) ainsi que b) s'il passe par un sentiment de menace et se généralise à tout type de stimuli indépendamment de leur valence.

L'objectif de ce chapitre est donc de pallier ce manque et de tester l'effet d'aversion à l'approche de manière plus écologique. Si l'approche est menaçante, nous devrions observer un effet d'aversion à l'approche au-delà de la valence initiale des individus. Par ailleurs, selon

l'hypothèse de la menace, cet effet devrait être d'autant plus fort pour des situations menaçantes. Nous avons testé ce raisonnement à travers trois expériences ( $N_{\text{Total}} = 450$ ) conduites en RVI. La RVI nous permettait d'accroître le réalisme de nos expériences tout en maintenant un niveau de contrôle expérimental élevé (Pan & Hamilton, 2018). Nous avons ainsi pu manipuler l'approche de manière non-ambigüe, prenant en considération à la fois les informations visuelles à propos de l'individu rencontré et du milieu environnant ainsi qu'en engageant la sensibilité de l'espace peripersonnel des participants (Bailenson et al., 2003 ; Iachini et al., 2014).

## **4.2. Expériences**

### **4.2.1. Procédure**

Dans chacune des expériences, la procédure était similaire. Dans l'environnement virtuel, les participants étaient placés sous un abris-bus et des individus virtuels venaient à leur rencontre un par un. Soit l'individu approchait les participants, soit il restait en face d'eux. Nous avons également manipulé la nature menaçante de ces individus de manière différente selon l'expérience. Dans l'Expérience 1 nous avons manipulé l'expression faciale des individus (i.e., sourire vs. froncement de sourcils). Dans l'Expérience 2 nous avons manipulé l'appartenance groupale des individus (i.e., endogroupe vs. exogroupe). Enfin dans l'Expérience 3 nous avons manipulé l'agentivité du mouvement (i.e., soi vs. autrui). Nous prédisions des évaluations plus négatives pour les individus approchant les participants que pour ceux restant statiques, mais que cela soit moins le cas pour les individus non-menaçants que pour ceux menaçants. En d'autres termes, nous nous attendions à une interaction entre le mouvement et le niveau de menace de l'individu virtuel. Les trois expériences de ce papier ont été pré-enregistrées (Pré-enregistrements : [Expérience 1](#), [Expérience 2](#), [Expérience 3](#) ; Matériel supplémentaire : [ici](#)).

### **4.2.2. Résultats**

Les résultats de chaque expérience sont reportés dans le Tableau 3. Les trois expériences révèlent un effet général d'aversion à l'approche. Afin d'asseoir la fiabilité de cet effet, nous avons conduit une analyse intégrative des données (Curran & Hussong, 2009) issues des trois expériences. L'ensemble des données a été soumis à une ANOVA 2 (mouvement : approche, statique)  $\times$  2 (menace: faible, élevée)  $\times$  3 (Expérience: 1, 2, 3) dans laquelle les deux premiers facteurs étaient manipulés en intra-participants et le dernier en inter-participants. Les résultats montrent un effet d'aversion à l'approche avec des évaluations plus négatives pour les individus approchants ( $M_{\text{Approche}} = 0.21$ ,  $ES_{\text{Approche}} = 0.04$ ) que pour ceux statiques ( $M_{\text{Statique}} =$



0.64,  $ES_{Statique} = 0.04$ ),  $F(1, 446) = 140.84, p < .0001, PRE = .24, 90\% CI [.19, .29]$ . Les résultats concernant l'hypothèse de la menace sont toutefois mitigés. Contrairement à ce attendu, l'effet d'aversion à l'approche est moins fort lorsque les individus virtuels froncent les sourcils que lorsqu'ils sourient (Expérience 1) et ne varie pas selon l'appartenance groupale des individus (Expérience 2). Par contre, en accord avec l'hypothèse de la menace, l'effet d'aversion à l'approche est moins fort lorsque les participants initient le mouvement des individus virtuels que lorsqu'ils le subissent (Expérience 3).

### Tableau 3

*Moyennes et erreurs standards des évaluations en fonction du mouvement et de la menace des individus virtuels.*

	Statique				Approche				Comparaison
	M		ES		M		ES		
<b>Expérience 1<sup>a</sup></b>	Froncement		Sourire		Froncement		Sourire		
	M	ES	M	ES	M	ES	M	ES	
	0.52		0.05		-0.08		0.08		$F(1,132) = 61.71, p < .0001, PRE = .32, 90\% CI [.21, .41]$
	-0.68	0.10	1.73	0.07	-1.11	0.11	0.96	0.10	$F(1,132) = 11.26, p = .001, PRE = .08, 90\% CI [.02, .16]$
<b>Expérience 2<sup>a</sup></b>	Exogroupe		Endogroupe		Exogroupe		Endogroupe		
	M	ES	M	ES	M	ES	M	ES	
	1.03		0.08		0.51		0.10		$F(1, 99) = 30.47, p < .0001, PRE = .24, 90\% CI [.12, .34]$
	0.90	0.10	1.16	0.09	0.41	0.10	0.61	0.11	$F(1,99) = 0.3, p = .59, PRE = .003, 90\% CI [.00, .04]$
<b>Expérience 3<sup>b</sup></b>	Agent: Autrui		Agent: Soi		Agent: Autrui		Agent: Soi		
	M	ES	M	ES	M	ES	M	ES	
	4.53		0.05		4.24		0.05		$F(1, 216) = 43.66, p < .0001, PRE = .17, 90\% CI [.10, .24]$
	4.58	0.06	4.49	0.06	4.16	0.06	4.32	0.06	$F(1,216) = 7.95, p = .005, PRE = .04, 90\% CI [.01, .08]$

<sup>a</sup> Echelle de -3 à +3

<sup>b</sup> Echelle de 1 à 7

### 4.3. Discussion

En répliquant l'effet d'aversion à l'approche dans une situation d'interaction sociale réaliste, nos résultats corroborent ceux de la littérature, obtenus dans des configurations moins écologiques et avec des stimuli plus décontextualisés (Hsee et al., 2014 ; Mühlberger et al., 2008). Cet effet d'aversion à l'approche est non négligeable car il explique en moyenne 24% de la variance des évaluations d'autrui. Du fait du réalisme et du caractère immersif de la RVI, une telle taille d'effet suggère qu'être approcher par autrui peut avoir des conséquences délétères au cours d'une interaction sociale. En testant l'idée que les individus approchants sont menaçants, nous pensons également montrer que l'effet d'aversion à l'approche pouvait être modéré par la nature menaçante des individus. Les résultats concernant cette hypothèse sont mitigés. En effet, seule l'Expérience 3 est en accord avec notre hypothèse en montrant que l'effet d'aversion à l'approche est moins fort lorsque le participant (vs. l'individu virtuel) initie

le mouvement. Par contre, contrairement à ce attendu, l'effet est plus fort lorsque les individus sourient que lorsqu'ils froncent les sourcils (Expérience 1) et ne dépend pas de l'appartenance groupale (Expérience 2). Il est possible que les expressions faciales manipulées avant et non pendant la réalisation du mouvement d'approche aient induit des états inverses à ceux attendus et que l'appartenance groupale que nous avons manipulée (caucasiens vs. maghrébins) n'est pas été la plus pertinente pour la population étudiante étudiée. D'autres recherches sont donc nécessaires afin de tester l'hypothèse de la menace différemment.

Ces résultats illustrent l'importance de considérer la situation d'interaction sociale dans son ensemble lorsqu'on étudie le comportement humain. En effet, si la littérature montre que le fait de réaliser des comportements d'approche (vs. d'évitement) améliore les évaluations d'autrui (Cacioppo et al., 1993 ; Kawakami et al., 2007 ; Woud et al., 2008), la présente recherche révèle que du point de vue d'autrui, celui qui réalise le comportement d'approche peut être négativement évalué. L'interaction sociale étant un processus dynamique, les conséquences négatives du comportement d'approche du côté de celui qui est approché pourraient donc mettre fin à toute intention d'interaction positive.

## **5. Discussion Générale**

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Dans cette thèse, j'ai proposé que les comportements interpersonnels d'approche-évitement contribuent de manière active à la manière dont les individus régulent leurs interactions sociales à travers leur influence évaluative. J'ai argumenté que si tel était le cas, ces comportements devaient 1) influencer les évaluations de manière à faciliter les comportements appropriés et intégrer toute modification dans la situation d'interaction afin de s'adapter de manière flexible à la demande changeante (Balci et al., 2009). Afin de pleinement rendre compte de la nature sensorimotrice et interactive de la cognition, j'ai capitalisé sur l'utilisation de la RVI dans l'opérationnalisation des comportements d'approche-évitement.

Dans le Chapitre 1, j'ai testé l'influence des comportements d'approche-évitement sur les évaluations au cours de l'interaction sociale. En lien avec la littérature, je faisais l'hypothèse que réaliser un comportement d'approche devrait mener à des évaluations d'autrui plus positives que faire un comportement d'évitement. Dans l'ensemble, les six études menées ne confirment pas les hypothèses. Dans le Chapitre 2, j'ai étendu le raisonnement aux évaluations intergroupes. Je faisais l'hypothèse que les comportements d'approche devraient mener à des

évaluations plus positives du groupe auquel appartenait les individus rencontrés que les comportements d'évitement. Les résultats des deux expériences réalisées ne soutiennent que partiellement cette hypothèse (Expérience 2). Enfin, dans le Chapitre 3, il s'agissait d'étudier la situation d'interaction du point de vue d'autrui. Plus précisément, je faisais l'hypothèse que du point de vue d'autrui, être approché (vs. non) est menaçant et peut mener à des évaluations plus négatives. Les résultats confirment cet effet d'aversion à l'approche et soulignent l'importance d'étudier le phénomène dans sa globalité si l'on souhaite comprendre comment les individus régulent leurs interactions sociales.

Dans l'ensemble, les résultats de ce travail de thèse offrent un faible support à la thèse selon laquelle les comportements d'approche-évitement contribuent de manière active au processus de régulation via leur influence évaluative. Cela soulève des questions : Pourquoi les comportements d'approche-évitement n'influencent pas les évaluations dans ces travaux alors que c'est le cas dans la littérature avec des configurations expérimentales minimalistes ? Faut-il conclure que les comportements d'approche-évitement ne contribuent pas activement au processus de régulation par leur influence évaluative ? Dans les sections suivantes, je discuterai de plusieurs pistes de réponses.

## **5.1. Limitations**

### **5.1.1. Réalité virtuelle mais expérience réelle**

Dans ce travail de thèse, j'ai capitalisé sur l'utilisation de la RVI afin de mieux considérer la nature sensorimotrice et interactive de la cognition dans l'étude des comportements d'approche-évitement. Toutefois, si la RVI permet d'offrir aux participants une expérience réaliste d'interaction sociale, elle peut avoir induit des états particuliers ayant interféré avec l'effet étudié. Tout d'abord, en RVI, les participants peuvent plus ou moins avoir l'impression d'être là, présents, dans l'environnement (i.e., sentiment de présence, Witmer & Singer, 1998). Ce sentiment de présence reflète l'intégration des aspects multisensoriels pertinents dans la situation présente (Carassa et al., 2005 ; Riva, 2009 ; Mennecke et al., 2011 ; Riva and Waterworth, 2014 ; Willans et al., 2015) et pourrait être une condition sine qua none pour que les comportements d'approche-évitement manipulés en RVI influencent les évaluations. Des patterns de résultats dans le Chapitre 1 vont dans ce sens mais n'ont pas été répliqués par la suite. Ensuite, les individus virtuels peuvent parfois créer un sentiment d'étrangeté du fait d'inconsistances dans le réalisme de leurs caractéristiques humaines

(MacDorman & Chattopadhyay, 2016 ; Mori, 1970). Bien que le graphisme des individus utilisés dans les expériences de ce travail de thèse ne semble pas suffisamment réaliste pour générer ce genre de sentiment, nous ne pouvons écarter cette hypothèse. Si tel est le cas, cela pourrait avoir gêné l'influence des comportements sur les évaluations.

### **5.1.2. Quid de l'état interne des individus ?**

Dans ce travail de thèse, j'ai envisagé la cognition comme ancrée dans les interactions individus-environnement. Toutefois, l'accent a été mis sur l'interaction physique entre l'individu et son environnement. L'état interne de l'individu (e.g. motivationnel, émotionnel) n'a pas été considéré. Par exemple, le besoin d'interactions sociale peut varier selon les individus et le contexte (Leary et al., 2013 ; Newman & Smith, 2016) ou se matérialiser sous différentes formes de motivations sociales (i.e., espoir d'affiliation ou peur du rejet ; Gable, 2006 ; Mehrabian, 1976). De même, selon l'état émotionnel de l'individu, le comportement d'approche ou d'évitement peut revêtir une signification précise et être associé à une expérience particulière (Barrett & Campos, 1987 ; Frijda & Parrott, 2011).

### **5.1.3. Une question de mesure ?**

Il est possible que l'absence de résultats probants dans le présent travail soit dû à un problème au niveau des mesures évaluatives. En effet, il se peut que dans le Chapitre 1 l'item utilisé n'ait pas été suffisamment sensible pour détecter l'effet des comportements sur les évaluations momentanées. Il se peut aussi que certaines des mesures évaluatives utilisées n'aient pas été suffisamment ancrées dans des situations sociales concrètes et réalistes (contrairement à l'induction). Enfin, contrairement au travail fait sur l'opérationnalisation, les mesures évaluatives utilisées dans cette thèse peuvent sembler peu écologiques. Les évaluations sont construites sur le moment au regard de ce qui est pertinent dans la situation actuelle (Schwarz, 2007). Le décalage entre la situation réaliste en RVI et celle décontextualisée au moment des mesures peut avoir empêché d'observer l'effet des comportements sur les évaluations. Il serait pertinent de recourir à des mesures plus écologiques en RVI comme l'orientation du regard ou du visage (Lahnakoski et al., 2020 ; McCall & Singer, 2015).

## **5.2. Les comportements ne contribuent pas en soi au processus de régulation par leur influence évaluative**

### **5.2.1. Artefact expérimental ?**

Du fait de la configuration expérimentale minimaliste et décontextualisée des travaux précédents, il est possible que l'influence évaluative de l'approche-évitement généralement observée soit due à un artefact expérimental. En effet, réaliser des mouvements du bras avec un joystick ou déplacer une silhouette sur un écran en réponse à des images ou des mots peut ne pas avoir de sens aux yeux des participants. Ces derniers chercheraient alors à en donner en utilisant par exemples les instructions de la tâche ou les labels de réponses (Van Dessel et al., 2016). Dans ce cas, les comportements d'approche-évitement ne contribueraient pas en soi à la régulation des interactions.

### **5.2.2. L'hypothèse de compatibilité**

Enfin, certains considèrent que l'influence évaluative observée dans la littérature à la suite de comportements d'approche-évitement seraient due à la compatibilité entre les comportements réalisés et la valence initiale du stimulus (Centerbar & Clore, 2006). Approcher du positif et éviter du négatif représenteraient des situations de compatibilité puisque le positif facilite l'approche et le négatif l'évitement. A l'inverse, approcher du négatif et éviter du positif seraient des situations d'incompatibilité. Selon l'hypothèse de compatibilité, toute situation compatible mènerait à des évaluations positives et toute situation incompatible à des évaluations négatives. A titre exploratoire nous avons inclus la valence a priori des individus (lorsque c'était possible) dans les analyses. Bien qu'à prendre avec précaution, les résultats ne vont pas dans le sens de l'hypothèse de compatibilité (voir [Appendice](#)).

### **5.3. Réintégrer autrui dans l'étude de l'interaction sociale**

Les travaux de cette thèse suggèrent que du point de vue d'autrui l'approche est menaçante : Les individus approchant sont évalués plus négativement que ceux restant sur place. Autrement dit, en considérant l'interaction sociale dans sa globalité, on s'aperçoit que les comportements d'approche pourraient paradoxalement avoir des conséquences négatives sur le déroulé de l'interaction (e.g., autrui pourrait prendre la fuite ou devenir agressif). Si les comportements d'approche-évitement contribuent de manière active à la régulation des interactions sociales, de telles conséquences négatives devraient pouvoir être prises en considération dans le processus pour permettre des réactions adaptées et satisfaire le besoin d'interactions. Il s'agirait maintenant de réintégrer autrui dans l'étude du phénomène en manipulant le comportement du participant et celui d'autrui.

### **5.4. Conclusion**

Pour conclure, cette thèse visait à mieux prendre en considération les implications d'une vision grounded de la cognition dans l'étude de l'influence évaluative des comportements d'approche-évitement (par rapport aux travaux précédents). Si les résultats sont mitigés, ils ouvrent la voie à de nouvelles pistes de recherche concernant cet effet. Ce travail de thèse représente un premier pas vers plus de considérations écologiques et épistémologiques dans l'étude des comportements d'approche-évitement et de la cognition sociale en général.



*scio me nihil scire*

*[Je ne sais qu'une chose, c'est que je ne sais rien.]*



Socrate, (469–399 BCE)