Feelings as direct information of our action capabilities

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Dedicatória

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Palavras-chave:
Sentimentos, Corporalização, Percepção, Capacidade de Ação, Julgamento, Affordance

Key words:
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Categorias de Classificação da tese

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RESUMO

A percepção destinada a guiar a ação é um processo ativo e contínuo em que os atores ressoam suas características corporais para medir constantemente as relevantes propriedades físicas do meio ambiente. Ao invés de serem guiadas por nossas crenças, nossas ações são guiadas por affordances. Ou seja, as oportunidades de ação que emergem do sistema ator-ambiente e que são limitadas pelas nossas capacidades de ação - os limites dinâmicos do nosso corpo que estão intrinsecamente relacionados aos estados morfológicos, fisiológicos e psicológicos do corpo. Aqui analisamos as evidências que demonstram que somos sensíveis e que acessamos informações sobre nossos limites de ação para antecipar ou realizar ações reais. Nosso objetivo é entender como os atores são informados sobre seus próprios limites de ação quando uma oportunidade de ação emerge. Por exemplo, como os atores que rastreiam visualmente uma bola a reduzir o tamanho são informados de que o tamanho da bola se encaixa (ou não) nas mãos quando estimando a agarrabilidade da bola?

Nesta tese abordamos diretamente a hipótese de que os sentimentos que surgem como parte de qualquer processo cognitivo são integrados como informações não-visuais sobre nossos limites de ação. Assumindo a perspectiva da incorporação (a integração da informação sensório-motora como moldando e integrando a cognição), combinamos dois quadros teóricos distintos e relevantes para investigar nossa hipótese: a teoria das affordances (Gibson, 1979) e a abordagem do sentimento-como-informação para o julgamento e tomada de decisão (Clore, 1992; Schwarz & Clore, 1983). A primeira teoria torna claro como as capacidades de ação estão intrínsecamente relacionadas à nossa percepção do entorno em termos de possibilidades de ação. A segunda abordagem mostra como sentimentos positivos e negativos informam o processamento em termos de custos e benefícios quando na interação com o contexto.

Em três artigos, testamos se os sentimentos informam nossas capacidades de ação. No primeiro artigo, examinamos se os casos anedóticos que sugerem a decisão dos atletas com base em sentimentos apresetam suporte fenomenológico. Em um estudo de campo que aplicou o método correlacional, encontramos evidências de que peritos jogadores de futsal se reconhecem como confiando em sentimentos em contraposição à experiência de pensamento deliberativo, principalmente em situações de jogo categorizadas por eles como imprevisíveis, complexas e dinâmicas. No segundo trabalho, iniciamos nossa série de investigações de laboratório, primeiro rastreando a atividade muscular do corrugador e do zigomático (índice de experiência afetiva negativa e positiva) numa configuração de capacidade de ação. Os resultados indicam que uma experiência de negatividade parece ser subjacente às estimativas baseadas em ações, uma vez que o músculo corrugador é ativado somente quando os atores precisam realizar acoplamento perceptual-motor para eventos dinâmicos, mas não quando eles apenas apreendem os mesmos eventos. Em adição, uma manipulação subliminar de primação afetiva indica que esse resultado não se deve apenas ao processo atencional. No terceiro artigo, replicamos a manipulação afetiva e, mais uma vez, descobrimos que ela promove mudanças confiáveis nos limites de ação percebidos pelos participantes. Isso ocorreu especialmente quando restringimos o tempo e os movimentos do corpo.

Juntos, esses achados sugerem que os sentimentos têm um papel nas estimativas baseadas em ações e em nossos limites de ação percebidos. Estes dados estendem a abordagem do sentimento-como-informação aos julgamentos que acoplam percepção-ação. Estudos futuros devem esclarecer melhor a natureza desse papel.

Palavras-Chave: *Sentimentos, Corporalização, Percepção, Capacidade de Ação, Julgamento, Affordance*

ABSTRACT

Perception intended to guide action is an active and ongoing process in which actors resonate their body features to constantly gauging relevant physical properties of the environment. Rather than by beliefs our actions are guide by affordances. That is, opportunities for action emerge from the actor-environment system and which are constrained by our action capabilities – the dynamic boundaries of our body that are intrinsically related to morphological, physiological, and psychological states. Here we review evidence demonstrating that we are sensitive and accede information regards our action boundaries to anticipate or perform real actions. Our aim is to understand how actors are informed about their own action boundaries when an affordance is made emergent. For instance, how actors visually tracking a shrinking ball are informed that the ball size fits its hands when estimating grasping?

We directly approach the hypothesis that feelings arising as part of any cognitive processes are integrating as non-visual information regards our action boundaries. Assuming an embodiment perspective (the integration of sensorimotor information as shaping and taking part on cognition) we approach our hypothesis by merging two distinct and relevant theoretical frameworks: the theory of affordances (Gibson, 1979) and the feeling-as-information approach for judgment and decision making (Clore, 1992; Schwarz & Clore, 1983). The first theory turns clear how action capabilities are intrinsic related to perception of surrounding in terms of action possibilities. The second shows how positive and negative feelings inform processing.

Across three papers we test if feelings inform our action capabilities. In the first paper, we examine if the anecdotal cases suggesting athletes' decision based on feelings had phenomenological support. In a field study applying correlational method we found evidence that expert futsal players indeed acknowledge themselves as relying on feelings in contraposition to deliberative thinking experience, mostly in game-situations categorized by them as unpredictable, complex and dynamic. In the second paper, we start our series of lab investigations, by first tracking the muscular activity of the corrugator and the zygomatic (respectively index of negative and positive affective experience) in action capabilities setting. Results indicate that a negativity experience seems underlying the action-based estimations, since the corrugator is activated only when actors need to perform perceptual-motor coupling to dynamic events and not when they merely apprehend the same events. In addition, a subliminal affective priming manipulation indicates that this is not merely due to attentional process. In the third paper, we replicated the affective priming manipulation and once more we found it promotes reliable changes in the perceived action boundaries of the participants. This occurring, especially when we constrained time and body movements.

Taken together these finding suggest that feelings have a role in action-based estimations and in our perceived action boundaries. This data extends the feeling-as-information approach to judgments coupling action-perception. Future studies should better clarify the nature of this role.#

Keywords: *Feelings, Embodiment, Perception, Action Capabilities, Judgment, Affordance*

SUMMARY

Feeling as Information for Action Capabilities

For many years cognition was enclosed by computer metaphor in which the brain was the richness process of mentally transformation of poor stimulus (e.g., Fodor and Pylyshyn, 1988; Chase & Simon, 1973) and feelings and actions the sub-product of this machine (Hurley, 2001).

Breaking with this hierarchic and disembodied view, cognition starting to be envisage as interdependent of the whole-body system and also the context (embodied and embedded), and reintegrates the affective and sensorimotor processes (e.g., Barsalou, 2008; Clark 1999; Gibson, 1979; Glenberg, 2010; Smith & Semin, 2004; Thompson and Varela, 2001; Wilson 2002).

The goal of the work here presented is to explore the idea that feelings that arising as part of the nature of any cognitive processes (memory, perception, sensorimotor activation) integrate the process by which we sense our action capabilities. Although the functional role of feelings has been widely investigating and demonstrate in judgments and decision making of attitudes and preferences (e.g., Clore, 1992; Schwarz & Clore, 2007, 2003, 1983), there is still a lack for investigate feelings as information to the perceptual-motor coupling involved in the affordances (Gibson, 1979; Zadra & Clore, 2011).

The general idea is that, the action-perception literature provides cues that the felt experience has an important role in the perceptual-motor fit. For example, evidence has shown that actors take in account their action capabilities when anticipate action or performing in online basis (Fajen, Diaz & Cramer, 2011). In addition, it has also been demonstrated that non-visual information seems to embody information when actors visually scaling the spatial layout (e.g., Proffitt, 2013, 2006), performing action-based estimations (e.g., Geuss, McCardell, & Stefanucci, 2016; Pijpers, Oudejans, Bakker, & Beek 2006), and decide to change their patterns of motor actions (e.g., Mark, 1997; Warren, 1984). However, none has investigated the direct role of the felt experiencing in these data. Specifically, whether feelings (while functional information of cost and beneficious of the system) underlying the perception and adjustment of our dynamic action boundaries when performing the actor-environment fit?

To answer this question, in this thesis I adopted the embodied perspective of cognition regards the action-perception coupling, and precisely the embodiment perspective of action capabilities. Therefore, at the Chapter I my aim is to elucidate that indeed our whole body as a role in shapes (or constraining) cognition. To this end, I review the literature around body-and-

action scaling mechanisms of the physical surrounding, and how changes on morphologic, physiologic and psychologic states of the body have a direct impact in our interaction with the environment in terms of functional actions.

Because my second assumption is that feelings likely to inform judgments and decision processes are also likely to inform action capabilities, next at the Chapter 2, I review the literature support by the feelings-as-information approach, in order to understand how feelings can also be information in action-perception processes.

At the Chapter 3 my aim is to create the bridge between the two previous and distinct frameworks reviewed in the Chapter 1 and Chapter 2, and provide support to theoretical hypothesis of bodily feelings embodied functional information regards our action capabilities. To this end, I review specific findings over the literature that corroborate to the role of feelings in our perceived action boundaries.

Finally, at the Chapter 4 my hypothesis is empirically adresses, and I provide the overview from the package of five studies presented through three papers and that in different ways approach my general question. Specifically, at the first paper we questioning if anecdotal cases underlying feelings as source of information regards the action decision of expert athletes has a phenomenological support? To this end, we set a field study to examining if athletes acknowledge themselves as rely on feelings when performing action choices in real game context. The second paper is supported by a lab study and aim to understand whether action capabilities can be informed by feelings? Two different perspective are applied to approach this question. First, the psychophysiological tracking of the electrical activity of two facial muscles that index subjective experiences of positivity and negativity while participants concomitantly perform action-based estimation. Second, by subliminally priming emotional faces with opposite valences (neutral, positive and negative) at the baseline of participants and examining whether it is possible to interfere with the perceptual-motor estimations grounded in the participants action boundaries. At the end, we present a third paper also applying the affective priming paradigm, and where we test whether and how induced feelings interfere with the estimation process.

Section I

Literature Review

Chapter I

Action capabilities and its calibration: theory, mechanism, and evidence

Puzzled about how air-force pilots were so accurate in landing their aircrafts, J.J. Gibson (1966; 1979) questioned the assumption that an accurate perception of the environment resulted from representations in the pilots' heads. Alternatively, he proposed that the environment offered reliable information, and postulated perception as a direct process sharing close relations with the environment. In addition, Gibson also proposed that action was guided by the detection of affordances- opportunities for action that match our action capabilities. Action capabilities entail properties associated with our body morphology and physiology, constraining our movements to fewer possibilities, and limiting the functionality of our motor interaction with the environment.

We start this chapter by reviewing some of the main assumptions behind Gibson's (1979) theory of affordances. Next, we examine evidence showing how actors rely on their dynamic boundaries as an intrinsic metric to scale size and distance. Following, we explore the mechanism of calibration and how it might support functional fits of the actor-environment system. We then conclude by presenting several reports showing that when changes of different levels happen in our body (i.e., morphologic, physiologic and psychologic) our action boundaries also change, directly impacting the perceptual-motor adjustment.

Affordances as the bidirectional properties of the actor-environment system

For many years, the dominant view of cognitive psychology sustained the hypothesis of indirect perception, assuming that to perceive meaningful information from the environment, a series of brain processes was needed (e.g., Fodor & Pylyshyn, 1988). Supported by psychophysics' concepts, the traditional approach presented a chain of serial processes initially triggered by the passive stimulation of the senses, followed by brain inferential processes to provide the actor meaningful and reliable information of the environment. In addition, the perception was understood as apart from the action. The two being linked by the activation of informational nodes that were stimulus-related to the perceptual information and the correspondent pre-programed ruled based orders (i.e., motor plan), responsible of sending the executive information to the muscles to generate the action response. So, according to this traditional framework the brain is understood as a potential biological hardware, and cognition

as the rich processes of mental computations, which has perception, and consequently action, has its byproduct (Hurley, 2001).

James Gibson (1979) assumed perception as a “psychosomatic act, not of the mind or of the body but of a living observe” (p. 240), and denied the brain the responsibility of mediating perception by simply assuming the environment offered information full of structure (i.e., meaning and value). For instance, he proposed that rather than separate snapshots (i.e., printed images on the retina) that were integrate by brain processes to produce movement perceptions, visual information was available in a continuum stream of apparent relations of the physical structure – the optical flow. These patterns could be perceived by simply detecting changes or invariances of the spatial-temporal relations (e.g., the displacement of two edges), with actors being a reference point embedded in the relational context and actively able to restructure their relation with the environment (Chemero, Klein & Cordeiro, 2003; Michaels & Carello, 1981).

Overall, the whole hypothesis was grounded by the assumption that organisms were endowed by evolution with a sophisticated perceptual system with active modes of overt attention and overlapped functions (i.e., more or less integrate and subordinated to other system levels). Unlike simple organs of reception, a perceptual system allows experiencing states of equilibrium and non-equilibrium, and can be used to support movement orientation (i.e., orient, extract, optimize and resonate a set of environmental features of the actor’s body), as well as, fast and dynamic interactions with the environment (Gibson, 1966; Turvey, Shaw, Reed & Mace, 1981).

Affordances as the ecological level of information. Although the conceptual level of information is important for language and communication, to guide action, the perception of abstract physical measures (e.g., meters and seconds) is not a functional standard unit of information. That is, a crawling baby can cross the gap of a door even before the concept of “door”, "width" and “distance” exist within the baby’s head (Gibson, 1988). Thus, Gibson (1979) proposed a more ecological level of information that should share law-full relations with the environment. He stated that although information is always available to be collected, it is only when taking in reference to the actor’s body that the value and meaning become available. This means that a ball by itself is only a set of physical combinations possible to be conceptually described in abstract units (e.g., mass and diameter). However, the ball becomes meaningful and functional when the actor with a member of apprehension, that is morphologic compatible in size and shape, interacts with the object to grasp or to throw it (Gibson, 1982; Mace, 1977).

Therefore, Gibson (1979) stated that what actors perceive in the environment to guide actions are not conceptual and abstract physical units, but rather affordances. That is the opportunities for action that emerge from the interaction between the actor and her/his surrounding when the physical properties of the world resonate the actor's features. Gibson describes affordances as what the environment "offers the animal, what it provides or furnishes, either for good or ill" (Gibson, 1979, p. 127), representing a higher order relation of the actor with her/his environment (Chemero, 2003; Stoffregen, 2003). So, an affordance is neither located in the environment nor in the actor's body, but rather is rooted in a relational principle of complementarity of the actor-environment system.

Fitting the body with the environment, and the environment with the body

Therefore, the affordance implies that "to see things is to see how to get about among them and what to do or not do with them" (Gibson, 1979, p.223). Due to that, affordances are rooted in a principle of bidirectionality that establishes a functional relation in terms of action categories – what is possible and impossible (Araújo, Davids, & Hristovski, 2006; Fajen, Riley, & Turvey, 2009; Franchak, & Adolph, 2014). However, to make use of the environmental information at a given moment and under a set of constraints, the actor needs to become sensitive to the properties of the environment that fits the body system. Thus, throughout the literature, it has been suggested that actors need to relativize environmental dimensions to some intrinsic metric that resonate the complementarity relation supported by affordances (Carello, Grosofsky, Reichel, Solomon, & Turvey, 1989; Gibson, 1979; Shaw, Turvey & Mace, 1982; Stoffregen, 2003). In this sense, affordances reduce what could be an infinite number of options two only a few; the ones that fit the actors' body.

The body as a dynamic ruler. An important fact underlying the detection of a possible or impossible action is the role the body plays in shaping affordance detection. Affordances are not the ultimate result of deliberative processes, and not even boundaries of action are imposed (or made up) by the actor's will. Instead, opportunities for action emerge during the constant activity of matching our body features with the properties offered by the surrounding. This entails a continuous process of learning about and development of our body, and also of ways to coordinate the body with the target situations (Gibson, 2002).

Thus, a large body of evidence has demonstrated that actors rely on their own body to action-scaling the physical surrounding in terms of affordances (e.g., Carello et al., 1989; Fajen

2007a, 2005a; Franchak & Adolph, 2014; Ishak, Adolph, & Lin, 2008; Mark, 1987; Pepping & Li, 2000; Stefanucci & Geuss, 2009; Warren, 1984). Early studies, focused on the body morphology of animals and its action decisions (e.g., Ingle & Cook, 1977), inspired the pioneering work of Warren (1984). Warren (1984) demonstrated that a relational ratio of the actor-environment system could constrain the perceived climb-ability of actors. Using two groups of participants (taller vs. smaller), that performed the same action estimation (climbable or not-climbable), Warren found a higher estimation of climbable in the group of taller participants. Interestingly, by adopting a dimensionless ratio (i.e., the ratio between riser height and leg length) that normalized the participants' height, he demonstrated that participants of both groups used similar ratios constraining their perceived climb-ability. This lead to the conclusion that participants took into account their leg length to estimate their perceived climb-ability, favoring the assumption that a relativized metric is used to measure the environment.

This initial body-scaling evidence was replicated by studies manipulating different body relations, like the influence of eye-height in the perception of maximum climb-ability, sit-ability or pass-ability of apertures (Warren & Whang, 1987; Mark, 1987). Other reports have also shown that actors rely on their leg-length to perceive the jump-ability of barriers (van der Meer, 1997) and arms-length to anticipate the maximum perceived reach-ability of targets (Carelo et al., 1989; Rochat & Wraga, 1997).

Although when taken together the findings of body scaling mechanism indicate that biomechanical properties of the actor' s body are important constraints that influence the detection of affordances, this does not mean they are the unique body properties implied in this process. Stoffregen (2003) advices that "any property of an animal can bear a relation to some property of the environment that gives rise to an affordance" (p.125). So, to guide action in real time other sources of information need to be taking into account, as for example the dynamic properties of an actor's system (Fajen & Turvey, 2003; Fajen, 2013, 2007a).

Through a series of studies using a simulated braking task, Fajen (2005a, 2005b) demonstrated that participants controlled their actions within a safety margin that took into account their maximum capacity of deceleration. Thus, when the brake was manipulated to a middle-to-weak level of resistance participants initiated deceleration later, whereas when the brake was manipulated to a middle-to-strong level of resistance participants initiated deceleration early. Similar evidence was found in more ecological paradigms. For instance, researchers investigated the perceptual-motor performance of goalkeepers in penalty-kick situations and demonstrated that goalkeepers action-scaled their timing dive (i.e., fasters

goalkeepers took longer to initiate their diving in comparison to their slower counterparts) (Dicks, Davis & Button, 2010).

In short, these findings report that to decide between crossing or not-crossing the closing gap of a slid-door, the actors rely on information about how fast and large their bodies are relative to the spatial-temporal information offered by the door space. If the actor is quick and thin enough, it is likely that the closing gap will afford to cross in safety. If the actors are not so quick and thin enough, it is likely that the same gap will afford to cross as unsafe. Due to that, theis evidence suggest that action capabilities define the boundaries between a possible and an impossible action (Fajen, 2007a; Oudejans, Michaels, Bakker & Dolné, 1996; Pepping & Li, 2000), and raise an important focus on the accurate sensitiveness of these boundaries.

Calibration and the proper adjustment of an actor's body to the environment

Coupled with the detection of affordances, a growing body of literature has investigated the perceptual-motor adjustment that underlies an accurate fit of the actor-environment system (e.g., for a recent review see van Ander, Colen, & Pepping, 2017). That is, action capabilities entail a critical constraint of the actor's body when detecting affordances, but calibration it is what makes possible that actors "perceive the world in intrinsic units even after changes in body dimensions and action capabilities" (Fajen et al., 2009, p.97).

Calibration has been claimed as a mechanism that allows actors to detect what they can do in reliable ways, whereas miscalibration has been claimed as a mechanism that signals to the actor that an inappropriate action was scaled (resulting in underestimation or overestimation of the perceived action capabilities) (Fajen, 2007b; Fajen & Turvey, 2003). Hence, to guide successful interactions with the environment, actors need to be able to re-adapt fast and be accurate about the changes in their dynamic boundaries. The importance of this mechanism can be exemplified with the nonfunctional fit (i.e., overestimation of action) that increases the risk of falls in elderly adults (Luyat, Domino, Noel, 2008). Due to that, when some feature of the actor's body changes, the probability of an action (becoming possible or impossible) can also change, and consequently, the accuracy of the perceived fit of the actor's body with the environment can oscillate. Fluctuations in the dynamic boundaries of the body happen due to different process, as aging (Konczak, Meeuwsen & Cress, 1992; Withagen & Caljouw, 2011), addition of implements as prosthesis (Ishak, et al., 2008), mental illness (Keizer, et al., 2013) or pregnancy (Franchak & Adolph, 2014). Having this in mind, researchers have manipulated

body changes and investigated how fast these manipulations are embodied and recalibrated as new information that actors rely on to anticipate or perform an action.

Calibration due to morphological changes. Under the perceptual-motor literature, a large body of evidence has demonstrated that body morphology is integrated into the perception of affordances and that actors body-scale the surrounding to estimate whether an action is possible or not. Thus, Mark (1987) investigated the influence of morphological changes at action-perception by adding a 10cm block to the participant's feet. He found that participants fast recalibrated and embodied the block height to scale the perceived maximum sitting and climbing ability. Ishak and collaborators (Ishak et al., 2008) investigated the perceive affordance for fitting an hand through different apertures sizes and found that participants scaled motor decisions based on their own hand size. They also found that participants fast recalibrated their motor decisions when wearing a hand-enlarging prosthesis. Indeed, it had already been demonstrated (Witt, Proffitt, & Epstein, 2005) that when actors hold a tool that expand their maximum reaching, this information is fast recalibrated to classify objects that were previously unreachable as reachable. Another example is provided by Higuchi and colleagues (Higuchi, Cinelli, Greig, & Patla, 2006). The authors analyzed the kinematic variables of participants when passing through three different sizes of aperture, under "normal walking" or "walking carrying a horizontal bar". Results showed that when participants were prevented to rotate their shoulders (due to carrying a horizontal bar), the smaller the aperture the slower the participants' speed, the larger the number of errors (i.e., stop moving and door collision), and the greater care participants took to accurately position their bodies in the center of the aperture.

The robustness of these experimental findings is corroborated by evidence grounded in natural and virtual changes in body size. Studying real body changes, Franchak and Adolph (2014) investigated the "gut estimates" of pregnant women when squeezing through different doorways apertures. They found that in line with increases in body size, previously passable doorways switched to the opposite category (without lost accuracy). In a set of studies manipulating body changes through an immersive virtual-environment, researchers increased and decreased participants' own hand size. They found that when participants experienced big hands the objects within hand reach looked smaller than when they experienced the smaller or standard size hands (Linkenauger, Leyrer, Bülthoff, & Mohler, 2013). It was also demonstrated that when the standard size of the body was virtually manipulated to smaller and larger virtual

bodies, estimations of affordance (i.e., an indirect measure) and body size (i.e., a direct measure) also changed accordingly (Piryankova et al., 2014).

Calibration due to energetical changes. Warren (1984) was the first to demonstrated that energetic costs could determine a space of "best fit" of the organism-environment system, such that affordances could be defined as the preferred regions of minimum energy expenditure (i.e., an optimal window). Thus, Konczak and collaborators (Konczak, et al., 1992) investigated the perceived climb-ability of younger and older adults and demonstrated that the older group operated within a smaller range of action capabilities relatively to wider action range of the younger group. Their analysis reported a trend for young adults overestimating their own action boundaries and indicated that older and younger could rely on information coming from different parts of the body when perceiving their maximum climb-ability.

Another interesting series of studies investigated the effects of energetic costs on the perceived geographic slant (i.e., specified in relation to a fixed environment frame) and demonstrated that fatigue could lead people to consciously estimate hills as steeper than reality (for a review see Proffitt, 2006). In a first study that integrated visual judgment of out-of-door and virtual geographic slants, Proffitt and collaborators (Proffitt, Bhalla, Gossweiler, & Midgett, 1995) demonstrated a higher tendency for participants to overestimate hills when providing verbal assessment and visual measures, from the top of the hill and under fatigue. In a second study, Bhalla and Proffitt (1999) tested the relation between energetic cost and the adaptability of the visual-motor system by manipulating the physical conditions of participants (i.e., when wearing a heavy extra load, tired, with low fitness, elderly or in declining health). Results indicated that energetic costs have a direct impact on the conscious perception of slant degrees, leading participants to overestimate the perceived hills. Finally, in two recent studies, the fatigue states of participants were direct manipulated with the ingestion of glucose (Schnall, Zadra, & Proffitt, 2010) and carbohydrate (Zadra, Weltman & Proffitt, 2016). Results revealed that higher concentrations of glucose lead participants to estimate hills as less steep, as well as higher concentrations of carbohydrate, leads participants to estimate distances closer.

Calibration to emotional changes. Regarding the influence of emotions in the perceptual system, findings have demonstrated that elicited states of emotions, categorized as higher on activation as fear and anxiety, are able to disturb visual accuracy and increase variability in the perceived fit. For instance, Bootsma and co-workers (Bootsma, Bakker, van Snippenberg, & Tdlohreg, 1992) investigated the effects of elicited states of anxiety in the detection of affordances. Reports demonstrated that although anxiety was not able to change

the nature of the affordance, elicited anxiety increased the variability of perceived action capabilities of participants, leading the authors to suggest a detriment of the accuracy of the perceived fit. Importantly, other researchers demonstrated that elicited anxiety not only affects the estimation of action but also the patterns of the action itself. Pijper et al. (2006) found that elicited anxiety states reduced the maximal reaching of climber not only when anticipating action but also when performing real climbing. The effects of elicited anxiety in visual scaling were replicated in a paradigm that induced anxiety immediately prior to the perceptual task and found a tendency for underestimation of different action capabilities (Graydon, Linkenauger, Teachman, & Proffit, 2012).

In what concerns the effects of fear in the visual scaling mechanism, results have been similar to the findings investigating the effect of anxiety. For example, studies relating fear and altitude demonstrated a tendency for overestimating height when fear is elicited (Stefanucci & Proffitt, 2009). This overestimation of perceived vertical heights happens, not only in association with acrophobia (i.e., fear of height), but also when participants on the top of a balcony are asked to imagine themselves falling (Clerkin, Cody, Stefanucci, Proffitt, & Teachman, 2009). Additionally, this effect can be extended to the estimation of horizontal distances (Stefanucci, Gagnon, Tompkins, & Bullock, 2012). Finally, within a virtual environment, researchers found that elicited states of fear associated with an overestimation of the width of gaps, as well as with a shift on motor-behavior (i.e., change from stepped over fewer gaps to stepped farther over the gap widths) (Geuss, et al., 2016). So, as reported for the effects of anxiety, elicit states of fear is also able to change action estimation or action itself.

Calibration due to mental changes. In what concerns the effects of mental states and the perceptual-motor adjustment, we report bellow studies investigating illness associated with body size, as anorexia. In a first study researchers found that relative to the control group, anorexic patients not only perceived themselves as not fitting-through on wide enough apertures but also demonstrated higher relational ratios between shoulder and aperture width. A clear indication that anorexic patients experience their body as larger than reality (Guardia, et al., 2010). In a second study, researchers investigated whether the disturbing experience of body size was associated to the conscious perceptual level (i.e., body image) or if it was associated to the unconscious level of action-related representation (i.e., body schema). Without the patients and the control group being aware, researchers recorded the action of walking through door-like openings that changed in width and subsequently analyzed kinematic variables. Results demonstrated that while control groups started rotating their shoulders for apertures

25% wider than their shoulders, anorexic patients started rotating their shoulders for apertures 40% wider than their shoulders (Keizer, et al., 2013). Finally, in a study investigating the effects of obesity and perceived distance, Sugovic and collaborators (Sugovic, Turk, & Witt, 2016) investigated whether action-specific effects were due to the unique contributions of beliefs about body size versus physical characteristics of body size. By comparing distance estimation of participants targeted as normal-weight, overweight and obese, results revealed a tendency for heavier participants to estimate distances as farther. This tendency was not related to participants' beliefs about their body size.

Taken together these results show that people are very sensitive to their dynamic boundaries and rely on action capabilities to scale spatial-temporal relations that guide their actions. Moreover, these findings also indicate that calibration is a mechanism that can be sensitive to changes of morphologic, physiologic and psychologic states of the body.

Despite the robustness of this evidence, several questions regarding the mechanism of our dynamic action boundaries remain unanswered. For instance, there is still a lack of understanding about (1) the nature of the information that underlies action capabilities and (2) how fast actors recalibrate new information about their action boundaries to keep accurate relations with the surrounding. Another piece missing falls on the sensitiveness experience of our dynamic boundaries, and how actors "know" and integrate it when anticipating or performing actions.

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Throughout this first chapter, we define our position in accordance with Gibson's (1979) assumptions of (1) perception as a dynamic act of living observers and (2) action guided by the detection of affordances. We also show robust evidence that actors rely on their body to scale the environment in categories going from possible to impossible actions and to detect affordances the opportunities for actions that entailing a reciprocity principle of the actor-environment system.

In this process, the dynamic boundaries of action are an important constraint, given that action capabilities limit what could be an infinite number of possibilities of action to only the ones that fit the body system. Also, to a functional and adaptive fit of the properties of the actor and the properties of the environment, two main assumptions are needed: (1) the sensibility of

the actor to the properties of the environment that suits her/his needs, and (2) the accurate calibration of the body to these properties. Therefore, an accurate calibration allows a good rescaling of the physical properties (i.e., size and distance) in functional units, whereas miscalibration leads to errors of underestimation and overestimation.

Data have indicated that changes in different levels of the body system – the morphologic, physiologic, and psychologic- are able to affect both the boundaries of action and the calibration of action. Specifically, the evidence indicates that morphologic changes (e.g., body size) can be rescaled as new information and be (relatively fast) integrated into the perceived action boundaries. This evidences have been found, for instance, when asking actors to estimate/anticipate their own action. In turn, changes at the physiologic (e.g., fatigue) and psychologic levels (e.g., anxiety and anorexia) seem to induce actors to miscalibrate the perceived spatial layout. Importantly, none of this evidence is restricted to conscious judgments, given that changes in the patterns of movement have also been shown.

Because of the involvement of different systems of the body and the dynamic features involved in the sensibility of action boundaries, the theories and data reviewed in this chapter lead us to hypothesized that sensorial levels – as feelings that agglutinate a myriad of bodily process- could be integrated as information from the experience of our action capabilities. In addition, data also suggest a clear connection of body-mind-environment, which is a fundamental claim of embodiment theories. These two topics are reviewed in the next chapter.

Chapter II

Feelings as information

The idea of visceral and physiologic changes feeding cognitive processes has been commonly pointed as a sophisticated upgrade to William James' (1894). Nowadays, this brain-body connection has been investigated as an important source of information that supports judgment and action, with different research lines (ranging from the neurobiological, physiological and psychological levels) indicating that feelings index positive and negative information (e.g., Cabanac, 2002; Clore 1992; Damásio, 1999; Garcia-Marques & Mackie, 2001; Larsen, Norris, & Cacioppo, 2003; Panksepp, 2011; Schwarz, 2012; Zadra & Clore, 2011). It has been suggested that some kind of law of affect constrains animals' behavior given that "animals do seek brain/mind affective comfort zones and avoid discomforts (Panksepp, 2010a, p. 51).

These findings are especially relevant for this thesis, which hypothesizes an informational link of feelings as modulating the dynamic boundaries of our body (action capabilities). Therefore, we begin this first chapter reviewing neurobiological findings that suggest an informational role of feelings. Next, we examine the experiential level of non-emotional feelings, and how it has been studied as an information route to judgment and decision making. To this end, we first distinguish emotional from non-emotional feelings, to subsequently approach the interplay of feelings and cognition. Specifically, we focus our review on findings showing that people rely on their subjective experience of "comfort vs discomfort" as a fast and direct route of information to judgment and decision making. We conclude this chapter by approaching feelings within an embodiment perspective.

Feelings at its roots

From its primal manifestation, the valence nature of feelings has its causality associated with changes in physiological aspects of the body-mind and it is related to survival, life regulation and the experience of sentience (e.g., Craig 2010; Damásio, 2003; Gu, Hof, Friston, & Fan, 2013; Panksepp, 2011). Under the scope of neurobiological research, feelings have been associated to brain sub-neocortical regions with the assumption that these brain regions are able to produce affective mentality on their own (Panksepp 2011, 2003). Researchers have also investigated the support of all subjective experiences, under the assumption that some brain

regions allocate a mapping of visceral states of body, (e.g., Craig, 2003, Damásio, 1999; Damásio et al., 2000; Polattos, Gramann, Schandry, 2007).

For instance, studies focused on interoception (i.e., the faculty to sense the physiologic state of our body; Cameron, 2001; Craig, 2002) have reported that primary interoceptive representation of the physiological state of the body seems to be strongly correlated with activation of the insular cortex (e.g., Craig, 2011, 2009; Singer, Critchley, & Preuschoff, 2009). Important to our goals, interoception has also been associated with body-ownership, specifically, the insular cortex activation has been correlated with body awareness and control of direct effort. For instance, Craig (2009) refers that "the insular cortex contains a somatotopic representation of the subjective feelings of one's current movements as part of a representation of all feelings from the body" (p.60). In this sense, evidence have demonstrated the plausibility of an immediate connection of the insular cortex with exercise (e.g., Williamson, McColl, & Mathews, 2003) and the voluntary control of hand movements (e.g., Brass & Haggard, 2007; Farrer et al., 2003; Tsakiris, Hesse, Haggard, & Fink, 2007). Finally, findings have also supported the emergence of theoretical models suggesting a multimodal integration of interoception and exteroception at the roots of body movement awareness (e.g., Suzuki, Garfinkel, Critchleym & Seth, 2013).

Overall, the primal feelings identified on the neurobiological level sustain the valenced phenomenal experience of emotions and emotional learning (Barrett, Mesquita, Ochsner & Gross, 2007; Pankseep, 2011). A growing body of theoretical proponents have indicated that the affective power of primary sensory can be cognitively re-symbolized to support social constructions (e.g., Barrett, 2006; Damásio & Carvalho, 2013; Pankseep, 2011; Seth, 2013). That is, the body experience, triggered by the visceral and homeostatic changes, constitutes raw information for cognitive processes as memory and learning because the primal bodily information is redirected to social demands. For instance, the felt experience of nausea understood as a bio-evolutionary answer of the body is a somatosensory experience that gives support to the emotional experience of disgust. It can also be conceptually used to guide communication (e.g., That place is dirty!) or leading to a preferable pattern of action (e.g., I jump the garbage on the floor).

Although the focus of this thesis is not to demonstrate the mechanism but rather to focus the experiential level of feelings, we speculate that a similar process might underly the experience of our perceived action boundaries and their adjustment to the properties of the environment. For instance, several sensory receptors located at neuromuscular structures (e.g.,

the Golgi tendon organ and the muscle spindle) feed the central nervous system with information about the level of tension and stretching of the muscle (e.g., Fortier & Bassett, 2012). Also, the high concentration of acid lactic in the blood, which is related to the maximum oxygen uptake (e.g., Bassett & Howley, 2000), might be at the roots of our subjective experience of (dis)comfort (see Mark et al., 1997; and Warren, 1984).

The felt experience matters

Although the mechanisms underlying subjective experiences have been studied, describing how feelings originate is not enough, because it “does not substitute for a description of what is felt” (Barrett et al., 2007, p.373). At a psychological level of analysis, feelings can be a non-inferential route of bodily information that signals the advantageous or disadvantageous nature of mental processing and behavior. Therefore, in a broad sense, all mind-body phenomena that sustain our subjective experiences can be captured by the ancient definition of the Latin word *affectus*: a state of body, and especially of mind produced in one by some influence (Lewis & Short, 1879). However, within the scope of the felt experience, different categories and levels of information can be found due to the combination of brain level activation (i.e., conscious, pre-conscious and unconscious) and the spatial-temporal constraints. In this sense, pain and hungry can be categorized as different of sad and happy, although for both the informative roots are anchored in a scale of comfort and discomfort regarding survival and life regulation.

At the level of psychologic experience the literature (see Clore, 1982; Clore, Gasper, & Garvin, 2001) allows us to identify at least two distinct classes of experiential feelings: i) those that are associated with constructive processes that encompass higher brain levels of activity (as the tertiary process of language, categorization and inference) and that have been defined as emotions (e.g., Barrett, 2006; Lindquist, Wager, Kober, Bliss-Moreau, & Barret, 2012; Scherer, 2009a; Damásio, 1999); ii) and those that do not reach the higher levels of processing associated with emotions and so might happen without our full awareness (e.g.,mood, intuitions and other sensorimotor changes). In this sense, Damásio (1999) adverts to the puzzled distinction of “having a feeling” and “knowing that we have a feeling”, and argues that feelings encompass an online biological process in which be fully aware of all the stages and mechanism would be counterproductive to the biological system. Damásio refers to “state-of-feeling” to describes the second step of a continuum of feelings that are unconsciously represented, and that ends when the state of feeling is made conscious (i.e., reaches the emotional level of experience).

This definition considers that emotion encompasses the last phase of a cognitive process of neurophysiologic experience.

Due to that, some researchers have proposed the existence of core feelings that"incoming sensory information from the external environment with homeostatic and interoceptive information from the body" (Barrett & Bliss-Moreau, 2009, p.04). It means that feelings that do not reach language and categorization are able to work as a barometer that informs us about our interaction with the environment. Specifically, it has been suggested that fluctuations at the level of core-affect are able to charge any emotional episode as well as free-floating and assuming the same attributes of mood (Russel, 2003; 2009). Hence, in its mild manifestation, the core-affect corresponds to a diffuse and neutral subjective experience. However, because of its dynamic properties (i.e., time-sliced) during environment interactions the neutral state can quickly change and range from positive-to-negative and from lethargic-to-energized (Barrett, 2006; Russel & Barrett, 1999).

In this sense, emotional and non-emotional feelings can be both a structure in models that suggest at least a hedonic dimension (i.e., pleasure or displeasure), plus a dimension of intensity or activation (i.e., arousal) (e.g., Cabanac, 2002; Russel, 1980). However, there is strong controversy if the valence dimension is bipolar, with the increasing of one preventing the other (e.g., Barrett & Russel, 1999; Russel, 1980), or if the valence dimension is bivalent and positive and negative can be co-activate because they are independent (e.g., Cacioppo, Berntson, Norris, & Gollan, 2012; Cacioppo, Gardner, & Berntson, 1999). In this sense, it is also possible that positivity and negativity are implemented dynamically in a general valence space (i.e., brain state rather than the ubiquitous relation between positivity and negativity) (see Lindquist, Satpute, Wager, Weber, & Barrett, 2016). Despite that, at the level of the felt experience and behavioral evidence the affective episodes can be represented in a bi-dimensional semantic space (valence-arousal), in which angry states are categorized as a negative and with high arousal, and sad states are categorized as negative and low in arousal (Barrett & Bliss-Moreau, 2009; Russel, 1980; Lang & Bradley, 2007).

Thus, Ekman (1999) and Plutchik (2001) have suggested that evolutionary roots shape our cognitive system with a set of defined patterns that include physiologic and mental responses. These basic emotions integrate a very complex mechanism of survival and play a preeminent role at the level of cognition and goal-direct behavior, being triggered to support daily life-tasks and action tendency (see, for example, Fridja, Kuipers, & ter Schure, 1989).

Unlike the assumption of discrete emotions as entities, Barrett (2006) and Scherer (2009a, 2009b) has proposed a more dynamic approach in which emotions are tailored for the immediate and emerge from a dynamic process. Thus, for Barrett and collaborators (Barrett, Ochsner, & Gross, 2007; see also Lindquist et al., 2012) emotions encompass a conscious experience that emerges only when the actor adds meaning to the sensory input from the body and the stimulus from the world (i.e., previous knowledge and the current sensorimotor experiences combine and constrain each other). In the same line, Scherer (2009a) considers emotional episodes to be anchored by five subsystems (i.e., cognitive, neurophysiological, subjective feelings, action-tendencies and motor expression) that feed cognitive process that is constantly re-feed and re-checked, linking brain information with the bodily state. Thus, emotions are categorized as the portion of the processes that reach the conscious level of categorization, with the mechanism anchored on the automatic, dynamic, unconscious and effortless process (i.e., rather than hard computations).

In what concerns the subjective experiences associated with non-emotional feelings, the body of evidence does not allow a clear categorization, because the experiences can be anchored under different perspectives. Thus, described as a non-emotional feeling that is always running in our background with low intensity, mood is a general subjective experience that conveys generic information of positivity and negativity valence (i.e., that attracts or repels our goal-motivation) that lacks a clear referent (Clore, 1992; Garcia-Marques, 2001; Schwarz & Clore, 2007). The mood may or may not be appraisal-based (Clore et al., 2001).

Other subjective experiences associated with non-emotional feelings are those linked with the nature of our mental operations, as the feelings-of-familiarity (e.g, Garcia-Marques & Mackie, 2001) and fluency (e.g., Winkielman, Schwarz, Fazendeiro, & Reber, 2003). Both of these feelings are associated with a specific valence that sustains an experience of pleasure, positivity, and easiness (Garcia-Marques, Mackie, Claypool, & Garcia-Marques, 2004; Harmon-Jones & Allen, 2001; Winkelmand & Caccioppo, 2001). Thus, feelings-of-familiarity are rooted in memory process and can be used as information when re-encountering a similar stimulus or event (Garcia-Marques, Prada, & Mackie, 2016; Garcia-Marques et al., 2004). Specifically, when familiarity arises the feeler feels good because there is a match between the actual context conditions and the knowledge acquired and stored in previous experience, signaling the actor to “keep going with the flow”. Feelings-of-fluency can be due not only to memory processes but also to other instances, such as the effort to perceive contextual stimulus or task (Alter & Oppenheimer, 2009; Reber, Schwarz, & Wilkman, 2004). Carver and Scheier

(1990) proposed that fluency indicates that everything is flowing to a positive outcome and so no additional effort is needed. Thus, the subjective experience of fluency is associated to the easiness of processing and low levels of effort, with disfluency signaling exactly the opposite feeling (e.g., Alter, Oppenheirmer, Epley, & Eyre, 2007; Topolinski & Strack, 2015).

Recent evidence also suggests that subjective experiences rooted in non-emotional feelings (positivity, negativity) are rooted not only at the level of a central system but also integrate sensorimotor information. For instance, Regenberg and collaborators (Regenberg, Häfner, & Semin, 2012) found that participants experienced grasp-ability more fluently (i.e., easier and fast) when there was congruence between the anatomical position of their hands and the target object. Overall, studies integrating motor response and cognitive processes under a stimulus-response paradigm have indicated a trend for fast responses when there is a match between the properties of the body and the object (i.e., sensitivity to affordance detection) (e.g., Constantini, Ambrosini, Tieri, Sinigaglia, & Committeri, 2010; Tucker & Ellis, 2001; 1998).

In this sense, Massumi (2002) visualizes feelings as being the body own grammar, happening beyond language and preparing the body for action prior to and/or outside consciousness. Thus, feelings signal the "suspension of the invariance that makes happy happy, sad sad, function function, and meaning mean" (pg. 27).

To capture these informational experiences happening beyond language, researchers have used paradigms involving physiological levels, action tendency, and motor expression. Studies associating the subjective experience of positivity and negativity to the electromyography activity of facial muscles (e.g., Dimberg, & Thunberg, 1998; Dimberg, Thumberg, & Grunedal, 2002) have reported that when participants are exposed (either at the supraliminal and subliminal levels) to pleasant stimuli (e.g., the picture of a flower or a happy face) a mild level of activation at the zygomaticus major (i.e., the muscle that pushes up lip corners to create a smile) is detected. In turn, when participants are exposed to unpleasant stimuli (e.g., snakes and a sad face) a mild level of activation at the corrugator supercilious (i.e., the muscle that knits the eyebrows to form a frown) is detected. A meta-analysis indicated that blood pressure, heart rate, and skin conductance were other reliable bodily correlates to discriminate subjective experiences charged with positivity and negativity (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000). For instance, Gomez and collaborators (Gomez, Stabel, & Danuser, 2004) tracked values of skin conductance, heart rate, breathing and also reports of affective judgments from participants who watched pictures with different levels of valence and arousal. Results revealed the association of higher levels of pleasantness with

lengthened inspiratory time, and of higher levels of arousal with a higher electrodermal activity and a short and accelerated breathing cycle.

The interplay of feelings and cognition

The assumption of a prominent role of feelings in human behavior rejects the idea of feelings as a merely residual phenomenon of a brain machine. In alternative, feelings have been investigated not only under the idea that they dictate the direction of cognitive processes (as claimed by dual systems theories; see Stanovich, West & Toplak, 2011), but rather that they constitute an integral part of information processing by regulating and/or modifying cognitive processes (Storbeck & Clore 2007).

Advances in neuroscience research have demonstrated to be hard to find the physical boundaries that separate the cognitive from the affective systems (e.g., Okon-Singer, Hendler, Pessoa, & Shackman, 2015; Pessoa, 2008). Overall, these data favor a dynamic and integrated web of connections and re-connections with the same brain regions actively involved in several behaviors. However, decades before the advent of neurological findings, psychologists had already indicated a possible interplay between feelings and cognition (e.g., Duncan & Barrett, 2007; Garcia-Marques, 2013; Inzlicht, Bartholow, & Hirsh, 2015; Pourtois, Notebaert, & Verguts, 2012; Storbeck & Clore, 2007). For instance, Bower (1981) showed that feelings support memory organization and activation by proposing the facilitation of memory processes under situations of congruency between the mood-state and the hedonic value of the assimilated content. In turn, Zajonc (2000; 1980) proposed that feelings and cognition were grounded in separate systems, with feelings having a temporal primacy over basic cognitive process as reason-based assessment (Pham, Cohen, Pracejus, & Hugues, 2001).

Feeling-as-information approach. Suggesting a different perspective Clore (1992; Clore et al., 2001) and also Schwarz (2012; 1990) have focused on the informative function of feelings as a direct route of evaluation, rather than effortful and analytical strategies. Thus, rather than facilitate the recall of material that matches the valence of our affective state (Bower, 1981; Forgas, 2000), the initial assumption of the affective hypothesis suggested that actors inspect their own sensory experiences, triggered by the target-object, by implicitly asking “How do I feel about it?” (Schwarz & Clore, 2007, 2003, 1983). This means that feelings are informative of the own nature and not because of a biased effect due to memory processes, or a belief coming from an attributional process. Indeed, one of the fundamental claims of this

affective approach is that people rely on their bodily feelings as an immediate route of fast information about their interaction with the situational context. For instance, we do not think "Sara is a beautiful dog" because of its color, body shape, nose, tail and other attributes, we instantly feel the beauty when visually seeing the dog and, so we use the attributes to describe it (Clore et al., 2001).

Overall, the idea behind the found evidence is that people always have incidental feelings rolling in their organism (i.e., without any relation to the current situation). Thus, because it is hard to detect the primary source of feelings, when new feelings are elicited at the current situation (integral feelings) people can misattribute the feelings triggered by the experiment as being from the target-object (Schwarz, 2012; Schwarz & Clore, 2007). According to Cohen and collaborators (Cohen, Pham, & Andrade, 2008), the third kind of feelings that are neither related to the actor's baseline nor elicited by the object, but rather lie between them are the task-related feelings. These feelings are triggered by the demand implicit on choices and decisions (e.g., doubts and stress).

To demonstrate that feelings integrate evaluative processes that follow a direct route and are not under the influence of cognitive content, researchers have used different sources of manipulation to induce feelings (e.g., using music, faces, words, imagination or episodic memory). Mood-congruence effects were found when participants reported more satisfaction about life: (1) in sunny days versus cloudy days; (2) after watching their national soccer team win versus tying a game; and (3) after being exposed to a room with very pleasant conditions versus very unpleasant conditions (e.g., Schwarz & Clore, 1983; Schwarz, Strack, Kommer, , & Wagner, 1987). Research on marketing and consumer behavior have also demonstrated the integration of sensory information in judgment and decision making (e.g., Avnet, Pham, & Stephen, 2012; Chang & Pham, 2013; Krishna & Schwarz, 2014; Pham 2004, 1998; Winkielman, Knutson, Paulus, & Trujillo, 2007).

Overall, mood effect is more relevant when the feelings are directly related with the task demand (Schwarz & Clore, 2007), however, despite the mood-congruence effect, feelings can assume different relations regarding the interplay of the baseline of actors, motivation, intention and contextual features. This happens because the informative value of feelings resides "in the interaction between these feelings and the questions that people are trying to answer when consulting their feelings, which depends on situational demands and more generally on the person's currently active goals" (Cohen et al., 2008, p.56; see also Pham 2004). Therefore,

rather than main-effects "the feelings-as-information hypothesis predicts an interaction between affective states and the perception of their likely causes (Schwarz & Clore, 2007, p.9).

In this sense, Schwarz (2002) suggests a cognitive tuning in which mood and environment have a bidirectional influence. Therefore, according to Scharwz, when the mood is experienced as a positive subjective experience it signals the actor a safe environment and the subject motivation is kept in a low level of processing style (i.e., without any need for change). However, when facing environmental changes an effortful processing might become necessary and feelings can be more informative than during regular conditions. In addition, contexts involving time pressure can also increase the impact of feelings given the short time available to the system to reach higher cognitive processes (e.g., attributional or discount mechanisms) (see also Siemer & Reisenzein, 1998).

Also seeing feeling as information, Martin (2001; Martin, Abend & Green, 1997) assumes that mood serves as an input to the judgment process (i.e., the mood-as-input model) and so participants in initial happy mood (for example) differ from participants with initial sad mood when facing the same sad manipulation. This contribution revealed that mood effect in judgments could be context-dependent and not merely based on congruence as demonstrated by other models.

Although at the beginning the feeling-as-information hypothesis was centered in the effects of mood in evaluative judgments, nowadays the perspective has been expanded to consider feelings as integrating different somatic experiences captured at the level of valence and arousal (e.g., Storbeck & Clore, 2008; Schwarz, 2004; Winkielman & Caccioppo, 2001; Zadra & Clore, 2011). In general, different sources of bodily feelings as physiological changes and metacognitive thinking can convey information about comfort and discomfort (Clore & Colcombe, 2003; Clore & Storbeck, 2006).

Therefore, it has been suggested that whereas valence can inform about positivity and negativity, arousal can be informative of urgency (Storbeck & Clore, 2008). Another field of study that has received increasing attention has been the interconnection of feelings as functional information integrating judgments of visual perception (e.g.; Gasper & Clore, 2002; Zadra & Clore, 2011). Mood has not only been associated with patterns of overestimation (e.g., Riener, Stefanucci, Proffitt, & Clore, 2011), but also with emotional episodes of elicited arousal as fear and anxiety (e.g., Stefanucci & Storbeck, 2009; Stefanucci, Proffitt, Clore, & Parekh, 2008) – a topic we will revisit on the next chapter.

Feelings-as-information: an embodied perspective

The idea of psychological events as the experiential counterpart of physiological events considers subjective experiences as being a partially visceral and a partially mental process. Otherwise, the ebbs and flow of feelings would be meaningless sensations (Barrett & Bar, 2009; Barrett, Wilson-Mendenhall & Barsalou, 2014). Thus, “all basic psychological processes are thoroughly dependent on brain biophysical processes, working together with body, environment, and culture” (Panksepp, 2010a, p. 58). This body-mind integration is a crucial claim of embodiment theories which assume that the form and experience of our body in interaction with the physical and social environment constrains cognition in the resolution of adaptive problems (e.g., Barsalou, 2008; Clark & Chalmers, 1998; Gibson, 1979; Glenberg, 2010; Schubert & Semin, 2009; Thompson & Varela, 2001).

Hence, the embodiment perspective assumes a critical position against the cognitive models supported by the functionalist view of the computer metaphor (e.g., Fodor & Pylyshyn, 1988, see also Harnad, 1990). Thus, rather than the disembodied brain that is conceptualized as the biological hardware that produces cognition, this approach favors the integrality of subjective-and-objective experiences. This means that the processes of the body (i.e., perception, sensorimotor system, and feelings) are not split from the processes of the mind (i.e., appraisals and inferences) (Colombetti & Thompson, 2008) and that somatosensory and motor experiences are not merely input-output devices that sub-serve a central processor.

Supported by the body-mind integration, embodiment studies aim to understand “the dynamic interaction (coupling) of a system that is embedded into the surrounding environment” (Gomila & Calvo, 2008, p.11). That is, “how behavior emerges from the real-time interplay of task-specific resources distributed across the brain, body, and environment, coupled together via our perceptual systems” (Wilson and Golonka, 2013, p.01; for a dynamic perspective see also Chiel & Beer, 1997). For instance, Wilson (2002) defined six core assumptions that underly embodiment framework: that cognition is situated, time-pressured and used to guide action; that attentional and physical limits constrain actor’s interaction with the environment; the surrounding integrates the cognitive system so the mind itself is not a functional level of analysis; and offline cognition is grounded in mechanisms that evolved or were learned in interaction with the environment (i.e., perception and motor control).

Multimodal representations and reenactment. Under the assumption of body-mind integration, embodiment theories have considered representations of multi-modal patterns of neural activations acquired in real interactions with the world (Barsalou 2010; 2008). In this sense, Glenberg (2010) argues that no matter how many symbols one can trace inside a semantic network, the first meaningful one will be always grounded in our bodily sensory, motor and emotional systems in interaction with the object and the situation denoted by the symbol.

Thus, rather than higher order mental contents that are stored in memory under the form of amodal symbols (i.e., knowledge representations that do not preserve any analogical feature of our interaction with the environment), under the perspective of embodiment theories the cognitive representations of any knowledge are delineate in partial mappings of perceptual, motor and introspective states of the body that are grounded in dynamic interactions with the environment (Barsalou, 2008; Niedenthal, 2007). Hence, the mappings are not full records of the experience but only partial networks of brain activation that integrates information about the environment, the action and the interplay (or mapping) between them (Kiefer & Barsalou, 2013).

In this sense, embodied simulation constitutes a partial, mild and not always conscious full-blown of physical and emotional episodes (Kiefer & Barsalou, 2013; see also Garcia-Marques, 2013). It is not merely an associative connection of concepts and somatic states, but rather constructive reenactments working as information processing, and that generate perceptual inferences that go beyond perceiving stimuli in useful ways. (Barsalou, 2008; Winkielman, Niedenthal, Wielgosz, Eelen, & Kavanagh, 2015).

Thus, under the assumption that neural mappings acquired in later experiences can be reactivated by ongoing contextual similarity and embodied information to subjective experience (reenactment), researchers have investigated the activation and reactivation of bodily and neural responses rooted in lower-level brain functions (i.e., somatic and sensorimotor representations) (e.g., Barsalou, 2010; Niedenthal, 2007; Thompson & Varela, 2001).

Examples of the role of simulation can be found in the work of Hauk and collaborators (Hauk, Johnsrude, & Pulvermüller, 2004). These authors have observed the cortical activation of motor cortex areas of participants while performing hand movements. They subsequently found an overlap of activation areas when the same participants passively read a relative action word (i.e., pick). Another evidence can be found in the reports that demonstrated that participants mimicked the muscles associated to sadness expression (i.e., corrugator) when

watching sad faces (i.e., a negative emotional experience) or judging words with context associated to emotions (in contrast with judging whether the words were or not capitalized). (Niedenthal, 2007; Niedenthal, Winkielman, Mondillon, & Vermeulen, 2009).

In what concern the reenactment of affective states, evidence have demonstrated how the activation of somatosensory states is able to trigger subjective experiences. For instance, in a study where participants hold a pen in ways that inhibited or facilitated zygomatic muscle activation, reports demonstrated that facial activity was able to influence the affective state. Specifically, it was demonstrated that activation of zygomatic major, the muscle associated with smiling, was able to elicit positive affect over the participants (Strack, Martin, & Stepper, 1988). Similar evidence is also found in the works of Dimberg (1982; Dimberg, & Thunberg, 1998; Dimberg, Thunberg, & Grunedal, 2002) who reported elicited activity of the zygomatic major when participants were exposed to happy faces, and elicited activity of corrugator supercilious when participants were exposed to angry faces (even when faces were presented subliminally; Dimberg, Thunberg, & Elmehed, 2000).

Overall, at least four possible influences of simulation on current action have been supported by empirical evidence: i) that action might be either facilitated or impeded regarding the match/mismatch between the actual context and the reenacted partial simulation automatically triggered by the stimulus; ii) that a concurrent task might block the simulation when the task involves the same sensorimotor resources; iii) that simulation can also work in offline mode; and iv) that simulations are dependent on expertise level (i.e., previous experience and skills) (Körner, Topolinsk, & Strack, 2015).

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Findings from neuroscience support the hypothesis of primal feelings linked with visceral and homeostatic states of the body, and also suggest the integration of these feelings in the roots of secondary and tertiary processes (i.e., memory, perception, reasoning).

These findings have been corroborated by psychological approaches that consider feelings as arising as the counterpart of any cognitive processes supplies direct information for behavior. In this sense, several evidence have demonstrated that feelings have a functional role (e.g., are taken into account in evaluative judgments). Overal the experiential dimension of feelings have been captured in a bidimensional representation that split our felt experience in

the axis of valence versus arousal. Thus, researchers have applied words, songs, faces or pictures that are pre-tested in these bidimensional features and use them to induce bias affective responses as a method to investigate the role of feelings in behavior. Despite of that, it is important to note that the nature and causality of valence and arousal is still in current development. For example, it is not clear the relation between these two components of the felt experience (Kuppens, Tuerlinckx, Russell, & Barrett, 2013). Also, there is controversy as to whether the positive and negative experience associated with valence has its root in an unipolar or bipolar dimension, as well as, if the two valences have a relation of dependency or not.

Although the idea of feelings as information started with a focus on cognitive feelings that were associated to mental operations (as memory retrieval), nowadays the sensorial information has been extend to different bodily processes, for example demonstrating sensorial fluency associated to affordances. However, mostly of the investigation in this field seems not approach the role of feelings when perception is intended to guide action in a dynamic context and when the own body system is the metric used to scale opportunities for action.We explore this point in the next chapter.

Chapter III

Feelings as an embodied route of information for action capabilities

"*What the organism senses is a function of how it moves, and how it moves is a function of what it senses*" (*Thompson and Varella, 2001, p.424*).

In this third chapter we use the theoretical lines of action-perception and feeling-as-information that were reviewed on chapter 1 and 2 in order to elaborate how feelings can be understood as the embodied route of information for action capabilities.

Can feelings modulate the actor-environment fit?

When Gibson (1966) claimed that animals were equipped with a perceptual system he also indicated that the perceptual system was integrate or subordinate to other system levels. According to Gibson (1979), the visual system is not only about the eyes, but the eyes in the head, the read in the neck and the neck in the body. So, although evidences of direct perception have been provided through the detection of invariant relation on the optical flow rather than retinal and mental pictures, visual perception does not happen in the eye as an isolate fashion. Information available in the optical array is interconnected in an embodied experience, with this body embedded in a context (Barsalou, 2008; Clark & Chalmers, 1998; Thompson & Varella, 2001; Wilson, 2012).

In this sense, ocular models (e.g., Shaffer & McBeath, 2002; Lee, & Kalmus, 1980) have provided evidences that optical cues are able to carrier spatial-temporal relations and direct specify information about the actor-environment system. For instance, the bi-dimensional optical variable tau denotes the inverse of the relative rate of the retinal expansion during the approaching of an object and specifies time-to-collision (e.g., Lee, 1998). Thus, tau is informative of spatial-temporal relations when adjusting perceptual-motor coupling in processes involving for example, grasping (e.g., Savelsberg, Whiting, & Bootsma, 1991) and hitting balls (e.g., Lee, Young, Reddish, Lough, & Clayton, 1983). However, a classical criticism resting on this kind of approach is that information from the optical array is limited to explaining how the action is guided by pursuit affordances, given that optical flow can for example be constraining by non-optical as action potential and its boundaries (e.g., Fajen, 2013;

2007a). For instance, if we explore the classic problem of an actor moving forward to catch a flying ball (e.g., Chapman, 1968; McBeath, Shaffer, & Kaiser, 1995), when the actor moves toward the ball abruptly (running) changes in the optical flow happens fast, when the actor moves toward the ball slowly (walking) changes in the optical flow happens slowly, and fast and slow displacement are constraining by action capabilities.

Thus, changes in the optical flow does not happening in disconnection with changes in neuro-physiologic processes at for example the level of muscular contraction and cardiorespiratory. It makes of running to catch a flying ball a embodied experience in which visceral and somatosensorial changes are in the roots of higher brain processes and shapes cognition. That is strategically important when considering feeling as information for action capabilities.

In classical study researchers demonstrated with monkeys that looming effect (i.e., the optical expansion in the retina that specifies collision) was more threathening (a felt experience) than receding effect (i.e., the optical shrinking in the retina), (e.g., Caviness, Schiff, & Gibson, 1962). Subsequently, it was demonstrated that when the approaching stimulus was felt as more threatening to the actor's body a trend of participants to overestimate time-to-contact was found (Vagnoni, Lourenco, & Longo, 2012), suggesting the same threatening experience. In addition, when the visual looming is associate with the tracking of a dynamic stimulus going toward the face of the participants (i.e., higher in feelings of threatening), rather than passing at the side of the body the area of the face predicted for the collision may enhance in terms of tactile sensibility (Cléry, Guipponi, Odouard, Wardak, & Hamed, 2015), a clear evidence that the body is connected with the phenomena in the eyes.

Another relevant point on the action-perception literature was raised by Fajen (2007a; 2005) and refers to the fact that when controlling action by detecting opportunities for action (Gibson, 1979) models must take in account that our action is constraining within minimum and maximum boundaries. So, the perceptual-motor adjustment is possible only when our action capabilities are above the minimum and below the maximum, otherwise actors are not in control of their movements (Fajen & Turvey, 2003). For example, Dicks et al. (2010) demonstrated that faster goalkeepers adjusted the initial of their diving in penalty-kick situations significantly different from slow goalkeepers (i.e., took long to start the safety movement), and so took in account their action capabilities. In addition, in Chapter 1 we provided a series of robust evidence indicating that we adjust of our body dimension and action boundaries to target features of the contextual to estimate and performing action.

In this sense, an accurate fit of our body with the environment properties cannot result from abstract choices and imaginative processes, but rather is the ultimate outcome of a processes of an accurate perceptual-motor adjustment (i.e., calibration), with miscalibration being detected in patterns of overestimation and underestimation. However, some evidences suggest that perhaps that calibration is not about an exact matching but rather can variety within an optimal boundary that is constraining by other body system variables, as for example energetic expenditure (Warren, 1984).

This means that within the window the minimum and maximum action boundaries (i.e., what could be possible for the system), there is another window that seems to be constrained by comfort-discomfort (i.e., a preferential range). If so, then it is plausible to hypothesize that feelings are informative of our action boundaries and actors learn to become sensitive and rely on them to perform perceptual-motor adjustment when fitting their body with the environment. In other words, feelings captured at the psychologic dimension of comfort-discomfort, positivity and negativity, costs and beneficious might be a functional and direct source of information regards our action capabilities and be integrated with optical flow information.

Some evidences already suggest this role of feelings. We may find support for this hypothesis in the action-perception literature when they provide evidence linking the informational role of subjective experiences (feelings) to action capabilities. For instance, Warren (1984) measured the energy expenditure (VO2 maximum) of participants during a task of climb-ability and found that action was constraining by a preferred "optimal window" of energy expenditure. That is, it seems that actors prefer performed actions within a zone in which the body experience is felt as more comfortable in terms of energetic cost. This finding leaded Konzack and collaborators (Konzack, et al., 1992; for a similar evidence see Comalli, Franchak, Char, & Adolph, 2013) to demonstrated that an elderly body does not behavior in terms of perceived action boundaries as a young body (i.e., seems to have a different subjective experience of effort). Warren's findings also inspired a series of studies of embodied perception claiming that bio-energetic costs embodied non-visual information (i.e., to our view by feelings) when visually scaling the spatial layout (see Profitt, 2013, 2006; Witt, 2011).

Investigating control of action, Fajen (2013; 2007, 2005) also demonstrated that actors rely on their dynamic boundaries to keep action within a safety margin of maneuver and avoid the risks of collision. Another evidence that supports the claim that feelings or subjective experience constraining action-perception can be illustrated by studies investigated the reach-ability of objects. When participants are asked to reach an object adopting a pattern of action

that involves lean forward using only the arm vs. lean forward using the arm-plus-upper torso, the transition from a pattern to other seems be constraining by feelings of comfort and discomfort (rather than biomechanical ratios) (Mark, et al., 1997; Petrovic, Berg, Mark, & Hughes, 2015). That is, although we can stretch our hand at the maximum to grasping a big ball with one hand, unless the reality demands it the maximum size of the ball perceived as graspable with one hand will not match with this biomechanical condition, but with a small aperture that is constrained by feelings of comfort and safety.

Similar evidence is demonstrated by reports of other type of feelings such as confidence, indicate that participants were more confident about their judgments when reaching targets located on the extreme of their action boundaries (i.e., very near or very far), than when the target is located at an ambiguous distance and the perceived reachability of the participants is more susceptible of noise and variability (Mantel, Stoffregen, Campbell & Bardy, 2015). In this sense, and considering distance as relativized by body features, the link created by body-space-feelings seems to indicate that experience of confidence direct translated a target that is clearly reachable or unreachable. In turn, when both possibility co-exists feelings of uncertainty are experienced. This U-shape pattern is typically from a dynamical system framework (e.g., Kelso, 1995) that preconize stable regions of action in the extreme of the boundaries (stable system = certainty) and a transition point where patterns of action co-exist (unstable system = uncertainty).

Thus, subjective experience or feelings of comfort has been linked as important information to shape the large and redundant number of options of the motor system (Barton, 2014). In addition, it has been described that when two or more affordances are made available in the context it is likely that the one associate with the lower energy consuming will be a more salient invite for action (Withagen, Poel, Araújo, & Pepping, 2012).

At this point, and as mentioning early in this chapter, it is interesting to note that feelings are aligned with the same principle of bidirectionality that entails the whole processes of affordance detection. That is, feelings constrain our action either because they are context sensitive, but also because they are informative of our bodily states. In other words, the features of the environment can modulate how feelings inform actions, but feelings can also constrain our body state and so modulate our perception of the environment properties. In this sense, it has been demonstrated that the feeling of fatigue (i.e., subjective experience of discomfort) can lead the participants to patterns of overestimation of size and distance (e.g., Bhalla & Proffitt, 1999; Zadra, et al., 2016). However, that embodied information associate to the physiological

potential of action seems to be more relevant when the actors are positioned on the bottom of hill and need to conscious estimate the perceived uphill slope, than when the actors are positioned on the top of the hill and need to estimate the perceived downhill slope (Proffitt et al., 1995). Similarly, the fear-arousal relation seems embodied functional information when associated to dangerous (height perception from above) than safety (height perception from below (Storbeck & Stefannucci, 2014).

Can feelings be a multimodal higher-order variable?

The integration of feelings as functional source of information for the perceptual-motor adjustment preconize two main assumptions. First, the informational role of feelings is rooted in bio-evolutionary mechanisms of survival and life regulation, and second the felt experience (psychologic dimension) is the counterpart of the myriad neurophysiological and neurobiological changes when facing the flow of events (see Chapter 2; e.g., Barrett & Bliss-Moreau 2009; Cabanac, 2002; Pankseep, 2011; Damasio, 1999). In this sense, perception is feeling, and feeling is perception, and there is no separation among them. According to embodied theories of cognition the processes of the mind are grounded in real interaction with the environment and separation from perception, feelings and other sensorimotor processes made no sense (e.g., Barsalou, 2008, Clark, 1999; Thompson and Varela, 2001; Wilson, 2002; see Chapter 2). Thus, not only sensorimotor information shapes cognitive processes but the features of the processes (the nature per se) is also able to constrain our behavior (see for example Thompson & Varella, 2001).

This leads to the second assumption of perception being multimodal rather than supporting by only an energetic array. In this sense, rather than guided by one unique pattern of information (e.g., optical array) or assume that visual, acoustic and haptic information are serial modules of perception that needs different and specialized processes in typical areas of the brain, Cisek (2007) has investigated perception as multisensorial and constantly shaping by dynamic and parallel brain functions. His approach is in line with other cortical findings which have demonstrated to be hard interpreting neural activity in terms of distinct perceptual, cognitive or motor systems (e.g., Cisek 2007; Pessoa 2008).

In a similar vein, some action-perception studies have also suggested that opportunities for action can be constrained by sensitive to a higher-order variable that extend across multiple and redundant forms of ambient array, that is a global array rather than a unique array (i.e.,

isolate information of the optical array or acoustic array, for example) (e.g., Mantel, et al., 2015; Stoffregen & Bardy, 2011). In complement, an extend global array could be a high-order variable that integrates proprioceptive and interoceptive information (see Witt & Riley, 2014). Indeed, as reviewed in Chapter 2 interoception is the faculty of sense physiologic state of our body that it is in the roots of the experience of feelings and have been associated to body awareness and control of direct effort (e.g., Craig, 2011, Singer, et al., 2009). Hence, White and collaborators (White, Shockley, & Riley, 2013) tested the hypothesis of actors being sensitive to a cross modal informational variable (i.e., high-order variable) that captures the relation among metabolic cost of locomotion and the coincident optical information about distance traversed. Results indicated that actors indeed where sensitive to the multimodal variable hypothesized but not to the low-order parameters that integrates the changes on this variable. That is, changes on the values of the high-order variable by manipulating the low-orders parameters leaded actors to overestimated and underestimated distance. This finding might help to explain the series of findings of the embodied perception account (Proffitt 2013, 2006; Witt, 2011), which have been demonstrating the interplay of energetic costs and changes on visual estimation of the spatial layout.

The subjective experience grounded in feelings is likely to be a high-order variable to which actors are sensitive when estimating their action capabilities. This because feelings direct embodied information of cost and benefits, comfort and discomfort, safety and unsafety (e.g., Pankseep, 2010a; 2010b). In this sense, it is important to note that paradigms adopting an embodied account of action-perception not rarely instruct their participants to rely on "experience" as a strategy to minimize confounding effects. For example, White et al (2013) mentioned: "we selected the specific instruction to report on the basis of how far it felt (our emphasis) that he or she had waked in order to minimize the possibility that participants could adopt simple unimodal strategies" (p.1376). In addition, as a strategy to investigate energetic cost as embodied information for action-perception several researchers have not only manipulated fatigue states, for instance with exercise (Bhalla and Proffitt, 1999; Zadra et al., 2016) and body weight (Lessard, Linkenauger, & Proffitt, 2009; Sugovic et al., 2016), but indeed they have provoked changes on emotional states as fear and anxiety to create changes on energetic states from a neurophysiological via (e.g, Greydon, et al., 2012, Storbeck & Stefannucci, 2014).

Can feelings inform action capabilities?

The idea of feelings as direct route of information is one important aspects underlying the whole processing of the actor-environment interaction and that have been largely approach on socio-cognition (e.g., Alter & Oppenheimer, 2009; Clore, 1992; Clore & Colcombe, 2003; Clore & Storbeck, 2006; Garcia-Marques & Mackie, 2001; Garcia-Marques et al., 2004; Schwarz, 2012; Schwarz & Clore, 2007). However, the informational role of feelings has been potentially neglecting in the action-perception literature (see Zadra & Clore, 2011).

Due to that sensorial experiences can serve as a source of information in their own right and interplay with processes as judgment and decision making, an assumption that have support the feeling-as-information approach (e.g., Schwarz & Clore, 2007, 1983; Clore et al., 2001). According to this theoretical framework, the experiential nature of feelings carries direct information of positivity and negativity, comfort and discomfort, beyond beliefs and deliberative processes.

Overall, experiments of this approach have linking sensorial experiences like mental processing, mood, physical arousal and bodily sensations in process as evaluative judgment and decision making (e.g., Schwarz & Clore, 2007, 2003, 1983; Pham, 1998). Evidences coming from this perspective have manipulate sources that promote feelings (e.g., pictures, words, letter fonts, smells) and tested the effects of the resulting feeling in biased a variety of judgments of effort, familiarity, risk, beauty, risk, life satisfaction, risk and probability of choices (see Schwarz, Son, & Xu, 2009 for a review). In addition, most of these judgments involving static events and feelings effects have been captured through rating scores or reaction times. So, perception is approach under the perspective of evaluative apprehension of forms and contents, but not connected with motor action itself and goal-task behaviors.

Although physical properties of the environment are stable our body is not. During an ordinary day, for example, oscillations can happen grounded on changes in physiological, psychological and morphological states. Thus, when considering the same actor standing on the pavement and exploring the space between two vehicles to crossing a bustling avenue, the same gap (i.e., same spatial-temporal relation) can afford crossing-safe and be detected in terms of its pass-ability during the beginning of the day (i.e., with the body system not fatigated), but cannot afford crossing-safe or even be detect in terms of its pass-ability after an extenuate day of working (i.e., with the body system fatigued). As demonstrated in Chapter 1 our action boundaries are not stable, and we need to be a reliable mechanism of information regards our boundaries of action to not put life at risk.

It is precisely because feelings are always underlying our experience and they "incoming sensory information from the external environment with homeostatic and interoceptive information from the body" (Barrett & Bliss-Moreau, 2009, p.04) that we believe that its feelings interplay with action-perception in functional ways. Our system needs to be sensible to the felt experience to develop ways to solve problems with less effortful and risk, which might be constraining by pleasurable-unpleasable dimension. Indeed, when visual detection is integrated with sensorimotor experiences in terms of how effort is mobilized, opportunities for actions are easier and faster detected when the features of the objects and tools match with the anatomic position of our hands rather than constraining our body to motor adjustments (e.g., Linkenauger, Witt, Stefanucci, Bakdash, & Proffitt, 2009; Regenberg et al. 2012) have demonstrated a preference (i.e., fast detection and feelings of fluency) that visual perception is integrate with. Thus, it seems that feelings of fluency or familiarity that have direct relations with effort of the motor and cognitive systems (e.g., Garcia-Marques, et al., 2016) can constrain action-perception.

Another relevant aspect to take in account when associating the approach of feeling as information to action capabilities it is the fact that feelings are diffuse states always running in our background (e.g., Damasio, 1999) and that lack of reference (e.g., Clore, 1992). Due to that, feelings that emerge from the process going on (i.e., online) can be confounded and misattributed to different features of the process. Therefore, feelings become informative when its ebbs and flow are associated to the current situation (Barrett & Bar, 2009), that is when feelings are called into question (how do I feel about it? Schwarz & Clore, 2007, 1983). It allows feelings that are experimentally manipulated to be integrate as information in processes like judgment and decision making (e.g., Cohen, et al., 2008; Schwarz & Clore, 2007). It is interesting to note that evidences around action-perception have also suggest that although dynamic properties of our action are always there it is only when they are called into question that they become informative (e.g., Constantini et al., 2010; Proffitt, 2013; Witt, Proffitt, & Epstein, 2005). So, the action boundaries of our hands are activated to grasp a ball, but not to kick a ball.

Finally, unlike the evaluative judgment approached by social cognition when visual perception is intending for effective actions (and not only to appreciate and describe features) the physical properties of the context are relativizing in accordance with our action capabilities (Chapter 1). Therefore, we should not expect to see changes on affordances given that they feature of the actor's mind or state, but rather emergent properties of the actor-and-environment

system Gibson (1979). Instead, we should look for changes in variables that informs about the perceived fit, as timing (“when”) or action pattern (“how”).

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We think that a new approach questioning whether feelings could be a functional information to our action boundaries could be able to bring new insights to the theoretical field of action-perception and expand the findings around the feeling-as-information approach.

To our view, there is not way to dissociate the energy consuming, heart beating and muscles strength from subjective experiences of comfort and discomfort, a very similar proposition of researchers that investigate feelings associated to mental operations, as fluency and familiarity. Thus, in line with assumptions suggesting non-emotional feelings i.e., sensorimotor information) integrates evaluative judgments, in this thesis we establish as goal to investigate if feelings are functional information of our action boundaries when gauging dynamic properties of the environment.

The evidence reviewed suggests that feelings in its own nature are rooted on the neuro-physiological changes that underlyie the fit of the actor-environment system.

Capítulo IV

Objectives and Description of the Empirical Session

The idea of changes at visceral and physiologic levels feeding cognitive processes have been commonly pointed as a sophisticate upgrade of William James (1894) assumption that visceral changes were integrated in psychology experience.

The empirical work presented in this thesis is focus on the experiential side of the body and how it affects the perceived fit our dynamic action boundaries to some relevant property of the environment when performing goal-direct behavior. To this end, we adopted an embodied perspective of action-perception in the sense that changes and permanence in the optical array are interconnect with a whole-body experience (i.e., muscles contractions and a cardiorespiratory system) and feeds cognitive process toward adaptive behaviors.

Our approach is that feelings are a direct (thus not inferential) route for accessing the experience of our action boundaries, and along with our interaction with the surrounding they provide us with functional information captured at the psychologic dimension of comfort-discomfort, cost and benefits and safety-unsafety. They do it because feelings are rooted in a principle of survival and energetic economy of the mind and behavior. Specifically, we aim to test and clarify the role of non-emotional feelings as modulating the processes of calibration of our action capabilities when facing dynamic events. Hence, the empirical work presented in this thesis is anchored by the feelings as information approach, and test if our subjective experiences (i.e., non-emotional feelings) interplayed with body constraints during the processes underlying affordance detection. The question pursuit by our empirical thesis can be translated by: “Are induced feelings able to affect the experience of our action capabilities and influence the perceive fit of the actor-environment system when performing a goal-direct behavior?”

Strategically, we conduct different types of research to approach our theoretical hypothesis. In a first study, we framed the link between feelings-as-information and action capabilities within a field context, and we adopted surveys to approach our data. In the subsequent studies, we framed the link between feelings-as-information and action capabilities within the laboratory context, and we adopted two different approaches to gain evidence that inform us if feelings were interfering with the process by which participants access their action capabilities. Within the lab conditions, we adopted two experimental paradigms, one based on psychophysiological processes and other based on subliminal affective priming mechanism.

The studies developed to support this thesis were integrated in 3 different papers submitted to publication.

Paper 1: Acting fast on feelings! Naïve theories of expert futsal players about feelings as information

Our first empirical study aims to understand if the mechanism that we hypothesize may be represented by naive theories of action. Anecdotal cases have associated athletes with reports of reliance of feelings when performing action-decisions. However, no systematic research has clarified if this is the case or some isolated episodes. Hence, in our first paper we address how athletes understand themselves accessing information about their action capabilities when facing action decisions that are imposed by the context. We have tree main objects with this paper: i) to confirmed the findings suggesting that actors acknowledge and rely on information about their action capabilities (e..g, Fajen, et al., 2011); ii) to explore if this information is conscious experienced as body own language (e.g., Clore 2001, 1992; Massumi, 2002; Pankseep 2011, 2010; Schwarz 2012, 1990); iii) and to gather evidences to our hypothesis of feelings as functional information of our dynamic actions boundaries. Therefore, in two studies (i.e., one pilot and one empirical) we address these points by asked elite athletes to indicate their reliance when in competitive context on three different sources of information: "visual looking" – as suggesting by information based models of visual perception (e.g., Lee, 1980; McBeath, Shaffer, & Kaiser, 1995); "deliberative thinking" – as suggesting by Type 2 process describe on dual-systems model of cognition (e.g., Evans & Stanovich, 2013); and "bodily feelings" – as suggesting by the feeling-as-information approach (e.g., Schwarz & Clore, 2007; 1983).

Sport context is a richness field for capture evidences of the link between feelings and action capabilities, given that athletes constantly need to coordinate their action capabilities with the information available in the context (see Fajen, Riley, & Turvey, 2009). However, because the experience reported by athletes may not represent alone a reliable source to validate our hypothesis. Due to that, the following two papers were grounded on experimental conditions that can inform us whether feelings are being used or not as functional information of action capabilities.

Paper 2: Relying on feelings as information to estimate action capabilities over dynamic events

Our second paper presented two complementary studies elaborated to support evidences that feelings are integrated in the mechanism of action capabilities.

Thus, in the first study of the present paper we adopted a psychophysiological paradigm to collect evidences that feelings are triggered in our body as a component of action estimation. Under the perspective of embodiment theories, it has been demonstrated that multimodal representations (i.e., neuronal patterns of activation) integrates lower-level of brain functions (i.e., somatic and sensorimotor representations) (e.g., Barsalou, 2008, 1999; Niedenthal, 2007). Thus, changes on the electrical activity of the facial muscles corrugator supercilii and zygomaticus major have been pointed as indicative of subjective experiences of positivity or negativity (e.g., e.g., Cacioppo, Petty, Losch, & Kim, 1986; Dimberg, Thunberg, & Grunedal, 2002), with these patterns of activation and deactivation reflecting a fast and very efficient adaptive response of our interaction with the target-situation. Due to that, we exposed participants to dynamic events (i.e., with changes in the optical array; Gibson 1979) and we tracked the activation of two facial muscles commonly used as indicative of positive feelings (i.e., zygomatic major) and negative feelings (i.e., corrugator supercillis) in two different conditions: only watched the events (i.e., without any association of perceptual-motor coupling) and watched-plus-estimate action capabilities. We did it with the intention to answer the question if feelings are triggered when performing online adjustments of our body with the environment, a pre-condition to its informational role.

Subsequently, in the second study we followed the studies developed in the field of “feeling-as-information” which usually manipulated feelings prior to the task to bias the judgments of participants by misattribution process (e.g., Schwarz & Clore, 2007; 1983). We follow the approach applied by Graydon and collaborators (Graydon, et al., 2012) who induced changes on feelings immediately before participants estimate their action capabilities. However, rather than use a restricted breathing task to manipulate feelings of anxiety in a conscious level (Graydon et al., 2012) we adopted a sandwich masking affective priming paradigm (i.e., non-conscious visual perception of the emotional face to create changes on the feelings of participants; see for example Tamietto & De Gelder, 2010; Wiens & Öhman, 2007) by presenting neutral, happy and sad pre-tested facial expression of low-arousal in subliminal way (i.e., less than 30ms).

In this sense, embodied researchers have suggested a single mechanism where activation of feelings by reenactment of somatosensory and motor states mimicked from the facial expression can partially activate feelings of an emotional experience (e.g., Adolph, Damasio, Tranel, Cooper, Damasio, 2000; Barsalou, 2008; Dimberg, Thunberg, & Elmehed, 2000; Niedenthal, 2007). Overall, we expect that feelings experimentally promoted at the baseline of participants can be carried as source of interference on feelings that are generated on-line in the perceptual-motor adjustment task (i.e., contextual setting). Thus, a neutral-priming condition is assumed as the control condition, with the positive-priming and negative-priming conditions being our manipulation of feelings.

During a situated action the sensorimotor simulation triggered by the priming can interfere with the mechanism triggered by the current task by facilitating or inhibiting concurrent sensorimotor activation (Körner, Topolinsk & Strack, 2015). This means that activation elicited by the priming can for example addition more or less comfort or confidence in the whole processes of the action estimation. Hence, if the participants took this felt information in account, we might capture changes in the perceived body-environment fit in the negative and positive priming relatively to the neutral one. If the feelings elicited by the priming are integrate in such way that drives the patterns of behavior of participant toward same significant changes, then these data may support our hypothesis that feelings indeed have a role (and likely an informative one) in our perceived action boundaries

Finally, we also presented a variety of dynamics events in which participants had to estimate two different hands capabilities to reduce confound effects associated with anticipation and bias of the events.

Paper 3: To touch or not to touch? Feelings as non-visual information for perceived reach-ability

Our last empirical paper applied the same affective subliminal priming paradigm and aiming to replicate the findings of our second study of Paper 2. To this end, in a first study we presented a different kind of dynamic event and captured the reach-ability estimation of the participants relatively of different spot of the computer display. Because the movement of reaching is constrained by the coordination of several motor degrees of freedom (Bernestein, 1967), we delve into the mechanism supporting feelings coming from the sensorimotor systems (i.e., embodied) and manipulated the degrees of freedom of participants (e.g., Carello, et al.,

1989; Fisher, 2000; Gabbard, Ammar & Lee, 2006; Rochat & Wraga, 1997). Specifically, in the first study we constrained the action experience of participants by prevented them from move their trunk and hips and asked (i.e., lean forward) and we asked them to estimate reachability only with their upper arms freely. We kept the condition of a dynamic event (i.e., temporal constraints) and the subliminal affective prime manipulation immediately before the task after. We believe that more uncertainty (or instability) could be created under this condition and the participants could integrate the feelings triggered by the priming effects as alternative to lack of information. In a second study, and concluding the experimental session of this thesis, we release the temporal constraining of the event by adopting a static presentation. We also released the postural constraints of half of the participants to examine what happened with the reaching estimations. We assume that without both the constraining of body movements and time, other strong feelings could be made available and reduce the effects of feelings coming from our mild manipulation.

Section II

Empirical Session

Acting fast on feelings! Naïve theories of expert futsal players about feelings as information*

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Abstract

Anecdotal evidence suggests that during a course of action athletes rely on feelings as information. In this paper, we address whether players' naïve theories about their dynamic course of action encompass reliance on feelings as a direct source of evaluative information to action capabilities. In a pilot study, we asked elite athletes from different sports modalities to identify typical changes of course of action performed during competition and subsequently to indicate how much they perceived themselves as relying on three sources of information to perform such changes: visual looking, body feelings and deliberative thinking. Next, in an experimental study, we controlled the features of game situations that involve action decisions performed in situ during a futsal match and asked expert players to rate their reliance on the same three sources of information when performing the target actions. The results from both studies clearly showed that athletes report relying on bodily feelings, although not exclusively, as a sensorial route of information when performing fast-paced actions. The data also indicate that reliance on feelings is highly informative and salient when athletes perceive game situations as uncontrollable, uncertain and dynamic.

Keywords: action capabilities, interoception, heuristic, task constraint

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Acting fast on feelings! Naïve theories of expert futsal players about feelings as information

Sports are filled with anecdotal cases documenting the fact that athletes rely on feelings as a source of information to guide action in dynamic and temporal terms. This fact is exemplified in the word of Tom Brady, the American quarterback: “I don’t know how I know where to pass. There are no firm rules. You just *feel* [our emphasis] like you’re going to the right place.… And that’s where I throw it” (as cited in Lehrer, 2009, p.08). The literature offers several reasons why athletes see themselves as relying on feelings as a source of information to guide action. Actions performed in a sports context are constrained by body morphology, physiology and affective systems. For instance, it has been demonstrated that athletes take into account both their body dimension (e.g., Warren, 1984) and the dynamic properties of their actions (i.e., the action boundaries in terms of agility, force and stamina) in order to act (e.g., Fajen, 2007, 2005). It is thus possible that actors’ awareness of these processes occurs by reporting them as feelings.

Here, we address whether actors rely on a subjective experience of bodily feelings to support their actions when performing fast-paced actions in a dynamic context. To this end, we first review evidence that may sustain the belief that feelings are a source of fast information to guide action. Next, we present self-reported data that document (if this is in fact the case) how athletes perceive themselves as relying on bodily feelings for information when performing fast-paced actions.

Feelings as a fast route to guide action

Since Hebert Simon (1955) indicated that human rationality, rather than being an ideal information processor, is bounded by time pressure, psychologists studying judgment and decision making have searched for the fast and simplified mechanisms that support our goal-directed behaviors (e.g., Kahneman, 2011). Within the context of sports, these fast mechanisms of cognition are crucial, given that action decisions are usually made under higher time pressure, in conditions of uncertainty, and with limited available information (Moran, 2012). Therefore, researchers have provided alternative models to account for action without the need to rely on a full rational analysis and complex algorithms. Rather, they assume fast routes exist to gather and analyze the environmental information. Some of these models are anchored by Simon’s heuristics perspective and its effort-reduction process of cognition (for a critical review point, see Shaw & Oppenheimer, 2008) and have been applied to sports as fast-and-frugal heuristic models (Raab, 2012; Raab & Gigerenzer, 2015). Thus, applying a video-based paradigm, researchers asked handball (Johnson & Raab, 2003; Raab & Johnson, 2007) and basketball

(Hepler & Feltz, 2012) players to watch courses of action in their respective sports performed in situ. The actions were stopped by the researchers at target moments, and the players' tasks consisted of first indicating potential actions to be performed by the ball carrier and next judging the best action to be adopted. In both experiments, researchers found that the players adopted the first option generation they reported and so used the take-the-first heuristic strategy (i.e., 60% of the time handball players and 70% of the time basketball players indicated the first option generation as the best solution). Researchers concluded that when facing divergent-thinking situations in a familiar context, athletes acted on the first thought that came to mind as a cue (i.e., heuristic) rather than deliberately processing all options.

Other models offer a much less brain-centered framework, for example, by rebalancing the weight of environmental information in supporting action. This is the case for the ecological dynamic approach of decision making offered by Araujo and collaborators (e.g., Araújo, Davids, & Hristovski, 2006). The eco-dynamic model assumes that action is directed by simple and fast decisions rather than being anchored in hard computation and choice dilemmas. These "action decisions" are, however, assumed to be guided by a confluence of situational constraints that emerge from the interaction of actors' bodies with the current scenario and narrow the amount of possible actions to only a few possibilities that fit the actors' systems. In line with this assumption, and adopting time-to-ball contact as a spatial-temporal variable, Travassos and collaborators (Travassos, et al., 2012) investigated the interceptive action of ball passing in futsal. These authors demonstrated successful trials in emerging from the dynamic regulation of the relation of the ball trajectory to the defender distance and speed relative to the ball.

Although both heuristic and eco-dynamic models address fast routes to gather and make use of information, none of these models theorize and explore the feature of the actor's experience in such a process or even whether athletes are aware of such feelings as a route of fast information that they rely on (or believe they rely on) to guide action (as Tom Brady's statement at the beginning suggests).

Several researchers have argued that feelings play an important role in judgment and decision making (e.g., Busemeyer, Dimperio, Ryan, & Jessup, 2007; Damásio, 1994; Schwarz & Clore, 2007; Seo & Barrett, 2007). Because feelings are pervasive in all phases of the decisional process (i.e., before, during, and after an outcome), it is likely that even when integrating emotions, they could support non-athletic goal-directed behavior (Zeelenberg, Nelissen, Breugelmans, & Pieters, 2008; Zeelenber & Pieters, 2006). If this is the case, then athletes' naïve theories about how their actions are supported by feelings may reflect an awareness of a real process.

Feelings are also an inherent experience that arises in the sports context (e.g., Martinent, Campo, & Ferrand, 2012), and competition itself has been demonstrated to be enough to trigger a myriad of bodily processes (e.g., Harrison et al., 2001; Veldhuijzen van Zanten et al., 2002). This makes bodily sensory experiences a likely sensitive and functional route of immediate information that actors can rely on, consciously or not. The affect/feelings-as-information model (Schwarz, 2012; Schwarz & Clore, 2007, 1983; Clore & Schnall, 2005) assumes that people rely on their bodily experiences as a direct source of evaluative information when facing demanding and complex situations by implicitly asking, "How do I feel about it?" (Schwarz & Clore, 1988). Therefore, it is experiential and sensorial information (rather than conceptual information or belief) that embodies values (i.e., positive and negative) and urgency (i.e., sleepy activation) (Storbeck & Clore, 2008).

Taken together, these approaches suggest that feelings may in fact be a source of information integrated into the dynamic context of sports and that athletes may rely on bodily feelings because they are aware of such processes. However, in this paper, we propose to investigate only whether athletes believe themselves to rely on feelings as sensory and direct information regarding their action capabilities. Specifically, our goal is to question whether athletes perceive their action capabilities as being driven by deliberative thinking, feelings or simple visual perception (looking). To this end, we first ran a pilot study in which a sample of athletes from different sports modalities were questioned about the general experience of thinking, looking and feelings as sources of information. Next, we developed an experiential study in which the course of motor action performed was constrained to futsal game situations, and we asked expert futsal players to indicate how much they rely on thinking, simple looking (apprehending) and feelings as sources of information when performing the target actions.

Pilot Study

A pilot study was developed to test the feasibility of our goals. We thus first collected evidence regarding whether athletes report relying on feelings as information to guide action. Additionally, the pilot study also allowed us to determine whether our definition of the three sources of information (looking, feeling and thinking) was comprehensible to athletes. At the end of this initial step, we expected to collect evidence that feelings are consciously recognized by athletes as a source of information and to draw cues for our main experimental design.

Method

Participants

The participants were 18 athletes (*M* = 20.17 age, *SD* = 3.34; 3 females) from the national squad of Portugal (time of practice: *M* = 8.89 years, *SD* = 3.96; training load: *M* =

17.83 hours/week, *SD* = 7.47) who came from 7 different sports modalities: 110m hurdles, judo, basketball, triathlon, skating, cycling, and modern pentathlon.

Procedure

The participants were received in a meeting room in their local training center, and the survey was administered daily before training sessions either in the morning or afternoon over a full week. After a brief exposition, the athletes were introduced to the first part of the survey and read some examples of actions performed in the sports context. Next, they were instructed to write at least 5 statements indicating changes of actions performed by them during their game, fight or competition. In the second part of the survey, the participants were introduced to the descriptions of three possible experiences of sources they could rely on as information: *thinking* (elaboration, calculation, and reflection); *looking* (direct and pure vision, no thinking and no feelings); and *feeling* (undefined body sensations and subjective experiences).

Subsequently, the participants were instructed to indicate which source they rely on to perform the mentioned action changes (more than one source was possible). Next, they were instructed to rate how much they rely on each of the previously assigned sources based on a 5-point scale, ranging from 1 – very weakly to 5 – very strongly. At the final stage, the athletes were instructed to provided information about their birth year, gender, time of practice, and hours of training per week.

Dependent variables

The total of 81 changes in course of action provided by the athletes (e.g., *"start running"* in athletics; *"perform a skill"* in judo; and *"jump to the rebound"* in basketball) was included in our analysis. The first dependent variable was the proportion of "yes" responses given by each participant to each source. The second dependent variable was the mean of the ratings that each participant provided for the different actions described. This process was done for each source.

Results and Discussion

To understand whether the participants had an awareness of relying equally or differently on each source provided, we compared the proportion of "yes" responses with a repeated ANOVA that had *looking, thinking* and *feelings* as repeated factors. The results revealed a non-significant difference among the three sources, $F\,(2, 34) = 1.29$, $p = .289$, $\eta_p^2 = .07$. This meant that the participants showed no tendency to rely on one source over the others, so that the *feelings* source was indicated to be used as frequently ($M = .59$, $SE = 0.08$) as *thinking* ($M = .51$, $SE = 0.06$) and *looking* ($M = .43$, $SE = 0.07$). A similar conclusion was reached when the analysis was performed on the mean ratings of how much athletes rely on the same three

sources. In this sense, the repeated measure ANOVA revealed a significant main effect, F (2, 34) = 3.66, p =.037, $\eta_p^2 = .18$, [*thinking* (M = 1.97, SE = 0.28); *looking* (M = 1.55, SE = 0.30); and *feeling* (M = 2.61, SE = 0.31)].

These results suggested that athletes are able not only to differentiate the experience of the three sources of information but indeed to report reliance on feelings as a source of information when performing action changes in general. In addition, these results noted the fact that feelings were perceived as the most informative source of information for the participants' actions.

Additional information was provided by correlational analysis, which revealed a significant negative correlation between the informational sources *thinking* and *feeling* (r = -.25, n = 81, p = .022). This result suggested that when athletes rely on feelings as a source, it is less likely that they will rely on thinking. However, it is important to note that the small magnitude found for this correlation may suggest the simultaneous use of the three sources, with one becoming more salient than the others at a specific moment. No other correlations were found between *thinking* and *looking* (r = -.16, p = .148) and *looking* and *feeling* (r = -.19, p = .086).

Finally, the most important information taken from this pilot study was that the participants were able to understand and to differentiate their responses regarding the different sources of bodily information. That is, athletes demonstrated awareness of experiencing simple apprehension of the situation (looking), general bodily feelings and the process of thinking. Moreover, this pilot study informed our goals by suggesting that a) athletes rely on the experience of the three sources of information provided; b) the use of the sources is not mutually exclusive because they can co-exist; and c) one source can be more salient and relatively more relevant than others in a given situation. Most importantly, this pilot study already revealed that athletes acknowledge the experience of feelings as a source of information to guide action.

Main Study

In the main study, we gained better control of the experimental conditions of the participants. Instead of several sports modalities, we decided to focus on only one that could provide us with the kind of fast-paced actions we were interested in investigating. We also determined the specific moments and action changes performed by players by selecting photos of in situ game actions. Thus, in the present study, we investigated whether futsal players rely on feelings as a conscious source of information by opposing action decisions made within a highly dynamic game context (e.g., 1 vs. 1) to action decisions made in less dynamic circumstances (e.g., a penalty kick). Given the feelings-as-information approach, we should

expect feelings to be a more relevant source of information when the context is more ambiguous and difficult. In our case, this means when players are in interaction in a game situation perceived as highly dynamic and with a short window of time to act. In turn, thinking is expected to be a more relevant source when players are in interaction in a less dynamic context and have more time to make their action decision.

Method

Participants

Data were collected from 6 futsal teams of the urban area of Lisbon currently playing at the elite national level (for a recent categorization of expert samples in sports, see Swan, Moran, & Piggott, 2015). The sample analysis consisted of 63 futsal players (M = 26.70 years, SD = 6.05; 26 female), with an average of 12.78 ± 5.14 years of time of practice and 4.75 ± 0.74 hours/week of training load apart from official matches. All the participants participated in the study voluntarily and were informed that their identity would remain confidential. We provided a debrief about the study after the athletes completed the questionnaire.

Materials and Apparatus

To select the game situations for this experiment, we first pre-tested 21 photographs that illustrated 7 game situations performed in situ (i.e., a subset of 3 pictures per situation illustrating 1 vs. 1, 1 vs. 2, kicking-flying-ball, kicking-ground-ball, dribbling, feinting, and dead-ball). All photos were retrieved from the Internet and randomly presented to a sample of futsal coaches and players (N = 17, M = 26.53 years, SD = 9.23 years; M = 11.12 years of practice; SD = 7.58 years of practice). The participants were given a link to an online survey (Qualtrics, Provo, UT), that was created by the authors and were instructed to evaluate each photograph (using a 5-point scale of agreement ranging from 1 – strongly disagree to 5 – strongly agree) based on 3 items: a) it is easy to identify the ball carrier in this action; b) this action is frequent during the course of a game; c) this photograph represents the game situation indicated. The registered scores were subject to a repeated measure ANOVA with 7 *actions* (1-2-3-4-5-6-7) x 3 *photos* (f1-f2-f3) x 3 *evaluations* (E1-E2-E3). After we identified a significant interaction of the three factors, F (24,384) = 11.00, $p < .001$, $\eta_p = 0.41$, for each action we selected the two photos with the highest scores. A survey using the 14 pretested photographs (i.e., 2 photos per situation and all photos with dimensions of 400 x 300 pixels) representing 7 in situ action decisions (1 vs. 1, 1 vs. 2, kicking-flying-ball, kicking-ground-ball, dribbling, feinting, and dead-ball) was created using Qualtrics software (Qualtrics, Provo, UT). Data collection was made using Apple iPad Mini tablets with 7.9-inch retina color display.

Procedure

After receiving authorization from the board of directors, we approached the athletes before training sessions and offered a tablet with the survey to be answered in approximately 20 minutes. All instructions were provided on the tablet screen and informed the participants that they would first be presented with a set of photos performed in situ, and "*After each photo, you will be asked to respond to how you perform this action during the game.*" Three response options were then introduced: *thinking* was represented by words such as *elaboration, calculation,* and *reflection* and exemplified by the following statement: *"By capturing the information with the eye (seeing), I use the knowledge regarding my action capabilities, and I calculate whether I am able to act"; looking* was represented by words such as *pure vision, not thinking anything,* and *not feeling anything* and exemplified by the following statement: *"By capturing the information with the eye (seeing), I directly access my action capabilities. I do it instantly without thinking or feeling"*; and *feeling* was represented by words such as *undefined body sensations, intuition,* and *instinct* and exemplified by the following statement: *"By capturing the information with the eye (seeing), I feel my action capabilities to perform in that moment."* Next, the 14 photos of futsal players performing action decisions in situ were randomly presented one by one (for two examples, see Figure 1). Above each photo, the participants received the following instruction: "*In the next photograph, imagine yourself playing the action of the ball carrier.*" Below each photo, the participants were instructed, "*At this exact moment, you believe that your action will be triggered by…*". Next, the participants saw the three sources (i.e., *thinking, looking,* and *feeling*) followed by their respective associated words. Next to each source of information, we presented a 5-point scaling of intensity (ranging from 1 – very weakly to 5 – very strongly), and the participants scored the intensity of each source's contribution.

Figure 1. Examples of ilustration used for in-situ game actions. (a) On the left side a 1x1 situation; (b) on the right a high-kick situation.

In the second part of the survey, we collected data regarding how the futsal players experienced the context of action illustrated by each photo. Thus, the 14 photos were associated with a set of six semantic differentials, each one with 7 points (point 4 was "neutral) that assessed six different features of the game situation. These features were *automatic-elaborate; uncontrollable-controllable; dynamic-static; complex-simple; unstable-stable; unpredictable-predictable*. In the last part of the survey, the participants were invited to provide personal data regarding their age, gender, time of practice, and training load per week.

Results and Discussion

A measure of reliance on each source was achieved by averaging the ratings of the two photos used to illustrate the same game action. To test the contribution of *Source* and *Game Action* in our dependent variable *Reliance-Ratings*, a restricted maximum likelihood linear mixed-model analysis was run using *Source* and *Game Action* as fixed effects and *Player* as a random effect to model individual differences. We tested the main effect of the *Source* (thinking, looking, feeling and the main effect of the *Game Action* (1 vs. 1, 1 vs. 2, kicking-flying-ball, kicking-ground-ball, dribbling, feinting, and dead-ball) as well as the interaction effect between them.

Acting on thinking, feelings, and looking

The result of *Wald Z* test = 4.60, $p < .001$, 95% CI [.084, .196], attested that the variance among *Players* was significantly different from zero and correctly controlled as a random effect.

Data also indicated that only *thinking* and *feeling* ratings established a relation between them ($b = -.778$, $t = -5.83$, $p < .001$), meaning that when players reported relying more on *feeling*, there was a significant trend to report relying less on *thinking* as a source of information.

Significant main effects were detected for *Source*, F (2, 1240) = 5.343, $p = .005$, and *Game Action, F* (6, 1240) = 8.901, $p < .001$. This means that both *Source* and *Game Action* are potentially important predictors of our dependent variable. A more detailed analysis (see Table 1) revealed that only the *thinking* and *feeling* sources were significantly different from each other and that from the seven *Game Actions* judged, the six performed "on-the-fly" (i.e., embedded in a dynamic course of action) were all significantly different from the static one (both at $\alpha = 0.05$ after performing a Bonferroni adjustment for the multiple comparisons (Table 1).

Table 1

Means (and standard deviation) of source, game-action, and the first order interaction

	Source			
Game-Action	Feel	Look	Think	
1x1	3.69 (.78)	3.61 (.91)	3.62 (.78)	3.64 (.82) [a]
1x2	3.82 (.66)	3.46 (.81)	3.25 (.81)	3.51 (.80) [a]
Dribbling	3.54 (.84)	3.72 (.69)	3.65 (.77)	3.64 (.77) [a]
Feinting	3.91 (.91)	3.26 (.89)	3.32 (.94)	3.50 (.96) [a]
Ground-Kick	3.52 (.76)	3.59 (.78)	3.34 (.77)	3.48 (.77) [a]
High-Kick	3.92 (.92)	3.57 (.77)	3.30 (.87)	3.60 (.89) [a]
Stop-Ball	3.44 (1.04)	4.19 (.84)	4.22 (.78)	3.95 (.96) [b]
	3.69 (.87) [a]	3.63 (.85) [a b]	3.53 (.87) [b]	

Letters shared within each factor indicate no significant difference. The mean difference is significant at the .05 level

The results also revealed that the effects of the *Source* differed by *Game-Action*, F (12, 1240) = 8.986, $p < .001$ and that this interaction seemed to sustain the hypothesis that the use of feelings as a source of information is more likely to occur when performing game actions under specific conditions. Figure 2 illustrates the pattern of data associated with this interaction.

As Figure 2 suggests, the variations found for *feeling* and *thinking* as sources of information are associated with the degree of dynamism of those actions. Players rely more on *feeling* as a source of information when performing the dynamic game actions than when performing the static one (which has a higher reliance on *thinking*).

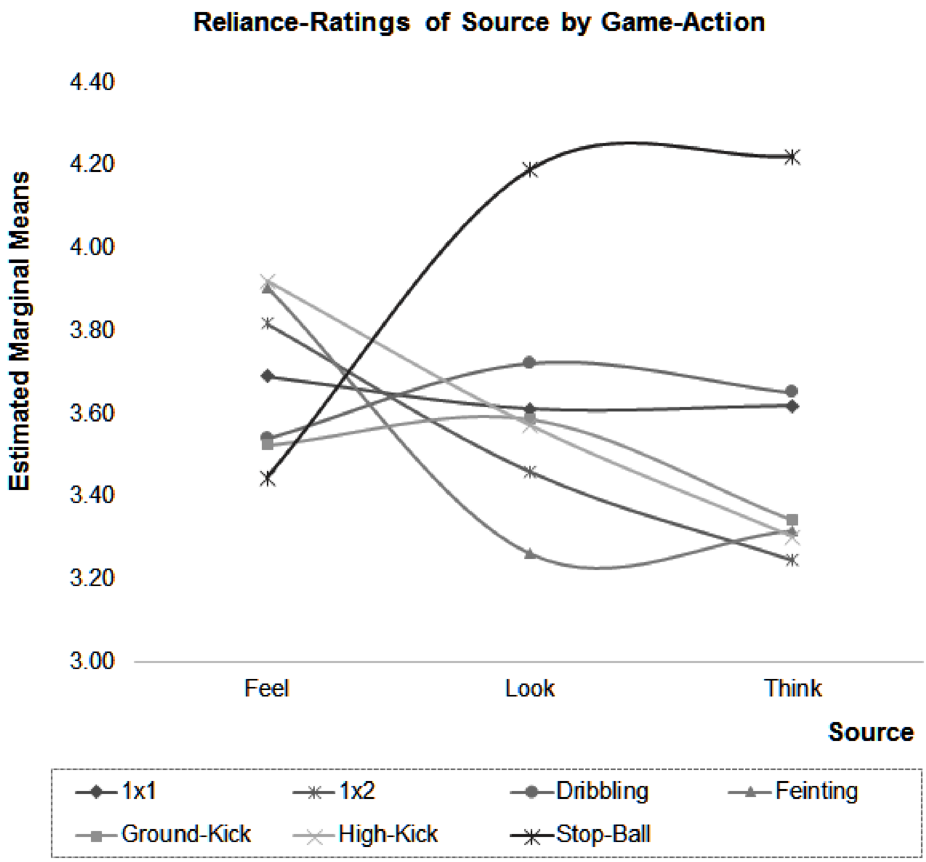

Figure 2. Reliance ratings indicated that futsal players' awareness of thinking as source is intensify during stop-ball situations (i.e., penalty-kick, corner-kick and free-kick), whereas feeling as source is intensify when performing within the course of an action.

Comparing in-situ game situations that rely more on feelings than thinking as sources

In order to characterize the game situations where athletes report to rely more on feelings versus deliberative thinking to guide action, we identified the two game situations with higher average score in feeling as a source (i.e., feinting and high-kick), versus the two game situations with higher average score in thinking as a source (i.e., dribble and stop-ball) (see Table 1).

We further compared the two game situations regarding the features measured by the six different semantic scales. We first averaged those ratings over the two photos of the same game situations and introduced them as measures in a repeated measures MANOVA defined by 2*Types of Situation* (high-feeling vs. high-thinking) x 6 *Contextual Features* (automatic-elaborate; uncontrollable-controllable; dynamic-static; complex-simple; unstable-stable; unpredictable-predictable). The results indicated that the two situations differed in their

Contextual Features, F (1, 6) = 25.75; p <.001; η_p^2 = 0.73; *Wilks* = .27, and a subsequent univariate analysis clarified that the differences were found across all features (Table 2).

Table 2

Mean, standard, and univariate analysis of high-feel versus high-thinking game actions

	High Feel *M (SE)*	**High Think** *M (SE)*
Contextual Feature		
automatic-elaborate	3.97 (1.54)	5.35 (1.15) ***
uncontrollable-controllable	3.83 (1.24)	5.46 (0.99) ***
dynamic-static	2.75 (1.12)	3.77 (0.96) ***
complex-simple	2.79 (0.91)	4.68 (1.13) ***
unstable-stable	3.32 (1.23)	4.88 (0.88) ***
unpredictable-predictable	2.94 (1.09)	4.13 (1.16) ***

*** $p < .001$

Overall, these results suggested that players rely more on feelings as a source of information to guide action when the situational context is perceived to be more automatic, uncontrollable, dynamic, complex, unstable and unpredictable. In contrast, players rely more on thinking as a source of information to guide action when the situational context is perceived to be more elaborate, controllable, static, simple, stable, and predictable.

General Discussion

A pilot study and an experimental study investigated whether athletes believe themselves to rely on feelings as a source of information for perceiving their own action capabilities. The results of both studies indicate that they do. The results suggest that athletes believe themselves relying on three different sources of information that we provided for them: visual looking, bodily feelings and deliberative thinking. Thus, although not exclusively, the results clearly show that athletes believe to rely on feelings as a source of information for their action capabilities. Data from study 2 also indicates that athletes' naïve theories report the use of feelings especially when actors are performing on the fly rather than in stationary situations (the latter being a game situation in which thinking seems to be a more salient source).

Being clear in suggesting that athletes acknowledge that they rely on feelings, our data allow us to speculate that feelings may in fact be an informational route for immediate information regarding the dynamic properties of action. Indeed, the fact that reliance on feelings

increases in association with game conditions embedded in a context featured as complex, uncertain and with actions performed under time pressure suggests that athletes rely on feelings as a heuristic route to rapid evaluation (for instance, whether they are fast enough, too tired), which is similar to the feelings-as-information hypothesis (Schwarz, 2012; Schwarz & Clore, 2007, 1983). However, this hypothesis needs more direct and robust research.

Indeed, future research should acknowledge that authors, such as Zadra and Clore (2011), have argued that as a source of information, feelings are likely to be integrated into the perceptual mechanism and to inform costs and benefits, allowing action decisions that minimize negative and maximize positive outcomes. Thus, it is likely that under an invitation for action with a higher energetic demand versus an invitation with a lower energetic demand to solve a goal-directed behavior, actors will follow the second course of action. Evidence favoring this assumption comes from studies showing that feelings of comfort and discomfort moderate the choice to insert or remove degrees of freedom in a postural movement and that actors rely on a preferred critical boundary rather than a biomechanical critical boundary regarding their action capabilities (Mark, et al., 1997; Petrovic, Berg, Mark, & Hughes, 2015). Moreover, in his pioneer work of perceived climb-ability, Warren (1984) indicated that action could be guided by “optimal points,” described as preferred regions of minimum energy expenditure that may be translated into feelings.

In this sense, future research should try to clarify and to understand the nature of the feelings that athletes report relying on. Most of the research linking feelings and motor action in the sports context have focused on the role of discrete emotions (e.g., anxiety) in relation to performance (e.g., Hanin, 2007) and choking under pressure (e.g., Beilock & Carr, 2001). However, not all experiential feelings are emotional. There is a wide range of non-emotional feelings working as the body’s own grammar, which signals suspension of the invariance (i.e., changes) (Massumi, 2002) and arises and disappears in a short period of time. Some of these feelings have been associated with mental operation as the feelings of familiarity (e.g.; Garcia-Marques, Prada & Mackie, 2016; Garcia-Marques, Mackie, Claypool, & Garcia-Marques, 2004) and fluency of processing (e.g., Alter & Oppenheimer, 2009; Winkielman, Schwarz, Fazendeiro, & Reber, 2003), which have been associated with subjective experiences of pleasure, positivity and easiness. Others have been claimed as the core of our body awareness and affective experience and described as signaling homeostasis and changes in our bodily systems (e.g., triggered by muscle contractions or an increase in heart rate) (e.g., Bechara & Naqvi, 2004; Cameron, 2001; Graig, 2009, 2002) – the so-called interoceptive feelings.

Therefore, rather than being discrete emotions (Ekman, 1999; Plutchik, 2001), "non-emotional feelings" present dimensions that underlie specific emotions (i.e., pleasure-displeasure and activation-deactivation). As such, they are supported by an online streaming "grounded in the somatovisceral, kinesthetic, proprioceptive, and neurochemical fluctuations that occur within the core of body" (Barrett & Bliss-Morreau, 2009, p.04). Although non-emotional feelings work as bodily information without the need to constantly cross the threshold of our consciousness (and engage in the constructive process assembled by emotions, Lindquist, Wager, Kober,, Bliss-Moreau, & Barrett, 2012), during a flow of events, the homeostatic state of these feelings can quickly change in dynamic ways (see Duncan & Barrett, 2007; Russell, 2009; Damásio, 1999) and become informative. If so, it is likely that actors would experience action based on those feelings.

Data from our studies do not allow any conclusion or provide answers to several relevant questions regarding the underlying mechanism of how feelings can inform action capabilities and integrated action decisions. The aim of this paper is merely to open new perspectives based on evidence collected from the reports of expert athletes regarding their naïve theories of what guides their actions. Future research should clarify the exact role of the subjective experience of bodily feelings as a route of information for action capabilities and its inherent relation to affordance detection. In addition, the hypothesis that the athletes' reports constitute only an illusory naïve theory should not be ruled out.

Conclusion

We concluded, based on the reports of expert athletes, that their naïve beliefs are that feelings can be an immediate and direct route of information to support perceived action capabilities and to guide fast-paced actions.

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Relying on feelings as information to estimate action capabilities over dynamic events [*]

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Highlights

- Facial EMG provided evidences of feelings activated when visually scaling action capabilities.
- Corrugator was elicited when estimating action over dynamic events, but not to only watching them.
- Induced corrugator activity via subliminal priming postponed the perceived action estimation.
- Corrugator was integrated as non-visual information when scaling action over dynamic events.

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Abstract

This paper presents evidence suggesting that people are informed about their action capabilities regarding dynamic events by the set of feelings that are activated when they are exploring the event. In a first experiment, correlational data showed that facial EMG measures that may be associated with affective experiences are also associated with perceived action capabilities. A second experiment revealed that the manipulation of affective experiences (subliminal affective priming) with a possible impact on EMG correlates had an impact on the visual scaling process. The results show that these manipulations postponed the estimation of the fit between the actor's body and the properties of the environment. Overall, our data suggest greater relevance of the corrugator activity and thus possible negative affective reactions in modulating the assessment of our own action capabilities when reacting to a dynamic event under time pressure.

***Keywords*:** perception, embodiment, corrugator, arousal

1. Introduction

Embodiment theories have addressed the perceptual system and sensorimotor and affective systems as being part of cognition rather than merely existing in its aftermath (e.g., Barsalou, 2008; Clark 1999; Profitt, 2006; Shapiro 2011; Wilson & Golonka, 2013). Previous studies have shown that as actors, we constantly rely on our interoceptions as information. This means that even without awareness of its influence, we rely on the senses offered by our internal bodily changes as heuristics to support evaluative judgments (e.g., Ducan & Barrett, 2007; Pessoa, 2008; Winkielman, Knutson, Paulus & Trujillo, 2007).

Evidence of these mechanisms is clearly stated by the mood/feeling-as-information theory, with data showing that when experiencing negative moods, people judge events as worse than when experiencing positive mood (e.g., Clore, 1992; Schwarz & Clore, 2007, 1983). Similarly, studies related to either processual or perceptual fluency have been linked to evidence showing that high perceptual fluency is experienced as a positive feeling (Garcia-Marques, Mackie, Claypool & Garcia-Marques, 2010; Garcia-Marques, Prada & Mackie, 2016; Winkielman & Cacioppo, 2001). Moreover, other evidence has shown that states of low levels of fluency are associated with negative judgments, while high levels are associated with positive judgments (Reber, Winkielman & Schwarz, 1998; Topolinsk & Strack, 2009). Importantly, subjective experiences (i.e., feelings), such as those described as mood and fluency, are subtle states that do not necessarily encompass the constructive process associated with emotion and language (Barrett, 2006; Lindquist, Satpute, Wager, Weber, & Barrett, 2016). Rather, these types of experiences are resonances of the constant streaming running in the background of the organism with transient alterations denoting the language of the body (see Massumi, 2002 for a discussion). Indeed, several authors have acknowledged the role of sensorimotor information in our affective and cognitive systems (e.g., Damasio, 1999; Pessoa, 2008; Russel, 2009), suggesting that these basic and psychologically primitive states are likely to be experienced at the level of hedonic valence (pleasure/displeasure) and arousal (activation/sleepy) (Russel, 2009; 2003).

By showing clearly that incidental affect informs evaluative judgments (for a review, see Schwarz, 2012), the literature suggests that feelings have a prominent role in our cognition. Here, we first relate this role to the judgments of action capabilities, and we hypothesize that feelings offer information about the perceptual fit of the actor's action capabilities and the relevant environmental properties when performing goal-directed tasks under time pressure.

The actor-environment fit underpinned Gibson's (1979) affordances theory, which has been investigated under the intrinsic metric assumption of visually scaling the physical properties of the world according to the actor's phenotype and action boundaries (e.g., Fajen, 2007, 2005; Proffit & Linkenauger, 2013; Warren, 1984; Witt, 2011). Rather than perceive the world in terms of meters, angles or retinal displacements, to guide themselves and detect opportunities for action, i.e., affordance (Gibson, 1979), the actors need to rescale size and time according to their own body dimensions and action capabilities. Evidence has shown that the relationship between the actor's boundaries and the reciprocal properties of the environment constrains the visual perception of affordances. For example, the physical ratio of the actor's leg length and the stair height determine whether a stair is climbable or unclimbable (Warren, 1984). Similar relationships have been found when investigating the relationship between shoulder width and the pass-ability of apertures (Higuchi, Cinelli, Greig & Patla, 2006) or between hand-size and the grasp-ability of tools (Linkenauger, Witt, & Proffitt, 2011).

Aside from the body-scale mechanism, evidence has also shown that actors quickly re-scale affordances according to bodily changes. Thus, when the actors' height was experimentally modified with the use of platform shoes, they quickly rescaled their new height and added it to the assessment of perceived sit-ability and climb-ability (Mark 1987; Warren & Whang, 1987). The same occurred when the actors wore hand-enlarging prostheses and judged the perceived pass-ability of their hands with different gaps (Ishak, Adolph, & Lin, 2008). Interestingly, this effect is detected both when the bodily change is caused by a natural source of change, such as pregnancy (Franchak & Adolph, 2014), and when it is caused by an induced illusory source (Linkenauger, Leyrer, Bülthoff, & Mohler, 2013; Piryankova et al., 2014).

Although no direct statement has been made regarding the roles that body sensations and subjective experiences have in perceptual fit, evidence has shown that affects (which rely on these subjective experiences) interfere with them. Induced states of fear (Geuss, McCardell & Stefanucci, 2016; Stefanucci, Gagnon, Tompkins & Bullock, 2012) and levels of anxiety (Graydon, Linkenauger, Teachman & Profitt, 2012; Pijpers, Oudejans, Bakker & Beek, 2006) are associated with the rescaling of action and action estimation.

Taken together, the reviewed evidence appears to suggest that the (re)scaling mechanism is strongly associated with bodily subjective experiences. Actors do not appear to perceive the world in terms of meters and kilograms (i.e., physical measures) nor in terms of mathematical relations between these physical properties, such as in the ratio between leg length

and stair height. However, this information needs to be present to inform the actors about their action capabilities. Therefore, knowing that these relations constrain and rule the fit, a relevant question is what tells the actors that the action category changed from impossible to possible and vice versa (see Heft, 2003). Thus, in the literature, some questions remain open: What really signals the fit? How do we as actors gather information about our own body dimensions and action capabilities? How does this information guide our actions quickly enough and with sufficient accuracy to perform the necessary movements and adjustments to fit the physical constraint of the current action?

Here, we propose and offer relevant data to test an embodied cognition hypothesis that suggests that feelings and subjective experiences work as experiential and evaluative information upon which actors learn to rely when acting in dynamic environments. We address this hypothesis with correlational and experimental evidence: in the Experiment 1, we present dynamic events unfolding in time and capture changes in affective experiences at the level of physiological correlates (Larsen, Norris, & Cacioppo, 2003) by recording the electrical activity of the facial muscles *corrugator supercilii* and *zygomaticus major* as an indicator of spontaneous activation of valenced feelings (Cacioppo, Petty, Losch, & Kim, 1986; Dimberg, Thunberg, & Grunedal, 2002). To detect how these feelings are related to the action itself and not only to the perception of a dynamic event, we compared the EMG activity of participants in two different conditions: a control condition in which participants only watch the dynamic events and a goal-task condition in which they have to watch and estimate their own action capabilities. We expected that the participants' facial EMG reactions would reflect the valence-arousal dimensions that are activated at the affordance detection moment, which is supposed to support the actor-environment fit.

In Experiment 2, we test whether we are able to interfere with the participants' affordance detection process by promoting changes in how the participants felt. To do this, we relied on the affective subliminal masking priming paradigm to induce mimicry (see Niedenthal, 2007), activating either the corrugator or the zygomaticus. Here, the embodiment perspective hypothesis (Barsalou, 2010, 2008) leads us to believe that a sensorimotor reenactment in a situated action can trigger concurrent automatic simulations that can either interfere with (facilitating or inhibiting the action outcome through a match or mismatch) or block the simulation if the current task involves the same sensorimotor activation (Körner, Topolinsk & Strack, 2015). Thus, in this second experiment, we expected that the affective experiences induced by the primes would interfere with the perceived fit underlying the

affordance detection process. This likely occurs because these experiences inform the concomitant action capability.

2. Experiment 1

2.1 Methods

2.1.1 *Participants and design*. After giving informed consent, twenty-four graduates (23.83 ± 4.54 years; 11 males and 4 left-handed) participated in this experiment and received monetary compensation. None of the participants suffered from attention disorders, and all showed normal-to-corrected visual acuity.

All participants' facial muscle activation was assessed in two conditions: watching the dynamic event (*W-condition*) versus watching the dynamic event and judging the action capabilities (*WJ-condition*). For both conditions, the participants had to interact with two dynamic visual events that were counterbalanced for order: a 3D baseball that was shrinking and a 2D square with an aperture opening. This reflects a 2 *Task-Goal* (W x WJ) x 2 *Dynamic-Visual-Events* (shrinking x opening) and the respective *Time-Windows* (with a 100 ms interval) as within-subject factors.

2.1.2 *Dynamic visual events.* A set of videos with dynamic visual events lasting 800 ms was pre-tested for perceived speed (1-very slow to 7-very fast). Two videos were selected as being dynamic fast events (i.e., *M*= 6). One dynamic event shows a 3D baseball image shrinking in size and supported judgments of perceived grasp-ability (Figure 1a). The other video shows a 2D square with the aperture size growing, and it was used to estimate the actors perceived pass-ability (Figure 1b).

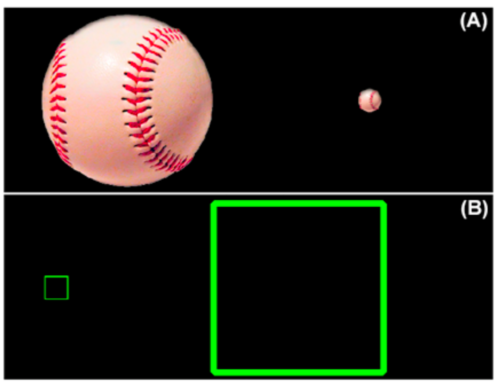

***Figure. 1.* The dynamic events. (A) The shrinking baseball to estimate grasp-ability; (B) The square opening aperture to estimate pass-ability.**

Adobe Photoshop (Adobe Photoshop CC, Version 14.2 x64) was used to create a total of 20 images of decreasing size. A first image of a 3D baseball (150 pixels per inch and 252.5 pixels in diameter) was centered on a black background (800x600 pixels), with a second image created by duplicating and reducing the original image by 10% (same proportions). A third image was created from the second one by applying the same procedure, and this process was repeated successively until a total of 20 images with the ball shrinking were obtained. Afterward, to create the motion event, each image was placed with 40 m/s of timing exposure and was rendered to a video file using Windows Movie Maker (Windows Movie Maker, Version 2012, 16.4.3528.0331). The same process was applied for the first 2D square image (150 pixels/inch of resolution and distance between outlines equal to 472 pixels) to create the second motion event of a square aperture size growing.

2.1.3 *Apparatus.* The tasks were programmed in E-Prime 2.0 software (Schneider, Eschman, & Zuccolotto, 2002) with the two dynamic events presented against a black background on a 23-inch monitor (1024 x 768 resolution) that was positioned 50 cm away from the actors. All responses and key release times were recorded with a PST Serial Response Box with 1.0 ms of precision (Psychology Software Tools Inc., Sharpsburg, PA).

2.1.4 *Facial EMG Recording.* The electrical activity was measured over the zygomaticus and the corrugator on the right side of the face using bipolar placements of 4-mm Ag/AgCl surface-electrodes (Fridlund & Cacioppo, 1986) and with 1.5 cm of distance between electrode centers. The skin surface was cleansed and gently abraded before placing the electrodes, which were filled with the appropriate conductive gel (i.e., saline paste). Raw EMG signals were collected with a Biopac MP100 system (Biopac Systems Inc., Goleta, CA), which was amplified by a factor of 5,000 and sampled at a 1,000 Hz frequency with an online 10 Hz low cutoff filter, a 500 Hz high cutoff filter, and a 50 Hz notch filter. Other physiological measures were also collected (i.e., ECG and skin conductance). The ground electrode for the EMG measures was in the left hand (i.e., skin conductance electrodes, in accordance with the Biopac guidelines).

2.1.5 *Procedure.* After the participants gave informed consent, they were seated in front of a computer screen on an individual room for electrode placement. The experimenter moved into an adjacent room, where she was able to control the physiological measurements. All instructions were presented on the computer screen. The participants were asked to use only their right hands to indicate their responses; the hand position was standardized by displaying a set of hand pictures. All participants performed two tasks with the dynamic events order

counterbalanced. One task (control condition) had 10 trials, in which the participants were asked to only watch the dynamic event at the display. The second task was performed with the same material by asking participants to release a key at the moment they estimate being able to perform an action (grasp or pass). Thus, for the 15 grasp-ability trials, the participants were instructed to "press this key and release it when you feel that your hand can grasp the ball". In turn, for the 15 pass-ability trials, the participants were instructed to "press this key and release it when you feel that your hand can pass through the aperture". Each trial started with a fixation cross that varied randomly and equally between 2,000 ms and 2,200 s. In the control condition, the participants watched the entire video (i.e., 800 ms), while in the experimental condition, video presentation stopped when the participants released the key box. At the end of each trial, a blank screen remained onscreen for 1,500 ms (inter-trial interval).

2.1.6 *Measures*

2.1.6.1 *Release-key-moment (RKM).* The time spent to release the key of available trials (94% of all possible trials) were all recorded and subjected to an outlier analysis when considering the responses of each participant at each dynamic event. A further 1.78% *RKM,* which was identified as 3 times the participant's average standard deviation, was removed, together with the respective EMG information.

2.1.6.2 *Psychophysiological measures.* The electromyography activity of the valid *RKM* trials were visually inspected (noise, artifacts and anomalous waveforms) and were filtered offline with a bandpass range of 20-400 Hz and was rectified and smoothed over a 20 ms moving window. To control for the baseline activity, the EMG scores, including the activity in the given trial and a pre-stimulus level — i.e., the mean activity during the 500 ms before video onset — were calculated. The EMG scores were aggregated over the 2000 ms (i.e., from 500 ms before video onset until 1600 ms after video onset), and trials with EMG activity above 3 times the participant's average standard deviation were eliminated (9.13 ± 0.70 trials per participant in the *W-condition* and 12.63 ± 1.44 trials per participant in the *WJ-condition*). Because *EMGc* (*corrugator supercilii*) and *EMGz* (*zygomaticus major*) vary inversely as a function of valence (Greenwald, Cook, & Lang, 1989; Larsen et al., 2003), a valence composite index was created to facilitate the data interpretation by subtracting the standardized values of the final time series of a muscle by the other (*EMGv = EMGz - EMGc*). A standardized value of activation of the valence composite index (*EMGv*), as well each independent facial muscle activity (i.e., *EMGz and EMGc*) was created to overcome the individual differences.

2.1.6.2.1 *RKM-window*: To analyze the muscle activity occurring with reference to the participants' moment of judgement, we defined the 100 ms window within which the key release was recorded, and we named it the "*RKM-window*". Because previous studies show a difference in the offset between the time a person decides to respond and the motor response being performed (electromechanical delay of approximately 22 to 100 ms; Cavanagh & Komi, 1979; Hug, Gallot, Catheline, & Nordez, 2011; Zhou, Lawson, Morrison, & Fairweather, 1995) we assume that action capability estimation precedes the moment in which the participants press the key, and we defined the initial point of the first window of analysis as starting 200 ms before each individual *RKM-window* (-200 ms RKM). Because previous research suggests that facial EMG measurements may have a delay of 300-400 ms of measurement, sometimes with clear-cut reactions 500-1000 ms after a stimulus onset (see Dimberg & Pettersson, 2000; Dimberg et al., 2002) we define the final point of the first window of analysis as 800 ms after the *RKM-window* (+800 ms RKM). To align the *W-condition* (i.e., without RKM) with the *WJ-condition*, an *RKM-index* was created by averaging the participant's RKM values of *WJ-condition* to extract the equivalent time-window (i.e., from the -200 ms RKM index until +800 ms RKM index) for the *W-condition*. Repeated measure ANOVA compared the facial activation under the eleven epochs of the time window for both conditions (*W vs. WJ*) and tested whether an affective reaction was promoted by the task goal providing information that signals the action-fit moment.

2.1.6.2.2 *END-window*: Because the actors watched the entire video (800 ms exposure) in the *W-condition* and the actors watched the video until they released the key in the *WJ-condition*, it is possible that differences in the electrical activity of facial muscles occurring before 800 ms was caused by one condition that easily indicated the end of the video and another that did not. To test whether the video endpoint promotes a facial reaction, we analyzed data with that moment as a reference point. Hence, we created data in a window that started 100 ms before the end-window (-100 ms *END-window*) and finished at 500 ms after the end-window end point (+500 ms *END-window*). For the *W-condition,* the endpoint window is equal to the *video-END*, whereas for the *WJ-condition,* the endpoint window is equal to the *RKM-window*.

2.2 Results and Discussion

An analysis of all the various measures was performed using repeated or mixed ANOVA models that were defined by the design in which a gender factor was associated whenever relevant to control for individual differences. The analysis aimed to both characterize

participants' reactions to our experimental conditions and identify whether there was any evidence of a relationship between the moment of feeling activation and the moment of the actor's response, given that it would support the hypothesis that the feelings inform that response.

2.2.1 Release-key-moment (RKM) analysis

The *RKM* means of the *WJ-condition* were subject of a two-way mixed ANOVA with 2 *Gender* (female x male) and 2 *Dominant-Hand* (right and left) components as between factors, and 2 *Dynamic-Visual-Event* (shrinking x opening) components as within-factors. A robust main effect of the *Dynamic-Visual-Event* was found, $F(1,20) = 40.84$, $p < .001$, $\eta^2 = 0.67$, indicating that on average, faster responses are captured when judging their grasp-ability (M = 432.18, SD = 36.52, 95% CI [356.00, 508.36]) than when judging their pass-ability (M = 620.39, SD = 31.56, 95% CI [554.56, 686.21]). It is possible that this occurs because the relationship between the hand size, material and tasks created different situational constraints, with the optimal time-window for judgement occurring before the grasp-ability (i.e., the participants had greater time pressure for withdrawing information when estimating grasp-ability). No other effects were found (all $F<1$).

2.2.2 Psychophysiological measures

Analysis were first run for the *RKM-window,* and second for the *EMG analysis of END-window.* Both windows the analysis were first run with the v*alence composite index (EMGv)* and then followed by analysis having the corrugator and the zygomaticus activity separately as dependent measures. Tests of all the ANOVA model assumptions were performed before each analysis. Greenhouse-Geisser correction of degrees of freedom were applied when Mauchly's Test indicate violations of the sphericity assumption (see Supplement 1).

2.2.2.1 *RKM-window*: Each dependent measure score (*EMGv scores; Corrugator activity or Zygomaticus activity*) was controlled for individual differences by considering the baseline activity. These measures supported three different repeated measure ANOVAs defined by 2 *Task-Goal* (W x WJ) x 2 *Dynamic-Visual-Events* (shrinking x opening) and 11 *Time-Windows* (11 x 100 ms). The time-windows of the two experimental conditions were aligned according to the *RKM-index* (*W-condition*) and *RKM-window* (*WJ-condition*) as described above.

2.2.2.1.1 *Valence composite index (EMGv)*. The main effect for *Time-Window*, $F(4.031,92.729) = 4.20$; $p = .004$, $\eta^2 = 0.15$, suggests that the activation of the corrugator relative to the

zygomaticus increased with time. This effect is likely to be moderated by the task goal, as documented by a non-reliable interaction between *Task-Goal* and *Time-Window*, $F(4.045,93.024) = 2.29$; $p = .065$, $\eta^2 = 0.09$ (see Figure 2).

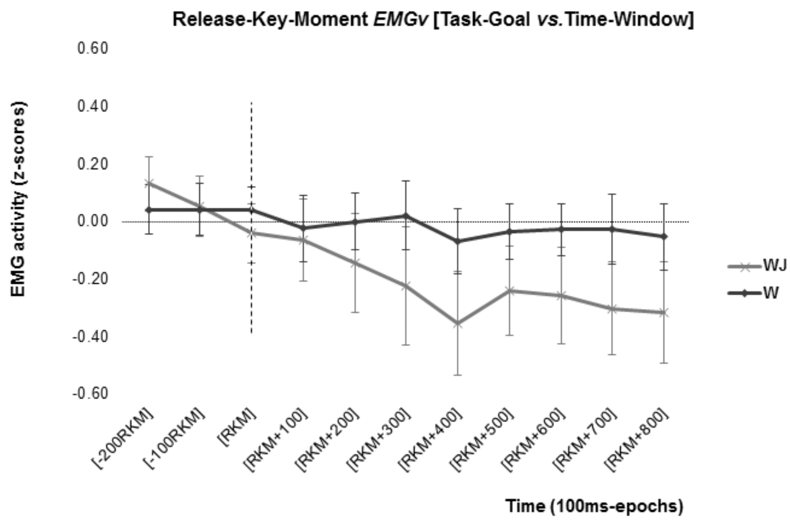

Figure 2. **Activation behavior of the *valenced composite index* (*EMGz-EMGc*) controlling for the baseline and after having been aligned by the release-key moment (dashed line).**

To understand whether the increase of the corrugator relative to the zygomaticus activity was associated with the release of the key, we ran linear contrasts that were separated for each experimental condition. As hypothesized, the linear trend was significant for the *WJ-condition*, $t(23) = 3.72$, $p < .01$, d = 1.55, but not for the *W-condition*, $t(23)=1.03$, $p = 0.341$, d = 0.43. This suggests that the facial muscle contraction is signaling a valence response that is likely to be associated with the process activated when the actors establish their action capability estimation for the dynamic event.

The ANOVA also shows two other possible effects. One is a non-reliable main effect for *Task-Goal*, $F(1,23) = 3.45$; $p = .076$, $\eta^2 = 0.13$, which documents the effect previously detected, whereas for the *WJ-condition,* the corrugator was more active than the zygomaticus (M = -0.16, SD = 0.40, 95% CI[-0.98, 0.66]); there was no difference in these muscle activations in the *W-condition* (M = 0.01, SD = 0.25, 95% CI [-0.52, 0.50]). The other effect is the main effect for *Dynamic-Visual-Event*, F(1,23) = 3.88; $p = .061$; $\eta^2 = 0.14$, suggesting greater activity of the corrugator than the zygomaticus when analyzing pass-ability {M = -0.16, SD = 0.34, 95%

CI [-0.87, 0.55) than grasp-ability (*M* = -0.01, *SD* = 0.30, 95% CI[-0.63, 0.61]). No other effects were found (all $F<1$).

2.2.2.1.2 *Corrugator Supercillis (EMGc)*. In line with analyses of *EMGv*, the ANOVA revealed significantly higher activation of the corrugator in the *WJ-condition* (*M* = 0.26, *SD* = 0.29, 95% CI [-0.33, 0.85]) compared to the *W*-condition (*M* = 0.11, *SD* = 0.19, 95% CI [-0.29, 0.51]), $F(1,23) = 4.69$; $p < .05$, $\eta^2 = 0.17$ and in the pass-ability (*M* = 0.26, *SD* = 0.23, 95% CI [-0.23, 0.74]) compared to the grasp-ability (*M* = 0.11, *SD* =0.24, 95% CI [-0.38, 0.60]) task, $F(1,23) = 5.34$; $p < .05$, $\eta^2 = 0.19$. The activity of the corrugator changed significantly with time, $F(3.843,88.383) = 8.51$; $p < .001$, $\eta^2 = 0.27$] (Figure 3a) in a very similar way in both experimental conditions (*Task-Goal* x *Time-Window*, $F(3.278,75.395) = 1.91$; $p = .129$; $\eta^2 = 0.08$] (Figure. 3b).

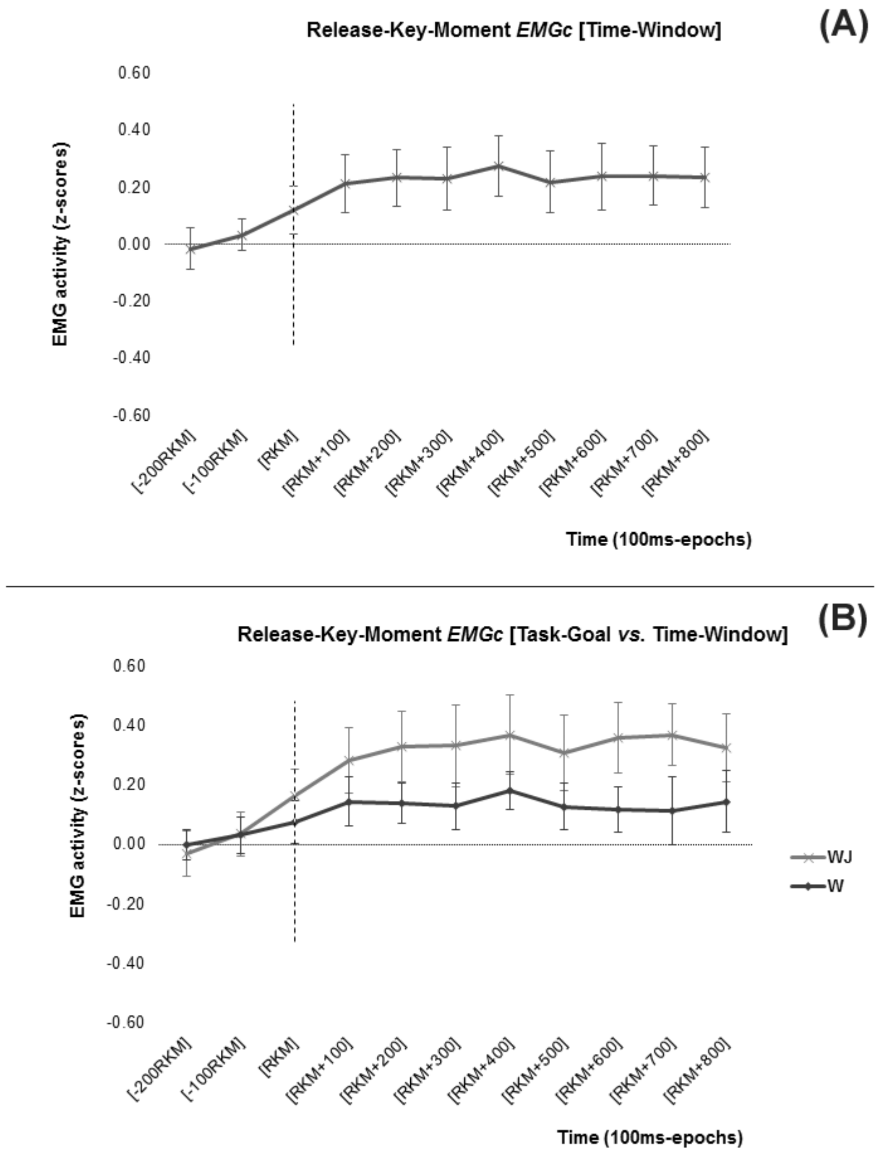

Figure. 3 **Corrugator activation controlling for the baseline and after having been aligned by the release-key moment (dashed lines). (A) Corrugator activation across time. (B) Corrugator activation when watching (*W*) and watching and judging the fit moment (*WJ*).**

To directly test our hypothesis that a different pattern is underlying in these changes, we separately test the presence of a linear trend in both conditions (*WJ vs. W*). Suggesting that the increase of the corrugator with time is more clear when a judgment of action capability was requested, we found a linear trend for the *WJ-condition*, $t(23) = 3.58$, $p = .002$, d = 1.50, but not for the *W-condition*, $t(23) = -1.49$, $p = .151$, d= 0.62. No interactions were found between *Task-*

Goal and *Dynamic-Visual-Event* (F<1), between *Dynamic-Visual-Event* and *Time-Window*, [F(4.666,107.316) = 1.29; *p* =.278], or for the second order interaction between *Task-Goal*, *Time-Window* and *Dynamic-Visual-Event* [F(5.130, 117.998) = 1.56; *p* = .176].

2.2.2.1.3 *Zygomaticus Major (EMGz)*. Documenting that the valence effects previously found were mainly due to the activity of the corrugator, no main effects were found with this dependent measure for *Task-Goal* (*F*<1), *Dynamic-Visual-Event* (*F*<1) or *Time-Window*, *F*(3.670, 84.410) = 1.46, *p* = .226. Equally, no first- or second-order interactions were found (all F<1). This suggests that zygomaticus activation is not relevant in the process for triggering the estimation of action capabilities.

2.2.2.2 *EMG analysis of END-window:* The analysis of the *END-window* aims to guarantee that the differences detected between the two experimental conditions are not caused by the video-end occurring in different moments in each experimental condition. Each of the mean EMG scores (controlling for baseline activity) analyzed above were now subject to a repeated measure ANOVA 2 *Task-Goal* (W x WJ) x 2 *Dynamic-Visual-Events* (shrinking x opening) and 7 *Time-Windows* (7 x 100 ms) as within-subject factors and after having being aligned based on the *END-window* (i.e., *video-ENDPOINT* for *W-condition,* and *RKM-window* for *WJ-condition*).

2.2.2.2.1 *Valence composite index (EMGv)*. No main effect reaches the conventional standards of significance. *Task-Goal* did not appear to generate any effect, *F*(1,23) = 2.09; *p* = .162, η^2 = 0.08. The analysis detected greater activity in the corrugator when facing pass-ability (*M* = -0.17, *SD* = 0.30, 95% CI [-0.80, 0.46]) compared to grasp-ability (*M* = -0.02, SD = 0.27, 95% CI [-0.58, 0.55]); however, the effect was not reliable, *F*(1,23) = 3.52; *p* = .073, η^2 = 0.13. Although the main effect of *Time-Window* does not reach significance, *F*(2.157,49.607) = 2.78; *p* = .068, η^2 = 0.11, a more powerful contrast revealed the presence of the linear trend associated with the increase of the corrugator relative to the zygomaticus with time, *t*(23)= 2.08, $p < .05$, d = 0.87. As previously detected, *Task-Goal* moderates the effects of *Time-Window*, F(3.365,77.383) = 3.04, *p* = .029, η^2 = 0.12. Thus, even when the two experimental conditions are calibrated for the end of the video, we can detect that the linear trend was significant for the *WJ-condition*, *t*(23) = 2.89, *p* = .008, d = 1.21 but not for the *W-condition* (*t*<1) (Figure 4).

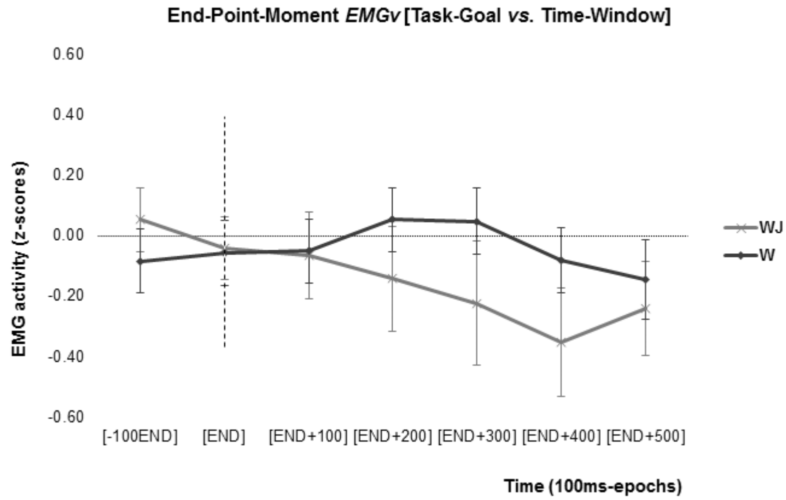

Figure 4. **Activation behavior of the *valenced composite index* (*EMGz-EMGc*) controlling for the baseline and after having been aligned by the end-point moment (dashed line).**

By replicating the effects previously observed, when controlling for the moment where the video ended, we can guarantee that the differences observed in the activation of the corrugator were not due to the different ends involved in the task conditions but were probably due to the task action itself.

2.2.2.2.2 *Corrugator Supercillis (EMGc)*. This analysis of the corrugator documents the effects previously detected, revealing a main effect for *Dynamic-Visual-Event,* $F(1,23) = 4.99$; $p < .05$, $\eta^2 = 0.18$, with increased activity of the corrugator for pass-ability ($M = 0.28$, $SD = 0.21$, 95% CI [-0.15, 0.71]) compared to grasp-ability ($M = 0.12$, $SD = 0.23$, 95% CI [-0.37, 0.61]) and the non-reliable effect of *Time-Window*, $F(2.683,61.703) = 2.34$, $p = .089$, $\eta^2 = 0.09$. Time effects was again shown to be moderated by *Task-Goal*, $F(3.561,81.898) = 6.48$; $p < .001$, $\eta^2 = 0.22$ (Figure 5). A linear trend of corrugator activity (i.e., higher than the baseline) was found for *WJ-condition*, $t(23)= -2.76$, $p =.011$, d= 1.15, and not for *W-condition* ($t<1$). No other first-order interactions were found (all $F<1$), and no second-order interactions were found, either, $F(4.243, 97.580) = 1.85$, $p = .122$.

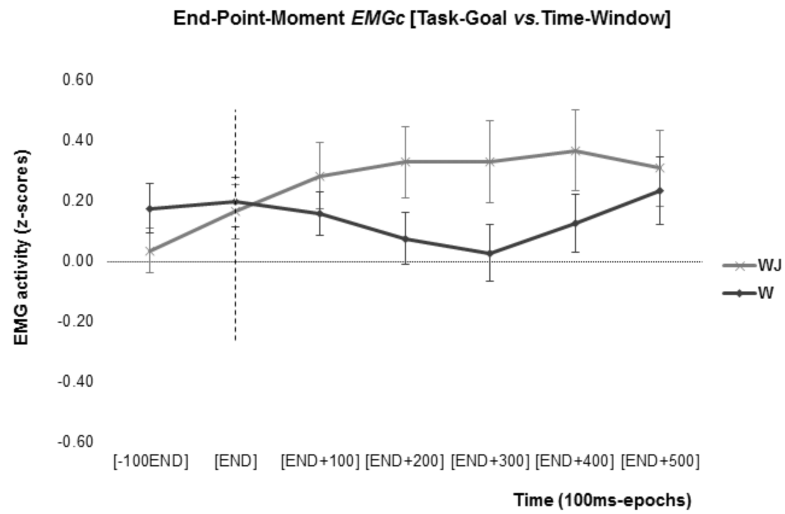

***Figure 5*. Corrugator activation controlling for the baseline when watching (*W*) and watching and judging the fit moment (*WJ*) after having been aligned by the end-point moment (dashed line).**

2.2.2.2.3 *Zygomaticus Major (EMGz)*. Contrary to what was found for the *RKM-window,* we found a non-reliable *Time-Window* effect, $F(2.785,64.048) = 2.35$; $p = .085$, $\eta^2 = 0.09$, for zygomaticus activity. After a graphic analysis (Figure 6), we hypothesized that this occurred as the result of increased activity of this muscle after the end of the video. Corroborating this hypothesis, we found evidence of a significant cubic trend, $t(23) = 2.34$; $p = .028$, d = 0.98. The zygomaticus activity increased from the -100 ms END until END+200 ms time-windows and subsequently decreased to the baseline value. This suggests that the zygomaticus activity was sensitive enough to detect the completion of the task (responding to or watching a video).

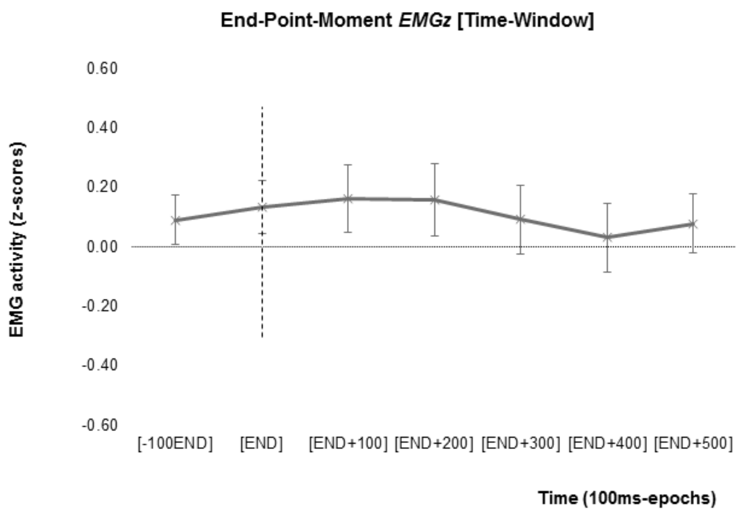

***Figure 6*. Zygomaticus activation controlling for the baseline after having been aligned by the end-point moment (dashed line).**

The aim of Experiment 1 was to determine whether the spontaneous affect measure through facial activation was specifically elicited when the participants judge their action capabilities over two dynamic events with time pressure. Indeed, the elicited activity of the corrugator relative to the actors' baseline was detected more when the actors had to estimate their own action capabilities than when they were simply watching the dynamic events video. This pattern of the activation of feelings is likely to be translating interoception and informing the estimation of action capabilities through the activity occurring around the *RKM-window* (i.e., the moment when the participants were giving their responses).

Clearly, all analyses suggest that the corrugator activity is related to the action capability estimation process. If it is sensitive to any feature of the task, the zygomaticus was only signaling that the task goal was achieved. The increase of positive affect associated with the finishing of a task was detected in many other studies (e.g., Garcia-Marques & Mackie, 2001; Wyer & Srull, 1989) and may be reported as a "Zeigarnik effect" (Zeigarnik, 1967). This effect refers to a "tension" with unfinished tasks that promotes a sense of satisfaction with its closure.

Before discussing our results in more detail, we experimentally tested the validity of this correlational data; thus, in Experiment 2, we manipulate the activation of the zygomaticus or the corrugator by priming participants with faces that either expressed sadness or happiness (see Niedenthal, 2007).

3. Experiment 2

3.1 Methods

3.1.1 *Participants and design*. Ninety-one graduate students recruited via local advertisement agreed to participate in the experiment for course credit compensation. All participants provided written consent and had normal-to-corrected visual acuity. After initial inspection of the data, 7 participants showed values higher than 30% of missing values in both blocks and were removed. The total sample included 84 participants (20 males; 9 left-handed) aged 21.12 ± 5.30 years. The participants were randomly distributed according to the design reflected an experiment with a 2 *Task-Condition* (order x random), 2 *Action-Judgment* (grasping *vs.* fitting), and 3 *Valence* (neutral, positive and negative) conditions as within-subject factors.

3.1.2 *Dynamic visual events.* Given the difference previously found between the two videos, we increased the variability of the two types of dynamic events. Five videos with 3D images and the motions of shrinking, spinning in a 360° movement and increasing in quantity were created for the grasp-ability task and were added to those used in Experiment 1. Equally, another five videos with 2D images were created for the pass-ability estimation, with motions including openings with one side moving and the other static and both sides moving and the area growing in size. All new videos were created according to the methods described in Experiment 1, and the frame exposure remained at 40 ms. A small variation in the video's total time was also applied, with the duration ranging from 800 ms to 1000 ms.

3.1.3 *Apparatus.* The experimental tasks were programmed in E-Prime 2.0 software (Schneider et al., 2002), and the dynamic events were presented on a 17-inch CRT monitor (15.9-inch viewable image) with a black background of 800 x 600 pixels of resolution. The release-key moments were performed with a target key on the keyboard and were recorded for time analysis. The manipulation included a paradigm of affective subliminal masking priming and to this end, 12 facial images (6 males and 6 females) with neutral, happy and sad expressions were selected from the NimStim Set of Facial Expressions (Tottenham et al., 2009). All pictures were previously gray-scaled and resized using a scale based upon a resolution of 100 pixels in Adobe Photoshop. Matching for exposure and luminance was also applied, and the faces were cropped to remove mostly of the hair and clothing information. The final facial shape was overlaid on a black background of 500 x 650 pixels (final image size).

3.1.4 *Procedure*. The hand position was the same as applied in Experiment 1, and the participants received all instructions on the computer screen, including the use of the right index finger to respond. Two perceptual training tasks were previously applied to improve the

participants' accuracy in the release-the-key task. Next, the participants started the experimental task. In the first block, judgments were counterbalanced by action, and the participants knew whether they would estimate grasp-ability or pass-ability, replicating Experiment 1. To increase ambiguity and create a more demanding task, in the second block, we removed the counterbalance order, and all 12 objects randomly appeared, with participants having to assess online whether they should judge the grasp-ability or pass-ability. Immediately before the start of each video, the affective valence was manipulated with a neutral, happy or sad facial expression appearing in a subliminal masking paradigm. Each trial started with a fixation cross on the screen (800 ms), followed by a forward mask (500 ms), the subliminal facial expression (30 ms), a backward mask (50 ms) and the start of the video. Perceptually, the participants experienced the subliminal process as a flashing of the computer screen. The cover-story offered for the flashing was that it was signaling the video loading process.

Each dynamic event was randomly associated with one valence without repetition; thus, each participant judged the same dynamic event three times. A total of 18 trials for grasp-ability and 18 trials for pass-ability were presented in both the first and second blocks. The tasks were instructed as in Experiment 1, and the released-key-time of the valid judgments was recorded, with the video stopping immediately at this point.

3.1.5 *Measures.* Release-Time-Index (RTI) for correct response were the main dependent variable.

3.2 Results and Discussion

A first inspection detected 0.05% of the missing trials in the first block and 0.04% of the missing trials in the second block. A second inspection retained only the trials in which the object was judged with the three valences (0.06% of the valid trials were removed from the first block and 0.05% of the valid trials were removed from the second block). The release-key-times of each participant and by the *Action-Judgment* were collapsed for valence condition, with 6 Release-Time-Indexes (RTIs) created, i.e., three combined judgments of grasp-ability with neutral, positive and negative valences and three combined judgments of pass-ability with neutral, positive and negative valences. A repeated measure ANOVA with 2 *Task-Condition* (order x random), 2 *Action-Judgment* (grasp-ability x pass-ability) and 3 *Valence* (neutral, positive and negative) components as within-subject factors were applied to the *RTI* values.

The main effect of *Action-Judgment*, $F(1,83) = 8.67$, $p = .004$, $\eta^2 = 0.10$, reinforced the results of Experiment 1, suggesting differences between the two tasks. The actors moved more quickly when judging the visual dynamic events associated with the perceived grasp-ability (M = 526.70, SD = 16.55, 95% CI [493.80, 559.62]) compared to pass-ability (M = 567.15, SD = 29.59, 95% CI [508.29, 626.00]). A main effect of *Task-Condition*, $F(1,83) = 12.62$, $p < .001$, $\eta^2 = 0.99$, revealed that actors more quickly estimated their action capabilities when they knew the action capability a priori (M = 539.99, SD = 17.69, 95% CI [504.82, 575.17]) compared to when discovering it on-line (M = 553.86, SD = 17.79, 95% CI [518.47, 589.24]). Being relevant to our goals, *Task-Condition* did not interact with the *Valence* factor, $F(1.742,144.585) = 1.22$, $p = .296$, $\eta^2 = 0.01$. Being important for our hypothesis, the main effect of *Valence*, $F(1.792,148.730) = 3.61$, $p = .034$, $\eta^2 = 0.04$, was found with the respective mean values of the release time in milliseconds: neutral (M = 543.30; SD = 10.90); negative (M = 550.33; SD = 10.47); and positive (M = 547.14; SD = 10.56). To approach the role of the corrugator as suggested by Experiment 1, we directly compared the neutral with both the negative, $t(83) = 2.40$, $p = .019$, d = 0.53, and positive, $t(83) = -1.78$, $p = .079$, d = 0.39, valence conditions. As hypothesized, through the activation of the corrugator, by priming with a sad face, we interfere with the estimation of action capabilities. However, the results of this study also suggest that a happy face prime may also interfere with task performance.

4. General Discussion

Two experiments give us convergent data suggesting that the corrugator is active when the participants estimate their action capabilities. In Experiment 1, we found elicited activity of the corrugator only in the condition in which the participants have to estimate their action capabilities and that, because of a known delay of facial activity measures (e.g., Dimberg et al., 2002), this activation was likely occurring contingently to their response timing. In Experiment 2, we directly investigated whether an induced reenactment by unconscious mimicry (Barsalou, 2008; Niedenthal, 2007) of the facial muscle corrugator (negative affect) and zygomaticus (positive affect) at the actor's baseline could embody information that facilitates or inhibits the actors' fit moment. As shown by the analysis of the Experiment 1 results, only the negative prime (sad faces) condition significantly differs from the neutral condition. In this condition, the actors postponed their perceived fit. This suggests that our manipulation used the same sensorimotor involved in the task and that it may have interfered with both the simulation and the estimation (Körner, Topolinsk & Strack, 2015). However, it should be acknowledged that

although unreliable, there appears to be a tendency for the happy face prime to also interfere with the task.

Two questions need to be answered to understand these data. The first question is about why the corrugator was activated in an action capability estimation task and why its activation interfered with the participants' perceived action capabilities. The second question is about the interference of the happy prime in the estimation of action capabilities in Experiment 2 given that no zygomaticus effects occurred in Experiment 1.

Although we believe that a clear understanding of the role of the corrugator shown in our studies needs further investigation, some research exists regarding the meaning of the corrugator activity that should be taken into consideration in the future generation of a response. The literature has associated corrugator activity with immediate experiences of negative affect (Larsen, et al., 2003; Dimberg, 1997; Dimberg et al., 2002), a disfluency due to surprise effects (Topolinsk & Stracks, 2015), and an experience of increased attention and mental effort (Waterink & van Boxtel, 1994; van Boxtel & Jessurun, 1993). According to Gibson (1966), our perceptual system ceaselessly reveals the relevant properties of our surroundings to be guided by opportunities for action. Thus, when performing goal-directed behavior, this ongoing activity needs be different from the baseline to allow the organism-environment fit that accomplishes the goal. This idea mainly suggests that attentional effort is involved in visual exploration because it is possible that the corrugator activity is indexing such differential activity. However, if this were the case, why would the corrugator not be deactivated immediately after a response is available? No specific attention demands are activated at that moment. Thus, even assuming that the measurement has a delay of approximately 300 ms, this explanation does not appear to completely explain our data. In addition to the attentional process, we propose that corrugator activity has an interoceptive role. The evidence that affect-laden stimuli result in similarly patterned changes in the facial musculature is not sparse (e.g., Arndt, Allen & Greenberg, 2001), and even recently, Heller and collaborators (Heller, Lapate, Mayer & Davidson, 2014) demonstrated the plausibility of simultaneous activity between the corrugator and neural correlates of affect, such as in the amygdala and ventromedial prefrontal cortex. However, these are empirical question that still need to be investigated.

Another question we should address in the future is the role that dynamic events have in our results. The temporal feature of these tasks created a demand that made it possible to detect the corrugator activity associated with the perceived fit only in these conditions. For

instance, feelings of uncertainty could have been elicited. The research has shown that feelings of difficulty or uncertainty co-vary with the contraction of the corrugator muscle (Koriat & Nussinsson 2009). Thus, the corrugator can only signal that the goal associated with the task is being experienced as difficult. Although this is an alternative explanation for our data, it is still necessary to explain why the experience of difficulty is not overcome by a response that is provided by relaxing the same muscle.

There would be a more of a global consensus if our data suggested that estimations were achieved in association with greater activation of the zygomaticus. As Canon and collaborators (Canon, Hayes & Tipper, 2010) demonstrated, there is greater activity in the zygomaticus muscle when there is a fit between the actor's hand-orientation and the object orientation. In addition, studies have suggested that a match can be experienced as fluent (Topolinski, Likowski, Weyers, & Strack, 2009), which is experienced as a positive feeling (Garcia-Marques, Mackie, Claypool & Garcia-Marques, 2004; Winkelman & Cacioppo, 2001). An expected result could thus be that activation of the zygomaticus occurred at the moment in which the participants generated a response. However, at least in a clear form, this did not occur with our data, given that the zygomaticus was shown to be activated only to signal the end of a task (even if it was one of simply watching the video) in the first experiment. One possible explanation for this occurrence is a lower sensibility of the zygomaticus when compared with the corrugator. In testing facial EMG activity, Van Boxtel and Jessurun (1993) found that the zygomaticus was not activated until the task load change from sub- to supramaximal capacity levels. Thus, in Experiment 1, the activation of the zygomaticus could have not been properly detected by our procedures (e.g., type of task, temporal demanding, etc.) when explaining the different results for the zygomaticus between Experiment 1 and 2. However, and slightly contradictory to that hypothesis, we also found differences in the activation of the zygomaticus when signaling the end of the video.

Another possible reason that primes of happy and sad faces had mirror effects in Experiment 2 in comparison with a neutral condition is that neither prime was clearly activating only one type of facial muscle. The research attempts to dissociate the activation of the two muscles, and the data analysis focuses on that. It is clear that the zygomaticus is the muscle associated with smiling, and it is the muscle that is more activated when we perceive a happy face compared to a sad face. The corrugator is the muscle that differentiates more reactions associated with a sad face. However, this does not mean that the zygomaticus is only activated when individuals perceive a happy face. It is even possible that the corrugator is more activated

when we perceive a happy face (e.g., Magnée, Stekelenburg, Kemner, & de Gelder, 2007). Thus, our results with the prime of a happy face may be indexing the activation of the corrugator. This is a hypothesis to be addressed in future studies.

Another possible reason that happy primes interfered with the perceived action capabilities is that the nature of our task does not allow the pure deactivation of any muscle since faces are being presented in sequence to one another (inter-trial interval). However, this would not explain why these carryover effects would be less often detected in the neutral condition.

A final explanation is that the effects are dependent upon what the two activations have in common; namely, an arousal state (Storbeck & Clore, 2008). Kuppens and collaborators (Kuppens, Tuerlinckx, Russel, & Barrett, 2013) suggest that these mirror effects may be associated with a weak and consistently asymmetric *V*-shaped relationship that in some ways matches our data. Hajcak and collaborators (Hajcak, Molnar, George, Bolger, Koola, & Nahas, 2007) found a similar pattern in the motor-evoked potential (MEP) that is promoted by the emotional nature of the stimuli. Usually, arousal is related to an energetic state and a mobilization of energy to face a task goal (Barry, Clarke, McCarthy, Selikowitz, & Rushby, 2005). Thus, in our experiment, both the sad and happy face primes may have evoked motor potential differently from the neutral face prime.

5. Conclusion

Taken together, our results clearly suggest the activation of feelings concomitantly with the visual scaling process that underpins the fit between actor-environment properties, and they suggest that these feelings interfere with the estimation of action capabilities when facing dynamic events. In addition, they suggest that these feelings are indexed by changes in corrugator activation. We propose that the role of corrugator activation in the visual scaling process is one of informing judgment, but this is a question that needs to be clarified in future studies.

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Supplement 1

Table 1

Values of sphericity violation and respective Greenhouse-Geisser corrections for Experiment 1

RKM-Window

Analysis		*Mauchly's Test*	*p*	*ε*
EMGv	*Time-Window*	$\chi^2(54) = 153.74$	< .001	.403
	Task-Goal x Time-Window	$\chi^2(54) = 139.82$	< .001	.404
	Dynamic-Visual-Event x Time-Window	$\chi^2(54) = 97.01$	< .001	.467
	Dynamic-Visual-Event x Task-Goal x Time-Window	$\chi^2(54) = 120.20$	< .001	.491
EMGc	*Time-Window*	$\chi^2(54) = 137.20$	< .001	.384
	Task-Goal x Time-Window	$\chi^2(54) = 173.57$	< .001	.328
	Dynamic-Visual-Event x Time-Window	$\chi^2(54) = 115.78$	< .001	.467
	Dynamic-Visual-Event x Task-Goal x Time-Window	$\chi^2(54) = 126.77$	< .001	.513
EMGz	*Time-Window*	$\chi^2(54) = 162.56$	< .001	.367
	Task-Goal x Time-Window	$\chi^2(54) = 137.78$	< .001	.391
	Dynamic-Visual-Event x Time-Window	$\chi^2(54) = 140.76$	< .001	.384
	Dynamic-Visual-Event x Task-Goal x Time-Window	$\chi^2(54) = 97.54$	< .001	.554

END-Window

EMGv	*Time-Window*	$\chi^2(54) = 103.75$	< .001	.360
	Task-Goal x Time-Window	$\chi^2(20) = 58.01$	< .001	.561
	Dynamic-Visual-Event x Time-Window	$\chi^2(20) = 59.03$	< .001	.499
	Dynamic-Visual-Event x Task-Goal x Time-Window	$\chi^2(20) = 38.69$	< .01	.671
EMGc	*Time-Window*	χ^2 (20) = 82.50	< .001	.447
	Task-Goal x Time-Window	$\chi^2(20) = 61.92$	< .001	.594
	Dynamic-Visual-Event x Time-Window	$\chi^2(20) = 49.63$	< .001	.597
EMGz	*Time-Window*	$\chi^2(20) = 65.16$	< .001	.464
	Task-Goal x Time-Window	$\chi^2(20) = 71.92$	< .001	.487
	Dynamic-Visual-Event x Time-Window	$\chi^2(20) = 54.15$	< .001	.478
	Dynamic-Visual-Event x Task-Goal x Time-Window	$\chi^2(20) = 57.33$	< .001	.497

Table 2

Values of sphericity violation and respective Greenhouse-Geisser corrections for Experiment 2

RTI			
Analysis	*Mauchly's Test*	*p*	*ε*
Valence	$\chi^2(2) = 10.12$	< .01	.896
Task-Condition x Valence	$\chi^2(2) = 13.15$	< .01	.817

To touch or not to touch? Feelings as non-visual information for perceived reach-ability*

Cristina Fonseca[13], Teresa Garcia-Marques[1], & Pedro Figueira[1]

Abstract

In two studies, we artificially promote differences in the affective experiences of participants to investigate whether feelings embody non-visual information to perceived reach-ability. In Study 1, an affective prime was associated with a dynamic dot task, and the motor degrees of freedom of participants were constrained by a horizontal bar that secured them to a chair. Findings indicated that participants overestimated their perceived boundaries of action when subliminally primed with both positive and negative affective faces. In Study 2, we used a static dot task, and we replicated the affective prime effect on the group that had the same motor constraints of Study 1; but we did not replicate the effect when no postural constraint was created and multiple degrees of freedom were available. Taken together, our data revealed that changes in affective experiences interfere with the reach-ability estimation process and suggest that feelings are likely to be incorporated as non-visual information in perceived action capabilities when a possible action is latent. The results also demonstrated the integration between the sensorimotor and perceptual systems, and that gauging affordances encompasses body features. Specifically, the data show that when multiple degrees of freedom are made available, the sensorimotor system is a more reliable source of information regarding the accuracy of anticipated action.

Keywords: affordance, interoception, degrees-of-freedom, affective prime

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To touch or not to touch? Feelings as non-visual information for perceived reach-ability

Recently, it was suggested that feelings could be integrated as non-optical information when visually scaling spatial layouts and detecting affordances (e.g., Fonseca, Garcia-Marques, & Fernandes, 2016; Witt & Riley, 2014; Zadra & Clore, 2011). Affordances (Gibson, 1979, 1966) are environmental properties that invite action and resonate with the capabilities of the organism. Although evidence has shown that actors rely on their own body dimensions as an intrinsic metric to rescale spatial layouts, the mechanism that underlies the organism-environment fit is still unclear. In this paper, we address whether feelings that arise from a myriad of bodily processes when actors interact with their current scenario are also integrated as non-visual information when visually scaling and perceiving reach-ability. To this end, in two studies, we applied subliminally affective primes to artificially induce feelings in the participants' baseline, and we investigated whether these feelings interfered with reach-ability estimates. In this way, we expected to find evidence that feelings serve as non-visual information when detecting affordances.

Resizing the world on intrinsic action units

The concept of affordances (Gibson, 1979) defines the set of action possibilities that are offered by the environment to the actor and resonate with the actor system. The detection of affordances denotes a latent match between the target features (e.g., size, shape, time) and the actor's body (Mace, 1977). This process constrains what could be an infinite space of possible actions to only a few opportunities, establishing a functional relationship between the organism and its surroundings and categorizing the performance of motor actions as possible and not possible (Fajen, Riley & Turvey, 2008). However, to detect affordances, actors need to become sensitive to the properties of the environment that *fits* their system. This means that, instead of perceiving the physical world in terms of an absolute metric (e.g., space, time, meters and units) and subsequently transforming it through internal process, actors directly perceive the physical dimensions of their surroundings relativized to some intrinsic metric (Turvey, 2004, 1992). This has been studied by Warren (1984), who shows how geometrical relations govern the organism-environment fit in a study of participants using their leg length to scale the maximum stair height perceived as climbable. Specifically, the data revealed that the taller group of participants could estimate higher heights as climbable compared to the smaller group. However, when the dimensional ratios of both groups of participants were analyzed (i.e., the ratio between the actor's leg length and the stair height), the results revealed that taller and smaller participants presented the same ratio constraining their perceived action category. This evidence was reinforced by a series of studies showing, for example, that actors used information regarding

their height and leg lengths to estimate the perceived pass-ability of barriers (van der Meer, 1997), that arm length was used to estimate an actor's perceived reach-ability (Carello, Grosofsky, Reichel, Solomon & Turvey, 1989) and that hand-size was used as an intrinsic metric to estimate the perceived grasp-ability of objects (Linkenauger, Witt, & Proffitt, 2011) or hand pass-ability through different gap sizes (Ishak, Adolph, & Lin, 2008).

Another set of studies revealed that the detection of affordances is not ruled only by geometric relations but also by temporal properties. Therefore, it was demonstrated that actors not only body-scale the physical surroundings, but they also action-scale the properties of the environment by relying on information about their action capabilities. This means that actors acknowledge their action boundaries (i.e., the range over which action is possible) and use this information to control and estimate proper movements (Fajen, 2007, 2005). For example, Fajen (2005) demonstrated this through a series of simulation braking tasks in which the braking varies in hardness level. The findings revealed that actors initiated deceleration later when the brake resistance was shifted from a middle-to-weak level, whereas when the brake resistance was shifted from a middle-to-strong level, the actors initiated deceleration early. Similarly, in a study involving the perceptual motor performance of goalkeepers in penalty-kick situations, researchers found that when attempting to save the ball, goalkeepers action-scaled the dive moment relying on their action-capabilities. Specifically, the data revealed that compared to their slower peers, the faster goalkeepers took longer to initiate their diving (Dicks, Davis & Button, 2010).

Based on these and other pieces of experimental evidence (see Proffitt, 2013, 2006; and Witt, 2011), Proffitt and Linkenauger (2013) recently proposed an "embodied perception" based on the assumption that visual information (e.g., visual angles, ocular-motor adjustments and retinal disparities) were directly scaled by nonvisual metrics derived from the body phenotype. They propose that the task demands constrain which features of the body are relevant to the intended action, with this feature being directly involved as the ruler embodied in the visual scaling of the spatial layout (e.g., arm's length for reaching and hand-size for grasping). Data provided from different body categories, such as the physiologic and morphologic, demonstrate, for example, that bio-energetic costs are integrated in the visual scaling mechanism. Thus, when actors were in a fatigued state, in a state of low fitness, carrying an extra load, in declining health, or in old age, the presented geographical slants were overestimated and perceived as steeper than reality (Bhalla & Proffitt, 1999; Proffitt, Bhalla, Gossweiler, & Midgett, 1995). Importantly, this evidence was replicated by direct manipulation of the physiologic states of participants. Thus, when participants' blood glucose levels were

depleted to trigger a fatigued state, the findings showed that actors estimated hills to be steeper (Schnall, Zadra, Proffitt, 2010). Similarly, when the blood level of carbohydrate of the participants was raised to increase energy, the data revealed that they perceived distances to be shorter, even after vigorous exercise (Zadra, Weltman & Proffitt, 2016).

Additionally, it has been demonstrated that when actors' body dimensions are modified by natural or experimental sources, they are able to quickly recalibrate their perceived boundaries of action and embody the new body dimensions in their visual scaling of the spatial layout. Franchak and Adolph (2014) performed a bodily longitudinal observation of pregnant women and found that as body size increased, previously passable doorways were perceived as non-passable. However, the women's accuracy remained the same as that of the non-pregnant group, indicating that tracking and recalibration were compatible with the bodily changes of pregnancy. In another experiment, when participants had their visual perception of their own hand size manipulated in an immersive virtual-environment, the data revealed that objects within hand-reaching distance were perceived as smaller when the participants experienced illusions of large hands relative to the experience of real hand size or the illusion of a smaller hand (Linkenauger, Leyrer, Bülthoff, & Mohler, 2013). Similarly, when participants experienced illusions of smaller and larger virtual bodies, they rescaled their body size in agreement with the size of the virtual body (Piryankova et al., 2014). Finally, a robust body of evidence has indicated that when the height of actors is modified with the use of platform shoes, they quickly rescale their new height and increase their perceived sit-ability (Mark, 1987) and climb-ability (Warren & Whang, 1987). When the weights of participants were changed by adding ankle loads, it was found that they quickly embodied the extra load and overestimated gap distances (Lessard, Linkenauger, & Proffitt, 2009). Questioning whether these action-specific effects were due to the unique contributions of beliefs about the actor's own body size, or due to experiential changes in the physical characteristics of body size, Sugovic and collaborators (Sugovic, Turk & Witt, 2016) found a direct influence of physical body weight. Thus, instead of distances being estimated based on the participants' beliefs about their own bodies weight, the findings demonstrated that heavier participants estimated distances to be farther.

Feelings as non-optical information integrating the visual scaling mechanism

In addition to the integration of morphologic and physiologic categories in the visual scaling of spatial layouts, a set of studies has suggested that feelings can also integrate the action-perception mechanism and that perhaps feelings are the level at which information is used to moderate the visual scaling accuracy of action-capabilities.

In line with this view, there is evidence suggesting that as the grasp orientation of a tool is perceived as more difficult, the farther away participants estimate their reach-ability, indicating that a type of subjective experience of easiness might also govern the perception of spatial layouts (Linkenauger, Witt, Stefanucci, Bakdash & Proffitt, 2009). Similarly, investigating whether these embodied effects in visual scaling were confined to explicit-judgments or could be extended to the implicit action-base, researchers found that when a task was adjusted to an easy level (i.e., relative to a difficult level), participants perceived a target moving at a constant speed as slower, and they also adjusted their performance accordingly (Witt & Sugovic, 2013).

In addition, elicited states of fear and anxiety were shown to interfere with the action-perception mechanism because they are embodied in the dynamic action-decision. This was shown by Bootsma and collaborators (Bootsma, Bakker, van Snippenberg & Tdlohreg, 1992), who investigated the impact of anxiety levels on affordances and found that anxiety increases judgment variability, probably due to a decline in accuracy. The elicited levels of anxiety were also shown to diminish the accuracy of handgun shooting performance (Nieuwenhuys & Oudejans, 2010) and to reduce climbers' perceptions of their maximal reaching height when they had to estimate or perform a real climb (Pijpers, Oudejans, Bakker & Beek, 2006). Additionally, Graydon and collaborators (Graydon, Linkenauger, Teachman & Proffit, 2012), investigated whether induced anxiety immediately prior to perceptual tasks could change the actor's action capabilities (i.e., grasp-ability, passing-ability and reach-ability), and found a linear association between the level of anxiety an underestimation of the range over which an action is possible.

Like anxiety, elicited fear also influences the perception of spatial layouts. This has been demonstrated, for example, by studies showing that participants overestimate height when fear is elicited by standing at actual higher altitudes (Stefanucci & Proffitt, 2009), by seeing images of falling (Clerkin, Cody, Stefanucci, Proffitt, & Teachman, 2009), or by imagining a dangerous outcome (Stefanucci, Gagnon, Tompkins & Bullock, 2012). Geuss and collaborators (Geuss, McCardell & Stefanucci, 2016) showed that such changes in conscious perception due to fear-inducing experiences have a direct impact on actions. Their findings revealed that fearful participants not only overestimated gap width but also changed their motor pattern by stepping farther over gap widths.

Finally, an interesting body of evidence regarding distorted perception of the body has also indicated that non-visual information is integrated into the action-perception mechanism. Adopting a body-scaled paradigm, researchers investigated the anticipated action of anorexic

patients and found that, relative to the control group, the anorexic group not only estimated that they would not fit through apertures that were wide enough, but they also presented a significantly higher ratio of shoulder width to gap size (Guardia, Lafargue, Thomas, Dodin, Cottencin & Luyat, 2010). Without the awareness of the participants, the researchers recorded the actions of people diagnosed and not diagnosed with anorexia as they walked through door-like openings that changed in width, and they found that while the control group rotated their shoulders for apertures 25% wider than their shoulders, the anorexic group rotated their shoulders for apertures 40% wider than their shoulders (Keizer, Smeets, Dijkerman, Uzunbajakau, van Elburg & Postma, 2013).

Perceiving the maximum reaching

As a goal-directed behavior, the task of "reaching" encompasses a type of space perception that necessarily integrates the visual scaling of target distance information with the initial position of the body. In addition, the movement of reaching is itself constrained by the coordination of several motor degrees of freedom (Bernestein, 1967).

There is vast evidence of constraints over reaching being promoted by body degrees of freedom (e.g., Carello, et al., 1989; Fisher, 2000; Gabbard, Ammar & Lee, 2006; Rochat & Wraga, 1997), with reaching paradigms investigating actors' perceptions of maximum reaching when the body is constrained to one skeletal degree of freedom (i.e., a functional link of hand, forearm and upper arm in which the actor can extend the arm from the shoulder) versus having multiple degrees of freedom available (i.e., several functional links, such as coupling from the shoulder and bending from the hip). For instance, Carello and collaborators (Carello, et al., 1989) manipulated actors' reaching (extending arm from the shoulder or bending from the hip) and asked participants to both anticipate and perform their maximum reach. Actors were shown to be sensitive to the functional variety of restriction applied, having higher accuracy in perceived reaching when more degrees of freedom were involved. Similarly, Robinovitch (1998) asked participants to estimate and perform their maximum reach and found that actors overestimated their perceived maximum reach when in a standing postural position but underestimated it when in a bending postural position. Taken together, this evidence suggests that beyond body dimensions (e.g., height and arm's length), perceived maximum reaching also encompasses bodily sensations associated with the limited range of action, or what Robinovitch called a "safety mechanism" that prevents the actors from attempting what is beyond their own limits. Gabbard and collaborators (Gabbard, Cordova & Lee, 2007; Gabbard et al., 2006) directly addressed this by asking participants to "kinesthetically feel" themselves when facing targets in different locations. Thus, studying the effects of postural constraints on perceived

maximum reaching, the data revealed that although participants overestimated more when their reaching estimate was associated with multiple degrees of freedom, this trend shifted in the opposite direction when participants had only one degree of freedom available.

More evidence is provided by Rochat and Wraga (1997), who developed six studies with variations in postural conditions and asked participants to estimate their maximum reach when facing static and dynamic objects. The data confirmed the systematic error of reach-ability judgments promoted by different degrees of freedom (i.e., whole-body engagement information) and that, independent of the postural constraint dictated by the task, the perceived multiple degrees of freedom were integrated into the mechanism of perceived maximum reaching.

Finally, evidence suggests that the body sensations that actors use to change their patterns of action come from a preferred critical boundary that is based on feelings of comfort instead of the biomechanical critical boundary and that these feelings of comfort and discomfort moderate the choice to insert or remove degrees of freedom in a postural movement (Mark, et al., 1997; Petrovic, Berg, Mark, & Hughes, 2015).

Taken together, the above studies provide evidence that feelings coming from bodily subjective experiences, and not only from ocular information, might integrate the mechanism behind perceived reach-ability.

Current Study

Taking perception as an integrative process based on a global array (Stoffregen & Bardy, 2001) that includes information about the ability of actors to act, Witt and Riley (2014) stress the need to extend this global array to interoception. Interoception has been defined as the body-to-brain axis of sensation, a sensing of internal bodily changes and subjective feelings that come from physiological conditions (e.g., energy, stress levels, mood, dispositions) and are integrated as information (Cameron, 2001; Graig 2002). Thus, individual affordances must include both higher-order patterns defined across not only exteroceptive but also interoceptive stimulus arrays.

Within the literature, these internal bodily changes and subjective feelings have been defined by two psychological properties: valence (pleasure/displeasure) and arousal (activation/calm) (Russel, 2009, 2003), and they have been strongly associated with measures of affective experiences (e.g., Cacioppo, Petty, Losch, & Kim, 1986; Dimberg, Thunberg, & Grunedal, 2002). However, some of these subjective experiences are not clearly recognized as emotions; rather, they are described as an online stream that is constantly running in our background, resulting from the myriad of neurophysiological and neurobiological changes we

experience when facing the flow of events. Moreover, this "*core-affect"* has also been defined as a primitive barometer that informs the feeler's interaction with the environment (Duncan & Barrett, 2007; Russell, 2009), and it is likely to be integrated in the extended global array that underlies affordance detection.

Convergent evidence from different scientific fields indicates that these subjective feelings are embodied information that can regulate cognitive tuning (e.g., Garcia-Marques & Mackie, 2001; Schwarz, 2002) to influence attentional process (e.g., Adolphs & Damasio, 2001; Phelps, Ling, & Carrasco, 2006) and be used as an heuristic to inform several types of evaluative judgments (e.g., Pham, Cohen, Pracejus, & Hughes, 2001). When associated with an anticipated action, these feelings, summarized in the perceptual array, can inform costs and benefits, allowing action decisions that minimize negative and maximize positive outcomes (Zadra & Clore, 2011). An example of the integration of feelings in our perceptual array is provided by Riener and collaborators (Riener, Stefanucci, Proffitt, & Clore, 2011), who demonstrated that participants in a negative mood visually estimated hills to be steeper compared to those in a positive mood.

The hypothesis that interception is available as non-visual information was directly tested by Fonseca and collaborators (Fonseca, et al., 2016), who tracked the facial muscle activity (a direct measure of affective experience) of participants interacting with dynamic events. The results revealed an elicited activity of the corrugator (which is associated with negative affect and attentional process) when actors had to watch events and estimate their action capabilities, but not when the actors only had to watch the same events. To better understand if the corrugator was activated as a signal of affect or attention, in a second experiment the researchers applied subliminal priming to induce changes at the levels of valence and arousal immediately before the task onset and found that participants postponed the perceived fit moment under the negative priming (i.e., sad faces). These findings led to the conclusion that feelings were not only activated concomitantly with the visual scaling process, they also seemed to be integrated into perceived action capabilities.

Thus, here we aimed to test the direct interference of feelings in reach-ability estimates. We hypothesized that the perceptual fit underlying affordance detection integrates visual and non-visual information with bodily feelings and is thus able to compose an extended global array (i.e., a higher order variable of multimodal perception). Thus, we expected that both feelings and postural constraints would be able to moderate the perceptual accuracy of the actor-environment fit. To this end, we manipulated mild levels of affective changes before the task onset and without the awareness of participants (Ducan & Barrett, 2007; Pessoa, 2008;

Winkielman, Knutson, Paulus & Trujillo, 2007), and we expected that our affective manipulations could interfere with the ability of the actors to gauge reachability in two studies. Specifically, in Study 1 we constrained the participants' motor degrees of freedom and asked them to estimate when a dynamic dot, initially within reaching boundaries, become non-touchable. Based on our initial findings, in Study 2 we released the postural constraints on half of the participants and investigated whether the perceived reachability of dots located in areas affording possible and impossible reaching was hampered.

Ethics

All participants provided prior informed consent and agreed to participate in the studies for course credit. The ethics principles expressed by the APA were followed, and experimental protocols were previously approved by the internal Ethics Committee of ISPA – Instituto Universitário de Ciências Psicológicas, Socias e da Vida.

Study 1

In Study 1 we directly investigated the impact that affective primes exert over the reach-ability of a dynamic dot moving across the computer screen and when participants are not able to draw bodily information from multiple degrees of freedom. Specifically, we displayed movies of a dot initially located near the center of a touchable area of the screen, which moved toward a non-touchable area of the screen. The participants' task was to release a computer key to indicate when the reachable dot become unreachable. Before each trial, participants were subliminally primed with a neutral (non-emotional), happy, or sad face. We predicted that if actors rely on feelings as non-visual information when estimating reach-ability, then when they lack bodily sensations coming from multiple degrees of freedom, actors will make use of the affective information created by our manipulation (by a process of misattribution) and change their perceived reach under the negative and positive affective primes, relative to the neutral prime (i.e., our control prime) (Fonseca et al., 2016).

Method

Participants and design. All participants signed the informed consent and received course credit compensation. No participant had any form of attention disorder, and all of them showed normal-to-correct vision acuity. Prior to statistical analysis, one participant was removed from the data due to presenting values higher than 2.5 standard deviations of the median. Analysis was performed using a sample of 23 undergraduate females (M = 21.65, SD = 5.85 years), all right-handed, and complying with an estimated power in the range of 0.70 to 0.80, assuming a moderate effect size (Erdfelder, Faul, & Buchner, 1996). The design was a

within-factor analysis with 3 *Blocks* (block1, block2, block3) and 3 *Primes* (neutral, positive and negative).

Stimulus and Apparatus. After pre-testing the reachability of different locations on the computer screen with the participants seated in a chair and performing real touches both with maximum bending and without any bending, we used 17 images of a dot (30x30 pixel and 96 dpi resolution) overlaid by a black background (800x600 pixel and 96 dpi resolution) and created a total of 10 dynamic events with a dot moving from an area with high probability of touch (more than 90% of real touch in the pre-test regardless of participants' height and posture) to an area of low probability of touch (less than 10% real touch in the pre-test regardless of the participants' height and posture) on the computer screen. Each video started with an image of a dot located at the center of the touchable area (frame 1) and finished with an image of a half-dot at the edge of the computer screen (frame 16), followed by an image of a black screen (frame 17). The dots' displacements were non-linear trajectories, and the transition from a touchable area to non-touchable area happened in different time-windows to prevent anticipation bias (see Figure 1). All 17 image-frames were set with 150 m/s of timing exposure and subsequently rendered to a video file using Windows Movie Maker (Windows Movie Maker, Version 2012, 16.4.3528.0331) with 2s60ms of total time. For the subliminal masking priming we used 10 facial pictures (equally representing male and female models) with neutral, happy and sad expressions selected from the NimStim Set of Facial Expressions (Tottenham et al., 2009). All pictures were previously gray-scaled and resized using a scale based upon a resolution of 100 pixels in Adobe Photoshop. Matching for exposure and luminance was also applied, and faces were cropped to remove most of the hair and clothing information. The final facial shape was overlaid in a black background of 500 x 650 pixels (final image size). The experimental tasks were programmed in E-Prime 2.0 software (Schneider, Eschman, & Zuccolotto, 2002) and the stimulus was presented in a 17-inch CRT monitor (15.9-inch viewable image) with a black background of 800 x 600 pixels of resolution. The key-release moments were captured through a target key on the keyboard and were recorded for time analysis.

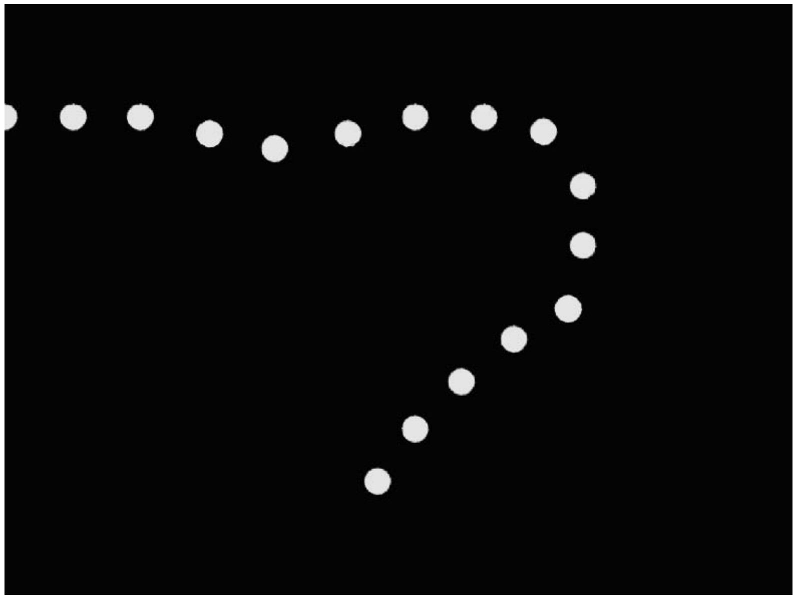

Figure 1. Dot dynamic event. Example of a whole trajectory applied in order to estimate reach-ability.

Procedures. To ensure the reliability of the pre-tested areas, each participant was first seated in a chair centered in front of the computer screen, at a distance that was calibrated by their arm length. At the end of the calibration process, each participant could touch – with the tip of the right index finger and without losing upper-back contact with the chair – the targets positioned at the center of the screen and the extreme right side, but they could not touch the target positioned at the extreme left side of the screen. After the calibration process, all participants were required to rest their left hand on the upper left-tight. Next, participants performed fast movements with the index finger of their right hand stretched (i.e., left-to-right, right-to-left, up-to-down, down-to-up) to interact with the computer screen at the calibrated distance, and subsequently they were instructed to place their index finger on the keyboard. Each participant seated in the chair, was then tied with a vertical bar positioned at the inferior level of the external bone. The use of the bar prevents participants from bending forward at the hip, and thus the degrees of freedom could not vary freely. Subsequently, instructions were transmitted via computer screen, reminding the participants to maintain their initial position and never attempt to touch the screen during the whole session. A training task was applied to improve the participants' ability to perform the release of the computer key to judge fast-paced movements. The training stimulus comprised five films of 800 ms that showed a small car moving (40 ms per frame) in the direction of a wall. Participants had to start the task by pressing and holding the key, and then they had to release it to stop the car as close as possible to the wall without crashing it into the wall. Next, the experimental task started, and the task of the

participants was to indicate when they could no longer reach the initially reachable dot. To this end, the participants were instructed to “press this key and release it when you feel that your right index finger cannot touch the dot”. To induce changes based on arousal and valence, participants were subliminally primed by a neutral, happy or sad facial expression that appeared immediately before the onset of the trial. Each video trial started with an instruction screen stating “press the key now and release it when you feel you cannot reach the dot anymore.” Next, a fixation cross appeared on the screen (300 ms), followed by a checkerboard screen of a forward mask (150 ms), the subliminal facial expression (30 ms), a checkerboard screen of a backward mask (30 ms), and the movie file. Perceptually, participants experienced the subliminal process as a flashing of the computer screen. A cover-story mentioning video load processing was applied for the visual flashing. All videos randomly appeared in three blocks, and participants had to judge the same video three times; each video was associated with a valence condition (e.g., video1-neutral; video1-positive; video1-negative), ensuring no repetition. A total of 90 trials were recorded (30 trials for each affective prime condition), and the released-key-time of the valid trials was recorded, with the video stopping immediately at this point.

Data Analysis. A total of 96.25% of trials were performed, and the release-key-time of each one was collapsed by averaging the valid trials within each block and per the affective priming condition. The six Release-Time-Indexes (RTI) created were analyzed as the main dependent variables.

Results and Discussion

The RTI values were subject to a repeated ANOVA with 3 *Blocks* (block1, block2, block3) and 3 *Primes* (neutral, positive and negative) as within-factors. The results revealed a non-significant influence of *Block* $F(2,44) = 1.04$, $p = .36$ in the participants’ perceived reaching, eliminating any confounding effects that may have occurred due to repetition and learning. The main effect of *Prime* was significant, $F(2,44) = 5.05$, $p = .010$, $\eta_p^2 = .19$ (see Figure 2), and as demonstrated by the planned contrast effect (1, 1, -2; $t(22) = 3.06$, $p = .006$, $d = 1.31$), participants postponed the perceived transition of a touchable to a non-touchable area under the effect of negative ($M = 1865.44$, $SD = 85.27$, 95% *CI* [1688.59, 2042.28]) and positive primes ($M = 1855.91$, $SD = 88.06$, 95% CI [1673.28, 2038.53]) compared to the control prime ($M = 1830.31$, $SD = 87.29$, 95% CI [1649.29, 2011.38]). No significant interaction was found for *Block* and *Prime*, $F < 1$.

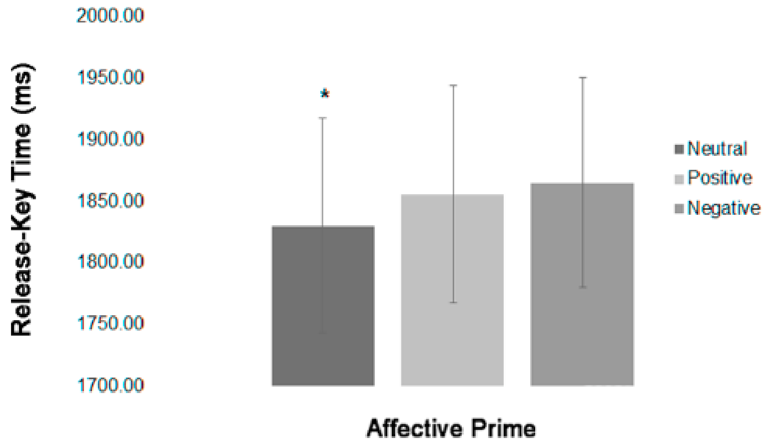

Figure 2. Release-key-time index. Affective prime effect on the release-key time, indicating how long participants take to estimate the dynamic dot as not-reachable.

As expected, these findings indicate that participants' actions were sensitive to our affective manipulation, which indicates that feelings were likely integrated as a source of non-visual information when estimating reach-ability. Under both the negative and positive affective primes, participants postponed the transition of the action boundary. This evidence replicates data from Fonseca and collaborators (Fonseca, et al., 2016), who demonstrated that participants postponed their fit estimates of hand grasp-ability and fit-through ability under the same affective primes. However, our data do not replicate the valence effect found by other researchers (e.g., Riener et al., 2011; Schwarz & Clore, 2007). That is, our findings did not demonstrate that a positive valence leads to action facilitation or that a negative valence leads to an inhibition of action.

In the current design, participants had to estimate reaching with a body posture that restricted their movement to extending the arm from the shoulder (one degree of freedom). Our intention was to promote a better isolation of the effect, ensuring that participants used the affective information provided by our manipulation (guaranteeing a lack of feelings coming from the sensorimotor system). However, it is relevant to know whether the same effects will be able to be detect under conditions in which such restrictions are not imposed. Thus, to better understand if that was the case, in Study 2 we made multiple degrees of freedom available for half of the participants. In addition, we also created an experimental setting that allowed us to understand how our manipulations of affect interacted with participants' accuracy.

Study 2

In Study 2, we released participants' postural constraints by making multiple degrees of freedom available to half of the participants, and we also removed the temporal constraint of the task by showing a static dot. Through these changes, we were able to investigate the role of the sensorimotor system in embodying non-visual information for perceived reach-ability. To this end, we asked the participants to estimate whether a dot – displayed along one of two opposite areas of the computer screen that afforded touch and no-touch – was perceived as reachable or not reachable. Immediately before each dot appearance, participants were subliminally primed with a neutral (non-emotional), happy, or sad face. We predicted that if, during affordance detection, the participants' accuracy when fitting their action capabilities to the current task relied on feelings, then the actors would score differently under the effects of negative and positive affective primes, relative to the control prime (Fonseca et al., 2016). Namely, because our manipulations interfere artificially with the natural mechanisms of affordance detection, we expect performance to be disturbed by them. In addition, we tested whether the affective priming effect is moderated by postural degrees of freedom, and we hypothesized that if actors use bodily feelings as non-visual information when estimating reaching, the induced effect of primes should be strong under the lack of other bodily sources of information (i.e., the constraint group).

Method

Participants and Design. All participants signed the informed consent and received course credit compensation. No participant had an attention disorder, and all showed normal-to-correct vision acuity. Two participants (one per condition) were removed from the data because they presented values higher than 2.5 standard deviations of the median. The final sample analysis was performed with 42 undergraduate females (*M* = 21.31, *SD* = 5.48 years), all right-handed, randomly distributed for the between conditions of the mixed design: 2 (free vs. constraint condition) x 3 (prime: positive, neutral, negative). There were 21 females for each condition, complying with the effects associated with a design calculated with an estimated power in the range of 0.70 to 0.90, assuming a moderate effect size (Erdfelder, et al., 1996).

Stimulus and apparatus. Thirty-six images of a dot (30x30 pixel and 96 dpi resolution) overlaid by a black background (800x600 pixel and 96 dpi resolution) were used after dots were pre-tested for reachability by participants who were seated in a chair and performed real touches either in maximum bending or non-bending conditions. The dots corresponded to three subset areas with 12 dots aggregated in each area (see Figure 3) and were distributed on the computer screen as follows: high probability of touch (more than 90% real touch in the pre-test regardless of participants' height and posture), low probability of touch (less than 10% real touch in the

pre-test regardless of participants' height and posture), and undifferentiated probability of touch (ranging from 40% to 60% real touch in the pre-test according to participants' height and posture).

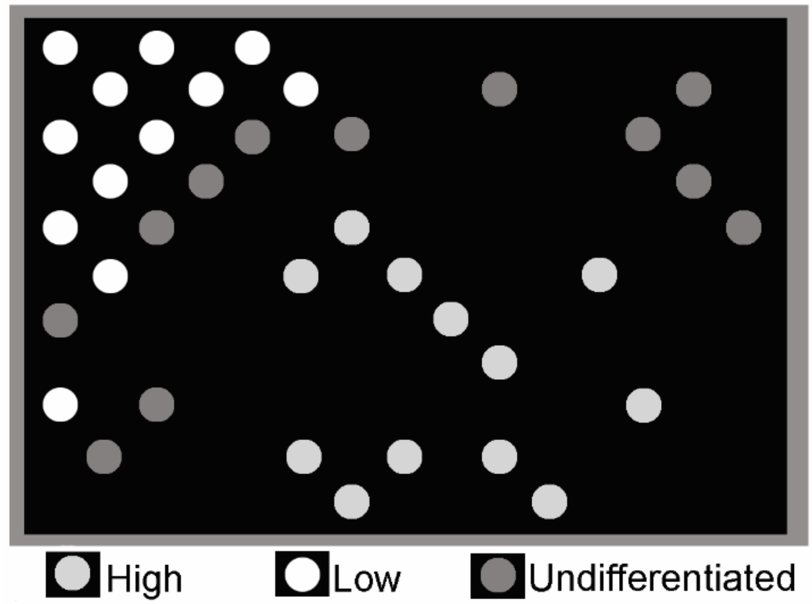

Figure 3. Disposition of dots on the computer screen and by the three areas of touch. Dots located in "High" and "Low" areas were subject to signal detection theory analysis.

Subliminal masking priming used 36 facial pictures (equally representing male and female models) with neutral, happy and sad expressions selected from the NimStim Set of Facial Expressions (Tottenham et al., 2009). Treatment and apparatus of pictures were the same as described in Study 1.

Procedure. Reliability of the pre-tested areas followed the calibration process of Study 1. Next, each participant was required to place their left-hand and limb on the upper tight and to position both the index and middle fingers on the keyboards. The participants assigned to the free-condition were instructed via computer screen to keep the initial position and to never attempt to touch the screen throughout the whole session. In turn, the participants assigned to the constrain-condition were secured at the chair with a vertical bar positioned at the inferior level of the external bone. Subsequently, these participants were also instructed via computer screen to keep the initial position and to never attempt to touch the screen during the whole session.

To train the experimental response mode, all participants performed a training task in which they had to indicate as fast as possible whether the appearances of geometric objects were congruent with the indicated side of the screen (left or right) by pressing the "yes-green-key" and the "no-red-key" with the index and middle fingers of the right-hand. Next, the

experimental task started, and participants were instructed to judge as fast as possible whether they could touch the tip of their right index finger to the spot on the screen that was signaled by the dot. When the dot was perceived as "touchable," participants had to press the "yes-green-key"; when the dot was perceived as "untouchable," participants had to press the "no-red-key". Participants were subliminally primed by a neutral, happy or sad facial expression that appeared immediately before the trial onset. Each trial started with a fixation cross on the screen (800 ms), followed by a forward mask (300 ms), the subliminal facial expression (30 ms), a backward mask (50 ms) and the dot. Perceptually, participants experienced the subliminal process as a flashing of the computer screen. A cover-story for that flashing mentioning video load processing was applied. All dots randomly appeared along three blocks and participants judged the same dot three times, with each one associated with a valence condition (e.g., dot1-neutral; dot1-positive; dot1-negative), ensuring no repetition. A total of 108 trials were recorded, with the dots randomly appearing across three areas of touch (i.e., high, low and undifferentiated).

Dependent variables. Each estimation provided by the participants was recorded and used to compute the total number of "yes" and "no" responses relative to the high and low areas of touch, which clearly afforded the two categories of action, reaching and non-reaching, respectively. The undifferentiated area was removed from analysis given that the pre-test indicated that reaching this area is dependent on both participants' height and arm length and is also affected by postural conditions, which does not allow clear control of the experimental conditions. Thus, SDT analysis (Macmillan & Creelman, 2004) was performed, considering the action estimations of high and low areas of touch, and when a dot within a high touch area was estimated as reachable, a "hit" was registered in the score, whereas when a dot within a low touch area was estimated as reachable, a "false-alarm" was registered in the score. Sensitivity (d') and bias (c') were then calculated.

Results and Discussion

Data analysis was guided by the replication of the prime effects found within the constraint condition of Study 1, with an empirical question regarding the presence of a weaker effect of primes on the free condition. We also expected a general impact from the postural condition (between effects). To directly address these hypotheses, we ran three planned contrasts (within the omnibus ANOVA model) on the four dependent variables (Hit, False-alarm, and the SDT indexes). The first contrast represents the replication of the *Prime* effect found in Study 1 on the constraint condition (i.e., neutral prime vs. positive + negative primes). The second contrast tests the same prime effect in the free condition. The third contrast directly

compares performance in the constraint and free conditions to understand how these conditions alone impact performance indexes.

Hits, reaching within a reachable area

Hit values were subject to a mixed ANOVA with 2 *Conditions* (free x constraint) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor. The first contrast (2, -1, -1) represents the replication of the *Prime* main effect found in Study 1 for the constraint group, and as we expected, it was significant ($t(40) = 2.35$, $p=.024$, $d = 0.74$), with the control prime ($M = 0.94$, $SD = 0.01$, 95% *CI* [0.92, 0.97]) differing significantly from the positive ($M = 0.90$ $SD = 0.02$, 95% *CI* [0.86, 0.94]) and negative ($M = 0.90$ $SD = 0.02$, 95% *CI* [0.88, 0.94]) primes (see Figure 4a). However, the same effect (2, -1, -1) was not significant for the free group, $t(40) = 1.06$, $p = 0.30$. Additionally, *Conditions* (1, -1) did not impact performance, t < 1, such that hit values were similar in the free ($M = 0.92$, $SD = 0.02$, 95% *CI* [0.88, 0.96]) and constraint ($M = 0.91$, $SD = 0.02$, 95% *CI* [0.87, 0.95]) conditions (see Figure 4b).

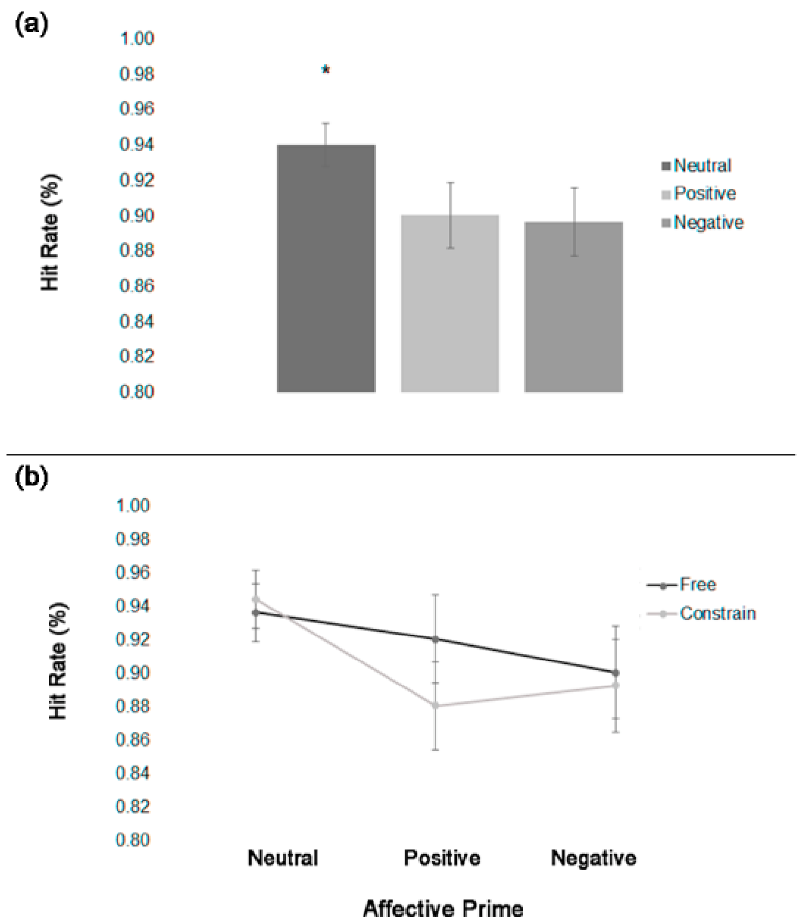

Figure 4. (A) Affective prime effect on hits; (B) The affective prime effect across conditions. Error bars denote standard error.

False-Alarms, reaching within a non-reachable area

False-alarm values were subject to a mixed ANOVA with 2 *Conditions* (free x constraint) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor. The first contrast (2, -1, -1) suggests that there is no effect of *Prime* for the constrain condition. Additionally, we found no prime effect for the free condition (2, -1, -1; all $t < 1$). *Condition* promoted different levels of false-alarm (1, -1); $t(40) = -2.21$, $p = .033$, with the constraint group scoring more false-alarms (*M* = 0.17, *SD* = 0.03, 95% *CI* [0.12, 0.22]) relative to the free group (*M* = 0.09, *SD* = 0.03, 95% *CI* [0.04, 0.14]).

Sensitiveness (d')

Sensitiveness values were subject to a mixed ANOVA with 2 *Conditions* (free x constrain) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor. The higher the *d'* value, the more sensitive the participants were in discriminating between a reachable and non-reachable dot. Overall, *d'* average values were higher than two, indicating that the task allowed participants to effectively discriminate between the touchable and non-touchable areas. The first contrast in *Prime* values for the constraints condition (2, -1, -1) indicates that relative to the control prime (*M* = 2.64, *SD* = 0.17, 95% *CI* [2.30, 2.97]), the participants were worse at discriminating between the boundaries of a touchable from a not-touchable dot under both positive (*M* = 2.34, *SD* = 0.17, 95% *CI* [1.99, 2.69]) or negative (*M* = 2.38, *SD* = 0.13, 95% *CI* [2.12, 2.63]) effects of affective primes, ($t(40) = 2.11$, $p = .041$). The same contrast (2, -1, -1) was not significant for the free group, $t < 1$ (see Figure 5a). The difference between *Condition* (1, -1) was marginal, $t(40) = 1.77$, $p = .08$, d = 0.56, with the free condition group (*M* = 2.78, *SD* = 0.13, 95% *CI* [2.51, 3.04]) discriminating better between the two distinct areas of touch compared to the constraint condition group (*M* = 2.45, *SD* = 0.13, 95% *CI* [2.19, 2.71]).

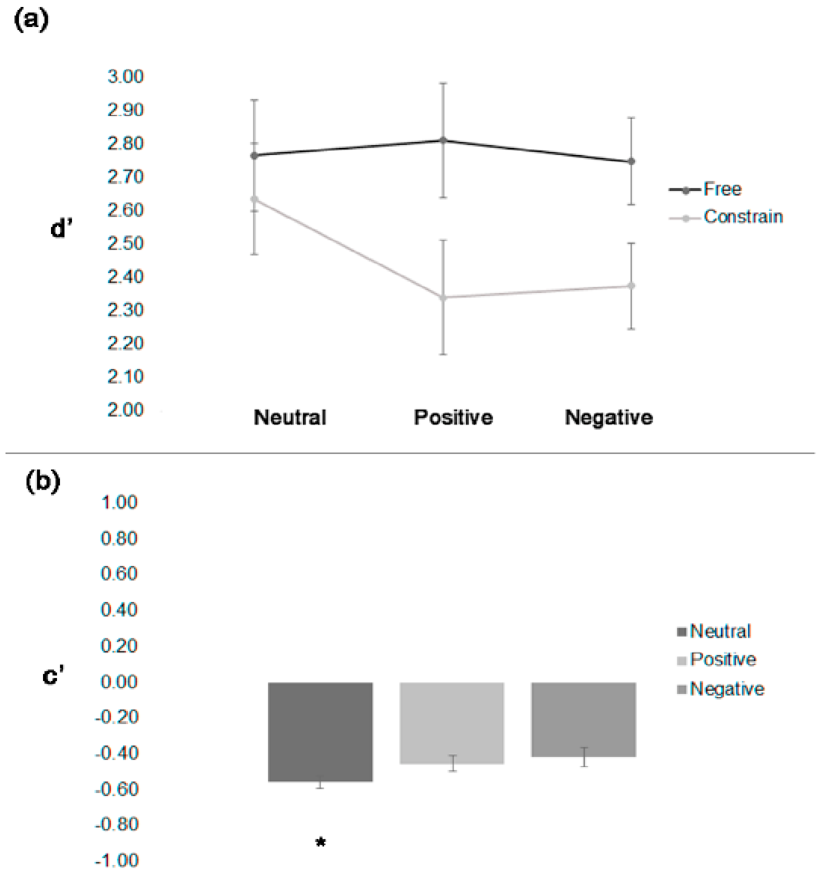

Figure 5. (A) Sensitiveness (*d΄*) across conditions. Effects of affective prime for participants with one-degree of freedom (Constraint), and multiple-degrees of freedom (Free) available. (B) Bias (c') main-effect. Under the effect of affective primes the bias for overestimating reaching was reduced.

Bias on estimate reach-ability (c')

The values of the criterion (*c΄*) adopted by the participants when estimating a dot as touchable or not touchable were subject to a mixed ANOVA with 2 *Conditions* (free x constraint) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor. Negative values of c' revealed that participants adopted a liberal strategy (i.e., they said "yes" more than the ideal observer). Positive values of c' revealed that participants adopted a conservative strategy (i.e., they said "no" more than the ideal observer). The negative values of *c΄* indicate that, overall, participants presented a slight bias to estimate a dot as reachable. Once more, we replicated the findings of study 1 with a significant effect for *Prime* (2, -1, -1; see Figure 5b), indicating that within the constraint group the control prime differs (M = -0.60, SD = 0.05, 95% CI [-0.70, -0.50]) from the positive (M = -0.45, SD = 0.06, 95% CI [-0.58, -0.32] and negative (M = -0.43, SD = 0.07, 95% CI [-0.58, -0.29]) primes, as signaled by the significant

contrast, ($t(40) = -2.37$, $p = .02$, $d = 0.75$). The same effect (2, -1, -1) was not presented for the free group ($t(40) = -1.09$, $p = .28$). No significant differences were found for *Condition* (1, -1; $t < 1$).

The findings of study 1 were replicated only for the constraint condition. However, in addition to data from study 1, data from study 2 revealed that the impact of the affective primes on reducing the number of hits is due to both a reduction in the bias to respond "yes, I can touch" (*c*') and a decrease in accuracy (*d*'). Taken together, these findings suggest that feelings are non-visual information that can integrate affordance. Because in our study the activated affect was induced artificially, it is understandable that the impact promoted hampers the participants' accuracy. In the present study, we also made clear that the effect of prime is paramount when participants are under postural limitations, indicating that the sensorimotor system embodied non-visual information when estimating reach-ability, as well as that we are not able to "trick" the system with our artificial manipulations when relevant information is incorporated in the affordance.

Moreover, and in agreement with previous literature (e.g., Carello et al., 1989; Gabbard et al., 2007, 2006; Rochat & Wraga, 1997), data from study 2 indicate that when multiple degrees of freedom are available, performance is changed in such a way that it calibrates participants' accuracy.

General Discussion

In two studies, we found evidence that by subliminally manipulating feelings we are able to interfere with the estimation of action capabilities. This is what we would expect if feelings are integrated as non-visual information during the process of visual exploration that underlies affordance detection. These findings replicate previous results suggesting that feelings are part of affordance detection (Fonseca, et al., 2016) and are at odds with similar empirical accounts that suggest non-visual information is directly involved with visual information (e.g., Proffit & Linkenauger, 2013; Proffitt, 2013, 2006; Witt & Riley, 2014; Zadra & Clore, 2011) when visually scaling a spatial layout and anticipated action.

The two studies demonstrated that participants' knowledge of their action boundaries (Fajen, Diaz & Cramer, 2011) is not fixed but rather sensible to external and internal changes in the body, such as subjective experiences or feelings.

In addition, the two studies also clarify the role of degrees of freedom presented in reach-ability studies, in the sense that the data allow us to infer that participants withdraw embodied information from their sensorimotor systems, namely from multiple degrees of freedom, to access their action capabilities. If they have this embodied information, they will be more

accurate and less sensitive to interferences of the environment, such as those we created by priming different emotions.

Below we discuss the limits of our designs, and to fully support our data we provide detailed information that is likely to be useful in future studies of similar effects.

Our affective manipulation clearly interfered with the way that participants relied on their action capabilities. That is, because of our manipulation, it seems that relevant environmental features were obfuscated in their capacity to offer accurate information regarding triggered feelings. The fact that these feelings indeed interfered with the process suggests that participants were attending to this source of information. However, the data also suggest that the prime manipulation can only be effective when less sensorimotor information is available (constraint conditions) and when action capabilities are being used as information for a possible action (i.e., within the action range). This is what the data from Study 2 revealed by showing replicate effects only when a dot was within a possible range of action. In turn, when a dot was located outside of a possible range of action for humans, our mild manipulation of feelings did not impact the reach-ability estimations (i.e., no more false alarms were promoted). One possible explanation for this is that our manipulation was not enough to change the actor's baseline (i.e., their sense of homeostasis). Another possible explanation may be that embodied information for an impossible action is different from an affordance that encompasses a calibration of the action itself. Otherwise, it is possible that the perceptual system would not be functional, leading to misjudgments that could be dangerous.

Therefore, changes in feelings would be expected to only moderate the accuracy of the perceived fit (i.e., increased variability), rather than to be engaged in the functional nature of the affordance (Boostman, et al., 1992).

One focus for future studies should be on trying to understand why a simple accidental affective state is not enough to interfere with an impossible action? That is, whether these feelings are less likely to be misunderstood as part of the decision process? Or, whether these feelings are never able to constrain actions to a unique pattern and only able to interfere with the calibratory mechanism that underlies the organism-environment fit.

Future studies should also address other features of our data, given that we found no difference between positive and affective states. Within the literature of affect-as-information, the two dimensions of affect have different informative roles. Whereas valence is embodied information of value (good vs. bad), arousal signals the urgency of an action (Clore & Hutsinger, 2007; Storbeck & Clore, 2008; Schwarz & Clore, 2007). Therefore, the null distinction of positive and negative prime effects seems to indicate that, at least regarding

estimates of action capabilities, the arousal dimension is more informative than the valence dimension. If this is the case, it is possible that it was arousal that disturbed the perceptual mechanism creating variability in the perception of the action estimation. In this case, arousal is not understood only as a mobilizer of energy (Barry, Clarke, McCarthy, Selikowitz, & Rushby, 2005) but rather as embodied information that intensifies the role of interoception in visual scaling mechanisms.

Future studies should try to compare groups with opposite sensibilities to interoception information (e.g., Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015) and to better understand what features of affect exert effects when gauging affordance, and manipulate valence and arousal orthogonally.

The second main body of evidence across our studies is that effects were only detected when multiple degrees of freedom were constrained and our affective information isolated from other sources of information. This clearly suggests that the kinesthetic source of information prevents us from being vulnerable to incidental variations present in the environment, such as those created by our primes, and strongly indicates that postural information interacts with visual information.

Conclusion

Taken together, our results suggest that feelings embody non-visual information and interfere with the estimation of action capabilities when a possible action is latent. In addition, the data also suggest that the sensorimotor system is integrated in the perceptual system, with actors relying on information coming from multiple degrees of freedom.

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Section III

General Discussion

General Discussion

The present thesis aimed to contribute to advancing research on psychology by integrating the feeling-as-information approach and the calibration of our action capabilities under the embodied perspective. We first address evidence regarding the anecdotal cases where athletes report this to occur, by inquire about the phenomenological experience associated with it. That support the goal of the thesis of investigating whether the subjective experiences of feelings that arise as counterpart of perceptual processing influences the perception of our dynamic action boundaries. Evidence offer us clear suggestions of how physical lawful relations of the actor's body and the environment properties constraining affordance-based estimations. Evidence also indicates that actors do not rely on the values of these boundaries, but instead searching for a window of action that seems to be modulate by feelings (likely comfort and safety). Within this line of reasoning we developed an approach centered in the perceptual processes of gauging spatial-temporal relations according to our action capabilities. Specifically, we investigated whether concomitantly with the visual exploration of the context, feelings embodied non-visual information that constraining our perceived action boundaries when performing perceptual-motor estimation.

Overview of the empirical findings

Study1. This study aimed to test if the anecdotal cases suggesting athletes' decision based on feelings had phenomenological support. This assumption sustained our main hypothesis. So, we firstly tested the functional role of feelings regards our dynamic action boundaries via reports of previous experience of expert athletes in a field study. To this end, we investigated if athletes acknowledge themselves as rely on feelings as source of information when performing action choices in real game context. We presented feelings in contraposition with deliberative thinking (cognitive inferential routes) and visual perception (changes in the optical array). The result indicates that expert futsal players recognize feelings and thinking as different subjective experiences coupling with changes in the optical array (i.e., we found a reliable difference between feeling vs thinking; but not between feelings vs looking; and thinking vs. looking). We also find that a higher reliance on feelings reduces reliance on thinking (and vice-versa). Thus, according to our data it seems that subjective feelings are experiencing as being sources of information, with the reliance of athletes on feelings being

constrained by spatial-temporal relations of the game situations. Specifically, reliance in feelings as source of information is higher when associate to actions embedded in a chain of movements than in stationary game situations as for example penalty-kick and corner-kicks.

Having support in both experiential and theoretical data, we approach our hypothesis in lab controlled conditions.

Study2. Our first lab study aimed to understand whether action capabilities can be informed by feelings through assessing evidence of feelings activation in conditions that participants are asked to do action-based estimations of their action capabilities. In the experimental condition, we presented two dynamic events that created changes in optical flow and we tracked the electrical activity of two facial muscles that index subjective experiences of positivity and negativity. The tracking was performed with participants anticipated the perceptual-motor coupling of their hands with the spatial-temporal relations of the events (i.e., changes in optical flow), in contraposition with the condition in which the participants only experienced optical flow (i.e., without perceptual-motor coupling estimation). Results indicate that feelings were experienced only when the participants had to estimate perceptual-motor coupling. The detection of these feelings is supported by a higher activation of corrugator supercillis, a spontaneous index of negativity. We also observed feelings being activated at the end of the task associated to the zygomaticus major (spontaneous index of positivity) which may suggest that some discomfort was relief after the estimation be done. Importantly to our hypothesis, when changes in the optical flow was uncoupled from the need of the motor action participants experience both facial muscles demonstrated a stable activity relatively to the baseline.

Study3. This study aimed to understand if the effects found in the activity of the corrugator was due to a subjective experience of discomfort or due to attentional mechanisms (i.e., more cognitive demand may be also indexed by the corrugator). We wanted to confirm that the corrugator activity detected at Study2 embodied information by the own nature of the process of making action-based estimation. Here we subliminally primed emotional faces with opposite valences (neutral, positive and negative) to promote feelings at the baseline of participants and tested the effects of the resulting feeling in biased the perceptual-motor coupling estimation. Results revealed that time elapsed (i.e., the indication of when the perceptual-motor coupling was possible) under the effects of negative priming was higher than neutral priming. Although not reliable, results also revealed a trend to positive valence postpone the perceived fit when compared with the neutral priming. This experiment made clear that by

interfering with natural feelings involving in the processing of action-based estimation we interfere with participants ability to estimate their action capabilities (i.e., the estimation of the perceptual-motor fit).

Study4. In the study 4, we aimed to replicate the finding of our study 3 and increases the ecological validity of our dynamic event by adopting a task in which the target object was real (i.e., touch areas of the computer screen). Besides the temporal constraining, we also included a postural constraining by limit the movements of participants. The two main aims of the postural constraining were gather a higher experimental control via blocking moto-cognitive strategies for reaching far away (e.g., imagine leaning the trunk forward), but also to understand if under sensorimotor constraining the reliance on feelings activated by our manipulations could be strong. Results indicated that under the effects of negative priming the participants once more elicited the time to perceived when a touchable dot become untouchable relatively to the neutral priming. The effect of positive prime was also significant in postpone the perceived transition relatively to the neutral priming. Again, this is clear evidence that by interfering with the affective experience of participants we disrupt their ability to infer action capabilities.

Study5. Finally, and keeping the same subliminal affective priming manipulation, in our last study we aimed to investigated if conditions that provide less cues to participants to evaluate their action capabilities favors the detection of the use of feelings as source of information. Using a static event that did not provided changes in the optical array during the perceptual-motor estimation (less temporal constraint), and additionally releasing the postural constraining of the half of participants, we found that the group with postural constraining have more difficult to perceive an impossible location as non-touchable. Results also indicated that this same group was more susceptive to the effects of negative and positive priming when comparing their results with the neutral priming condition. Specifically, in this situation we found that participants with postural constraining had difficult to distinguish the boundaries of a touchable from a not-touchable location and they had also underestimated touchable points in reliable ways. The same patterns were not found in the group without postural constraining. This pattern of results suggests that our manipulations that were shown to interfere with how feelings naturally inform action capabilities are more powerful when no other source of information is available to participants.

What this set of findings reveals?

Firstly, taken together the results of the correlational study, the psychophysiological measures, as well as behavioral measures in the experimental settings, support our hypothesis that feelings embodied functional information regards our own action capabilities and have direct impact in the estimation of the perceptual-motor coupling. Secondly, studies suggest that this latent information of our body language seems to be more prominent when the temporal window does not allow the overlap of other higher cognitive processes. That is, when action estimations are highly constraining by dynamic and unstable spatial-temporal relations of the environment (i.e., shorter than 1s).

Taken together, these findings corroborate to the body of research demonstrating that immediate feelings of easy or difficulty that people experience associated every cognitive process as perceiving, thinking and memory retrieving can also influence action capabilities (e.g., Clore, et al., 2001; Schwarz & Clore, 2007, 2003, 1983). Therefore, our data extends a body of evidence that is mostly anchored in evaluative judgments that decouple perception from motor actions, and highlight the importance to investigate the nature and mechanism of feelings as information also when perception is intended to guide action (Zadra & Clore, 2011). In addition, and because our investigation is also related to action capabilities, our data parallel with findings of the embodied perception account (e.g., Proffitt, 2013; 2006) and the assumption that perception for guide action is not sustaining by unimodal information (i.e., one unique array), but rather cross-modal information that integrates a myriad of neuro-physiologic processes of the body (e.g., Stoffregen & Bardy, 2001; Witt & Riley, 2014). Indeed, we think that it is the felt experience that turns possible access information regards a myriad of bodily processes underlying our active interaction with the surrounding in terms of action possibilities. We address the main singular contributions of our findings in the light of evidences of the relevant literature.

Increasingly, different fields of the literature have shown that sensorial information that arises as counterpart of neurophysiological and neurobiological changes when in interaction with the surrounding is able to index positive and negative information regards survival and the energetic economy of the mind and behavior (e.g., Barrett, et al., 2007; Clore, 1992; Damasio, 1996; Panksepp, 2010b; Russel, 2009). All our five studies indicate that feelings indeed can support actions. The idea of visual information scale by nonvisual information grounded on our body physiology and shaped by intentions (Proffitt & Linkenauger,2013) is in line with propositions that ocular heuristics are not enough to guide action prospectively but must considering, for instance, the dynamics of our action boundaries (Fajen, 2007a; 2005a).

Findings from Study 1 indicate that if optical flow has a role it is not perceived by athletes to be taken apart of other phenomena of the body. When performing in game context expert futsal athletes acknowledge feelings as source of information regards their own action potential. If relevant to inform about the role of feelings in action-based estimation, it is worthwhile to acknowledge that awareness would not be necessary for feelings to have an informative role (e.g., see for example Winkielman & Berridge, 2004; Pankseep, 2010). The ebbs and flow of subjective experience can be direct informative even without introspection and higher constructive processes associated to basic emotional episodes. In this sense, feelings can direct specify information just like retinal transformations translated by changes on tau variable can specify collision without the awareness of actors (e.g., Savelsberg, et al., 1991).

In this sense, our data indicates that the reliance of athletes on experiential feelings arises in contraposition to the experience of thinking (with both being concomitantly to visual information). Also, feelings become more salient as source when actors perform within a chain of actions and the access to their action capabilities is constrain by a decisional context featured to very short time windows and higher unpredictability.

Over the literature the idea of expert athletes using a non-reflective and immediate route of information in a course of action has not rarely being related to intuitions, in the sense of some "automatized entity" that expert acquired and taking control of their decisions (e.g., Dreyfus, 1997). However, this idea of "not-thinking" has been criticizing by researchers who have argue that athletes might shift attentional focus from a reflexive body awareness to a more pre-reflexive (e.g., Montero, 2010; Toner, Montero, Moran, 2015). Data from Study1 indeed indicates that different sources of information regarding body movement awareness can co-exist. From the perspective that feelings are a route of cognition (e.g., Duncan & Barrett, 2007; Storbeck & Clore, 2007), this may be understood as all bodily processes having cognitive informative value. Evidences have indicated that there is more in cognition that the content of thoughts influencing our behavior (e.g., Schwarz & Clore, 2007). For instance, the subjective experience of positivity due increasing sensorimotor fluency can support action by constrain actors to fast action-perception couplings (e.g., Canon, Hayes, & Tipper, 2010; Regenberg, et al., 2012). It is only under the perspective of a disembodied mind (e.g. Frazier & Fodor, 1978). where information is abstract, amodal and functionally independent from the sensorimotor system, that feelings (subjective) can be envisage as split from cognition (objective). There is no such a thing as "purely feeling" and "purely thinking" routes. Simply, one aspect of the

processing can become more relevant than other because that is what the situational constraints requires.

In this sense, the literature has provided several models sustaining informational routes for judgment and decision making that are more slowly or faster (for a critical review see Evans & Stanovich, 2013). It has also been pointed that in time, feelings overcoming higher cognitive processes (e.g., inferences) because they are anchored in minimum cognitive processes (e.g., Zajonc, 1981; Pham, et al., 2001). Therefore, feelings can be much more usable for online than future decisions (e.g., Chang & Pham, 2013) and become more relevant when the situational constrain make processing conditions more difficult. For example, regards the role of feelings in consumer behavior, Avnet and collaborators (Avnet, et al., 2012) indicate that influence of feelings increases under lower process of information, time pressure or cognitive load (i.e., lack of resources). Thus, the higher reliance on feelings as functional information indicated by athletes, can merely reflect a suitable route to the contextual circumstances that athletes by their own choice and expertise classified as fast, complex, uncontrollable and uncertainty.

Results from our Study3, Study4 and Study5 demonstrated that our affective priming manipulation interferes with the natural process of estimation of action capabilities. This finding corroborates the evidence demonstrating embodied effects in action-perception (e.g., Proffitt, 2006; Stefanucci, Gagnon, & Lessard, 2011; White et al., 2013), and specifically associating direct effects of feelings and emotional states in action capabilities (e.g., Geuss, et al., 2016; Graydon, et al., 2012; Pijpers, et al., 2006).

However, it is worthwhile to knowledge that although our manipulations interfered with the natural process of action scaling, our effects did not follow evidence on affective priming showing congruence (match) to be associated with facilitation, and incongruence (mismatch) to inhibition (e.g., Fazio, 2001). our data revealed a higher activation of corrugator when estimating dynamic events, which is pointed as a index of a negativitivity (e.g., Dimberg, Thunberg, & Elmehed, 2000; Hellera, Greischara, Honora, Anderlea, & Davidson, 2011; Larsen et al., 2003) and that might be underlying the action-based estimation. Being so, relatively to the control priming condition in Study 3 and Study4 it should be expected the facilitation of the process at the negative priming (less elapsed time to the perceived fit), and an inhibition of the process at the positive priming (higher elapsed time to the perceived fit). Instead we found that not only the negative condition interfered in the action estimation postponing the perceptual-motor coupling in a reliable way, as well as the positive condition also presents the trend to follow the same direction of the negative priming. According to the

sensorimotor simulation the pattern of delay found in our data might have occurred because the same sensorimotor resources were involved in the process (Körner, et al., 2015) and so priming manipulation might have simulated the embodied information trigger by the estimation processing. However, this explanation only makes sense if we consider the negative prime condition (see results of Study2) and does not fit with the results of the positive prime condition.

Although future studies are needed to explain the positive priming effect some speculation can be provided about our data. In a singular study linking feeling-as-information and visually estimation, Riener and collaborators (Riener, et al., 2011) found a mood congruent effect on visual estimation of fixed spatial relations (i.e., sad mood leads hills to be perceived stepper). This paradigm differs from ours that applied action-based judgments over dynamic events (i.e., facing changes on spatial-temporal relations). That could be a first possible explanation to our divergent results.

Another possible explanation for our findings may occur it is because of the nature of our dependent measure. Unlike mostly findings from socio cognitive literature that investigate processual feelings associating to mental operations as memory retrieval or fluency (e.g., Garcia-Marques, et al., 2004; Schwarz, 2004; Winkelman & Cacioppo, 2001), our findings are underlying by a body-mind unit in which sensorimotor information exerts a real and direct constraining into the perceptual processes. Changes on our action potential can direct change our perception of a same physical dimension (see Turvey, 2004). Thus, our judgments are not about preferences and attitudes in which visual perception is concerning with structural features of the layout in terms of beauty, liking and other kind of preferences (for a review see Schwarz & Clore, 2003). Instead, we have action-based judgments in a context that perception is intended (and interplay) to action in online basis, and it is likely that another pattern of information become more relevant (for differences between visual cues for perception intend to action and non-action see for example Araújo, Davids, & Passos, 2005; Dicks, Button & Davis, 2010).

Data from Study2 indicate that action-based estimation of dynamic events seems to be underlying by a high activity of the corrugator supercilli, whereas purely changes on optical flow (decoupling from action estimation) does not. Also, graphic inspection illustrated that activity of corrugator started from the baseline and our Study3 indicated that it seems to occur because participants have anticipated knowledge of the task on demand. The higher activity of corrugator seems to embodiment information of discomfort, disfluency and increased mental effort (e.g., Larsen, et al., 2003; Dimberg et al., 2002; Topolinsk & Stracks, 2015; Waterink &

van Boxtel, 1994). Thus, our data might indicate that action-based judgment of dynamic events was underlying by a negative index, and generate higher energetic demands (i.e., activation) into the system (e.g., Hajcak, et al., 2007; Storbeck & Clore, 2008). Thus, we speculate that our positive and negative priming might interplayed with the negativity index elicited by the experimental task (Cohen et al., 2008) and increased the energetic demand in the system. Panksepp (2010b) states that in its roots feelings are intrinsic values in which the various positive affects indicate returning to “comfort zones” that support survival, whereas negative affect reflects “discomfort zones” that may impair survival (and both sustain secondary and tertiary process in terms of cognition). According to Eleanor Gibson (2000) “economical pickup and use of information can be described as a kind of minimum principle (p.299)” in which a principle of reduction of uncertainty “is achieved by discovery of unit, order, and economy (our emphasis)” (p.301). Thus, it is likely that feelings of discomfort arise and constraining the system to compensate and adopt a more economic/comfortable pattern of perceptual-motor coupling.

Translated to our designs it means a preference for grasping small ball (shrinking in size) and fit-through large openings (increasing in size) in Study3, and a trend to the remaining on a more comfortable zone in Study4. Indeed, we found a higher elapsed time for estimations of perceptual-motor fit under the negative and positive priming in Study3, and a higher elapsed time to perceive transition from a touchable to a non-touchable location of the scree in Study 4. To note, the effect size associated to the negative priming was always higher ($d=0.53$ in Study3 and $d=0.41$ in Study4) than the positive priming ($d=0.39$ in Study3 and $d=0.29$ in Study4). Over the literature there is indications that corrugator is able to be higher activate at the low arousal condition of our priming faces than zygomaticus (Fujimura, Sato & Suzuki, 2010). It has also been founding faster (Mavratzakis, Herbert &Walla, 2016) and large (Lu, Zhang, Hu & Luo, 2011) amplitudes of activation associated to the negative priming. So, overall it is likely that negative priming induced higher noise in the system that positive, explaining the pattern of results found in our Study3 and Study4. Finally, data from Study5 also fits in this line of thinking, although we cannot guarantee the same baseline conditions of Study3 and Study4 given that we applied a static event and partially remove postural constraining. Results of Study5 indicates that participants were more conservative at the positive and negative priming than at neutral condition, and priming effects were only reliable at the conditions associated to postural constraining (discomfort).

If that is what really happened to our findings, our data corroborate with propositions that energetic expenditure captured at the psychological dimension of comfort-discomfort embodied information to perceived action (e.g., Mark et al., 1997; Warren, 1984; Zadra & Clore, 2011) and also to visual estimations of the spatial-layout (e.g., Proffitt, 2006). Because participants are not aware of priming manipulation and the time window available to estimate the fit with the dynamic events was short (i.e., less than 1s) we think be difficult that our effects are sub-product of supplementary cognitive process as bias and artifacts applied to verbal judgments (Durgin, et al., 2009; Heft, 1993).

Over the action-perception literature researchers have investigated the assumption of perception grounded in multimodal arrays rather than unimodal, with actors learning to become sensitive to a higher order variable that is supporting by cross-modal information at low level (e.g., Stoffregen & Bardy, 2001; Witt & Riley, 2014). This proposition is not too distant of what have also been suggested for feelings. For instance, to Barrett et al. (2007) feelings emerge from the dynamic interplay of multimodal changes on neurophysiological and neurobiological level (i.e., interoceptive level) in interaction with information of the surrounding (exteroceptive level), and it is functionally designed for the immediate action.

Along of the literature on action-perception is not rarely to find terms as “confidence”, “comfort”, “sensibility” and “felt” in the interpretation of results of different experiments. All them suggest the experiential nature of the information underlying the process. Likely the latent variable associated with those concepts is their representation on a valence dimensional space of feeling good or bad. Not having conscious accesses to the metabolic processes at the level of cells regarding, for example our respiratory processes, we can develop sensitive to the felt experience that arises as functional information associated to different states of our respiratory processes (see for example Barrett, 2009), and make a constructive process above it. In this sense, the grounded perspective of cognition (e.g., Barsalou 2008) have defend the idea that concepts as “easy” and “hard” are rooted in sensorimotor experiences acquired in real interactions with the world, just as language (Gallese & Lakoff, 2005). As, White and collaborators (White, et al., 2013) found, rather than have a main effect of low-order parameter as walking rate, grade inclination and optical change, it was the felt experiencing of energetic expenditure capture by the multimodal ration (i.e., energy expenditure by optical information) that directly impacted in the perceived distance of their participants. That is in line with findings demonstrating that feelings of comfort or discomfort underlying action (Mark et al., 1997; Petrovic, et al., 2015).

In line with Proffitt (2013; Proffitt & Linkenauger, 2013) who propose the body as the scale metric embodied non-visual information to perception, we add that this sensibility is feelings, and feelings are the intrinsic metric. Thus, supporting by this literature we reinforce the idea that is not so much the valence of our manipulation per se that was effective in the priming manipulation (Study3, Study4, Study5), but rather how our priming information interplay to the diagnostic feeling of comfort or discomfort of our action capabilities relatively to the task in hand. In adopting this perspective, we could interpret that our priming manipulation was interfered with the high-order variable that emerge from the interplay of other low-order variables as the optical flow and the time constraint. Thus, and like we see in our data (Study3, Study4 and Study 5), the felt experience could be intensify by the priming rather than guided by the priming). In addition, in our Study5 our design might be changed some low-order variables that could be feeding the felt experience, namely time pressure and optical flow information. Thus, as already mention previously, it is likely that we facilitated the task demand in such a way that priming information (i.e., another low order variable) just had effect when the postural movement of participants was freeze. Mantel et al. (2015) found that confidence of participants about their action judgments are associated to stable relations in the actor-environment system. That is, when for example the target is very far or very near regards our action capabilities. In turn, confidence decrease when the relation is ambiguous and both conditions co-exist. Thus, under ambiguous situation the vulnerability of the system to noise (as those induced by our priming manipulation) can be higher (Kelso, 1995), which could be a possible explanation to our findings.

Thus, in Study3 and Study4 our design was grounded in more unstable/uncertainty condition given the features of our fast-dynamic event. The same could be extend to Study5 when participants had their postural constraining frozen, and loss of stability happening because information anchoring in the usual body condition was remove. At these conditions, our priming activation seems to be more informative (as low-order variable) to the general felt experience underlying the perceived fit. In turn, when participants had both constraining remove (i.e., static event plus free postural condition in Study5), our priming seems not be enough to induce noise and disturb perceive fit. We speculated that it might be happened because the felt experience was grounded in other low order variables that we did not control. To better understand if that is what really happened more work is needed.

Limitations of our findings

A first limitation to generalization of our study it is the fact the we did not approach an effective action, but only anticipate actions. We are aware that in real life a different combination of results could be found, either because other variables could become more significant in the processes or because the feelings experienced in real life context are not the same elicited in laboratory or training sessions. However, because data generating in both, the feeling-as-information approach and the action-based estimations have largely adopted similar experimental designs, we consider that our data reveals important contributions to the literature given that we adopted the strategy of provide different measures around the phenomena investigate, and adopted dynamic events that change in online basis to provide the necessary optical information (e.g., changes in the edges with a fixed background, depth, colors). Also, although in Study1, Study2 and Study3 our events lack on ecological validity in terms of real action (i.e., 3D images and 2D images), in Study 4 and Study 5 action estimation were made through a more realistic scenario and participants have available information to perform real touches at the target areas of the computer screen if the experimental protocol allow them to do it and as indeed they perform in the calibration phase. Thus, a good path of new research could be to follow paradigms that have measure not only action-based estimation regards an action capabilities, but also real action (e.g., Geuss, et al., 2016).

Another important limitation to our data is that only at Study1 and Study2 we have better control of the participants baseline. In the Study 1 this control was made by statistical proceeds by control random effects at the mix-model, whereas in the Study2 the facial muscles activation starting to be tracking before the onset point and all calculations were made relatively to this phase. Our findings suggest that baseline conditions might be crucial to understand how feelings interplay with action capabilities in functional terms.

Therefore, a traditional approach to investigate action capabilities has been determine the actors baseline in terms of distinct body morphology as for example “taller” vs “short” group in absolute heights (Warren, 1984), or in terms of maximum action boundaries, as for example the group “near” vs “far” when considering maximum reaching (Mantel et al., 2015). Another classical procedure that has been adopted to equate participants of different body scales it is identify a threshold point between the target action capability and the total number of attempts (e.g., 50% ratio of successful; Ishak et al., 2008) or the absolute critical boundary of each participants (e.g., Mark et al., 1997). We lack on this precisely control, and we also lack in understanding how feelings associated to the participants action capabilities and induced by the task could interplay with the estimation of the perceptual-motor adjustment.

A third main point is that we only know how our priming might be interfered with feelings by an indirect route. That is, only with supporting of evidences coming from other literatures. Although we have an affective measure of the task in the Study2 (i.e., EMG), we did not have the same measure for the interplay of the priming and the task. This remove some power of our discussion and indicates the need of studies with a better control of the effects of affective priming in fast action-based estimation processes as well measuring feelings underlying the processes.

Finally, a last important issue that our priming was not informative at the valence level, and positive and negative presented a similar trend. So, we did not understand what the priming manipulation was adding to the processes in terms of feelings. Our data only allow us to demonstrate that feelings interfere, but have not evidences of how? For example, whether priming really increased activation a triggered a higher energetic demand as we speculated or not? Or if or positive and negative priming had the effect expect, that is sad face induce negativity and happy face induced positivity? For instance, manipulating energetic states through other neurophysiological sources grounded in interoceptive feelings that supports hedonic experiences of positivity and negativity, as blood sugar (Schnall, et al., 2010) or blood oxygen (e.g., White et al., 2013).

Future avenues

Based on our findings and relatively to what the literature offers to us as evidence, we envisage two main open questions and how future studies could be set to provided evidences that support answering them.

Feelings as online information (not before and not after). Evidences of feelings as embodied effects on perception intend to action (e.g., visual scaling of the spatial layout or action-based estimation) have been support by two kinds of experimental designs: asking participants to recall their felt experiencing after each estimation or action performance (e.g., Mark et al. 1997; Mantel et al., 2015; Pijpers et al., 2006); or manipulating the felt experience on participants baseline before the task as we did in our priming studies (e.g., Graydon et al., 2012). For example, Mark et al. (1997) instructed participants to rate 3 point-felt comfort after each reaching (i.e., a post-effect) being completed (i.e., 1-felt very natural or comfortable; 2-felt slightly unnatural or uncomfortable, and 3-reach felt awkward or the block was

unreachable. In turn, Graydon et al (2012) used both a breath tasking a rating scaling to induce and control anxiety states just before estimation of action capabilities.

Therefore, there is a lack of understanding feelings as functional information that underlying the process of action capabilities in on-line basis and by its own nature. A good alternative to solve it could be step-back and simply measuring feelings during different action-based estimations conditions, which means turning the feelings our dependent variable and the action capabilities our independent variable. In this sense, we avoid manipulating feelings at the baseline and stop to tracking its effects, as well as the interference of post-perceptual cognitive processes more susceptible with post-effect measures (see Philbeck & Witt, 2015).

Our designs could replicate tasks that constraining body postural (Mark, et al., 1997) or creates effective changes on action boundaries via the addition of tool in reaching estimations (e.g., Witt, et al., 2005), as well as wearing large-hand prosthesis to manipulated hand size (e.g., Ishak, et al., 2008) for grasping or fit-through estimation. Concomitantly to the action-based estimation we could measure facial activity muscles that index feelings of positivity and negativity in on-line basis (e.g., Cacioppo, Petty, Losch, & Kim, 1986). Additionally, we could also measure feelings elicited at the action-based estimation indirectly via an affective priming paradigm (e.g., Fazio, 2001) immediately after the action-based estimation to capture the positivity or negativity of estimations pre-test as clearly possible and impossible, as well as unstable (i.e., where possible-impossible co-exist).

Feelings as macro-order or latent variable. The idea of feelings as non-visual information embodied information that constraining our perceived action boundaries fits with evidences indicating that actors are not sensitive to changes at specific low-order variables (i.e., amodal or grounded in unique pattern of sensorial information), but rather a macro or high-order variable that extend across multiple and redundant forms of information (e.g., Mantel, et al., 2015; Stroffregen & Bardy, 2001; White, et al., 2013; Witt & Riley, 2014). Not rarely, researchers have use the “felt experience” to both instruct participants or explaining findings (e.g., White et al., 2013; Mark et al, 1997). Thus, because metabolic cost has been associated as embodied information when anticipated action (e.g., Proffitt, 2006; Warren, 1984) or choosing affordances (Whitagen, et al., 2012), and interoceptive awareness being associated with feelings (e.g. Craig, 2011; Herbert, Pollatos & Schandry, 2007) it could valuable explore the linking between sensibility to feelings as a latent or high-order variable, physiologic changes in terms of energetic expenditure and the perceived action capabilities (i.e., perceptual-motor coupling).

This latent variable could be isolated if the several measures that have been reported are directly assessed at the same time. Methodologically, overcoming this differences in scale of measurement of each variable, a confirmatory hierarchical factorial analysis could directly test our assumption. But an alternative avenue to investigate it could be to assess participants sensitivity regards their felt experience (e.g., Barrett, Quigley, Bliss-Moreau, & Aronson, 2004; Bechara & Naqvi, 2004; Garfinkel, Seth, Barrett, Suzuki, & Critchley, 2015) and expecting that it be related with the physiological indexes that have been addressed as related at the action-perception features. For instance, by replicating the breathing task of Greydon et al. (2012) and manipulating reach-ability of static and dynamic events, we could concomitantly have the measuring of the action-based estimation and the measuring of such sensibility to feelings. We should expect the last variable to moderate the expected effects, in such that only the high sensible individuals will completely replicate previous results. Another alternative study could be achieved by manipulating the breathing task to induce higher energetic demands (e.g., Greydon, et al., 2012) or less energetic demands (e.g., Goldin & Gross, 2010) and see how high and low sensible participants will react regarding action-based estimation when facing static and dynamic-events (low and high temporal pressure).

In sum, the approach followed in this dissertation, can be understood as a first approach to relate the social cognitive literature regarding feelings as information with the literature being developed with regard action-perception abilities. From this relationship, we bring more questions to the literature than answers, but expect to turn clear both the fact that feelings have a role in action capability estimations and that the different literature will gain with establishing new bridges between them.

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Section IV

Appendix

Appendix A

Acting fast on feelings! Naïve theories of expert futsal players about feelings as information

Material

Pilot Study

Caro(a) participante:
As suas respostas são confidenciais e anónimas. A sua participação é voluntária, não envolve riscos e é indispensável para o sucesso desta investigação. Agradecemos a sua colaboração.
Este questionário é constituído por três partes e demora cerca de 15 minutos a ser respondido: 1ª parte: lista de acções; 2ª parte: capacidade de agir no dia-a-dia; 3ª parte: capacidade de agir no desporto.

1ª Parte: Lista de acções

Durante o desempenho no desporto existe uma regulação da acção com base na informação do ambiente, isto é, o atleta em função do ambiente muda a sua decisão de agir e acção. Alguns exemplos: para o atirador uma mudança da acção é premir o gatilho; para o jogador de futebol, uma mudança da acção é rematar à baliza ou fazer um passe; para um surfista uma mudança da acção é ficar em pé na prancha ou arriscar uma manobra na onda; para um nadador uma mudança da acção é acelerar aos metros finais ou sair do bloco.
Por favor, analise o seu desempenho no desporto como praticante e identifique 5 (cinco) mudanças de acção que realiza habitualmente numa competição da sua modalidade.

- [Acção 1] :
- [Acção 2] :
- [Acção 3] :
- [Acção 4] :
- [Acção 5] :

Obrigada pela sua participação! Por favor, prossiga para a segunda parte deste questionário.

2ª Parte: Capacidade de agir no dia-a-dia

Nesta parte do questionário pense na acção que lhe fornecemos e avalie de que modo acede à sua capacidade de agir em cada uma das situações.
Queremos que reflita sobre o <u>momento exato da mudança da acção</u>. Ao reflectir considere apenas que nesse momento a informação sobre a sua própria capacidade de agir pode ocorrer por três vias distintas:

COM BASE NO PENSAR (elaboração, cálculo, reflexão)	COM BASE NO PURO OLHAR (puramente visão)	COM BASE NO SENTIR (sensações corporais indefinidas, intuição, instinto)
Capto a informação com o olhar (vejo), uso o conhecimento das minhas capacidades de acção gerais e calculo se consigo agir.	*Ao captar a informação com o olhar (ver), já acesso directamente à minha capacidade de agir. Faço-o instantaneamente sem pensar ou sentir.*	*Capto a informação com o olhar (vejo) e sinto que consigo agir naquele momento.*

Exemplo de acção: ATRAVESSAR A RUA.

Se for com base no pensar: estimo o espaço entre os carros; conheço a minha velocidade de deslocação habitual; faço um cálculo mental de forma a chegar a uma resposta adequada de acção e de agir.	Se for com base no puro olhar: ao perceber o espaço instantaneamente percebo que consigo atravessar.	Se for com base no sentir: ao perceber o espaço sinto que é naquele momento que devo atravessar.

Agora use as três definições apresentadas e considere cada uma das acções que estão no quadro abaixo. Caracterize aquilo que habitualmente se passa consigo no <u>*exato momento descrito.*</u>. Para o efeito, em primeiro lugar, seleccione com um "X" a via, ou as vias (*pensar, puro olhar, sentir*), pela qual <u>*no exato momento da acção*</u> acede ao conhecimento da sua capacidade de agir. A seguir, refira a intensidade da(s) via(s) escolhida fazendo um círculo "O" em torno do número seleccionado da escala.

CENÁRIO 1: IMAGINE QUE VAI ATRAVESSAR UMA RUA COM MUITOS CARROS.

**Acção 1: <u>Estou parado e começo a atravessar a rua.</u>* (Com que base agiu?)

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

**Acção 2: <u>Estou a atravessar a rua a uma dada velocidade e acelero ao ver um carro.</u>* (Com que base agiu?)

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro olhar	Pouco	1	2	3	4	5	Muito

☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

CENÁRIO 2: IMAGINE QUE VAI PASSAR POR UMA PORTA QUE SE ESTÁ A FECHAR.

**Acção 1:* <u>*Vejo o espaço e concluo que não tenho tempo para passar.*</u> (Com que base agiu?)

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

**Acção 2:* <u>*Ao aproximar-me da porta necessito de virar o corpo para passar.*</u> (Com que base agiu?)

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

<u>3ª Parte: Capacidade-de-agir no desporto</u>

Pense agora no seu desempenho como praticante relativamente às actividades que descreveu na TAREFA 1.
<u>No *momento exato de realizar a mudança da acção descrita,*</u> como acede à sua capacidade de agir?
Para responder, pedimos-lhe que escreva cada uma das mudanças de acção que listou na 1ª parte na ordem correspondente e depois execute a mesma tarefa que realizou na 2ª parte deste questionário.

01.
(liste aqui a sua acção):

____.

No exato momento em que desempenha esta acção com que base age e qual a intensidade desta via?

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro-olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

02.
(liste aqui a sua acção):

____.

No exato momento em que desempenha esta acção com que base age e qual a intensidade desta via?

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro-olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

03.
(liste aqui a sua acção):
____ .

No exato momento em que desempenha esta acção com que base age e qual a intensidade desta via?

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro-olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

04.
(liste aqui a sua acção):
____ .

No exato momento em que desempenha esta acção com que base age e qual a intensidade desta via?

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro-olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

05.
(liste aqui a sua acção):
____ .

No exato momento em que desempenha esta acção com que base age e qual a intensidade desta via?

☐	Com base no pensar	Pouco	1	2	3	4	5	Muito
☐	Com base no puro-olhar	Pouco	1	2	3	4	5	Muito
☐	Com base no sentir	Pouco	1	2	3	4	5	Muito

Para finalizar a sua participação informe por favor:

1. É praticante federado? ☐ SIM ☐ NÃO

2. Indique o seu desporto: _

3. Tempo de prática? _ _ _ _ (anos).

4. Horas de treino por semana (valor médio)? _ _ _ _

5. Data de Nascimento (dd/mm/aa): _ _ _ _ /_ _ _ _ /_ _ _ _ _ _ _

6. Sexo: ☐ M ☐ F

OBRIGADA PELA SUA PARTICIPAÇÃO!

Main Study

Survey Part 1.

Imagine-se em jogo a realizar a ação do jogador(a) em posse de bola na fotografia:

Neste exacto momento o quanto acha que durante o jogo esta sua acção é desencadeada por:

Via	Pouco				Muito
Pensar (elaboração, cálculo, reflexão)	**1**	**2**	**3**	**4**	**5**
Olhar (visão pura)	**1**	**2**	**3**	**4**	**5**
Sentir (sensações corporais indefinidas, intuição, instinto)	**1**	**2**	**3**	**4**	**5**

Survey Part 2.

Sinta-se a realizar a ação que está apresentada na fotografia:

Esta é uma acção:

Automática	1	2	3	4	5	6	7	**Pensada**
Controlável	1	2	3	4	5	6	7	**Incontrolável**
Dinâmica	1	2	3	4	5	6	7	**Estática**
Simples	1	2	3	4	5	6	7	**Complexa**
Instável	1	2	3	4	5	6	7	**Estável**
Previsível	1	2	3	4	5	6	7	**Imprevisível**

Survey Part 3

Para finalizar responda as próximas quatro questões a respeito de suas características pessoais e atléticas:

Qual o seu género?

- ○ Feminino
- ○ Masculino

Qual o seu ano de nascimento? (4 dígitos)

Há quantos anos é atleta de futsal? (2 dígitos)

Qual é a sua carga horária total de treino no futsal em uma semana (7 dias)?

- ○ 1 a 2 horas
- ○ 2 a 3 horas
- ○ 3 a 4 horas
- ○ 4 a 5 horas
- ○ Superior a 5 horas

Images presented as Game-Situations.

1x1.

1x2.

High-Kick.

Ground-Kick.

Dribling.

Feiting.

Dead-Ball.

Statistical Analysis

Pilot Study

Athlete Statement. The score of each source was subjected of a Repeated Measure ANOVA with 3 *Intensity-of-Sources* (thinking, looking, feeling) as within factor. A Pearson product-moment correlation coefficient was also computed to assess the relationship of *Intensity-of-Sources* between the three variables: *thinking*, *looking,* and *feeling*. Next, we counted how many times each participant indicated rely and not rely on thinking and feeling as an informational source, and the total score of "yes" and "no" of these sources was subject of a Chi-Square test of independence to examine relationship between thinking and feeling.

Within-Subjects Factors

Measure: MEASURE_1

SOURCE_POS	Dependent Variable
1	Pensar
2	Puro_Olhar
3	Sentir

Descriptive Statistics

	Mean	Std. Deviation	N
Pensar	1,90	2,101	81
Puro_Olhar	1,41	1,973	81
Sentir	2,52	2,080	81

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
SOURCE_POS	,993	,530	2	,767	,993	1,000	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: SOURCE_POS

b. May be used to adjust the degrees of freedom for the averaged tests of significance.
Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
SOURCE_POS	Sphericity Assumed	50,206	2	25,103	4,952	,008
	Greenhouse-Geisser	50,206	1,987	25,271	4,952	,008
	Huynh-Feldt	50,206	2,000	25,103	4,952	,008
	Lower-bound	50,206	1,000	50,206	4,952	,029
Error(SOURCE_POS)	Sphericity Assumed	811,128	160	5,070		
	Greenhouse-Geisser	811,128	158,936	5,103		
	Huynh-Feldt	811,128	160,000	5,070		
	Lower-bound	811,128	80,000	10,139		

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	916,807	1	916,807	366,979	,000
Error	199,860	80	2,498		

Estimates

Measure: MEASURE_1

			95% Confidence Interval	
SOURCE_POS	Mean	Std. Error	Lower Bound	Upper Bound
1	1,901	,233	1,437	2,366
2	1,407	,219	,971	1,844
3	2,519	,231	2,059	2,979

Pairwise Comparisons

Measure: MEASURE_1

(I) SOURCE_POS	(J) SOURCE_POS	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	,494	,345	,469	-,350	1,338
	3	-,617	,368	,292	-1,517	,282
2	1	-,494	,345	,469	-1,338	,350
	3	-1,111*	,348	,006	-1,962	-,261
3	1	,617	,368	,292	-,282	1,517
	2	1,111*	,348	,006	,261	1,962

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Pensar * Puro_Olhar	81	100,0%	0	0,0%	81	100,0%
Pensar * Sentir	81	100,0%	0	0,0%	81	100,0%

Pensar * Puro_Olhar

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.	Exact Sig.
Interval by Interval	Pearson's R	-,162	,109	-1,459	,148[c]	,150
Ordinal by Ordinal	Spearman Correlation	-,164	,109	-1,474	,144[c]	.[d]
N of Valid Cases		81				

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

d. Cannot be computed because there is insufficient memory.

Pensar * Sentir

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.	Exact Sig.
Interval by Interval	Pearson's R	-,254	,110	-2,335	,022[c]	,023

Ordinal by Ordinal	Spearman Correlation	-,220	,113	-2,006	,048[c]	.[d]
N of Valid Cases		81				

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

c. Based on normal approximation.

d. Cannot be computed because there is insufficient memory.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
condition * source	162	100,0%	0	0,0%	162	100,0%

condition * source Crosstabulation

Count

		source		
		feel	think	Total
condition	no	30	42	72
	yes	51	39	90
Total		81	81	162

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	3,600[a]	1	,058	,082	,041
Continuity Correction[b]	3,025	1	,082		
Likelihood Ratio	3,614	1	,057	,082	,041
Fisher's Exact Test				,082	,041
N of Valid Cases	162				

a. 0 cells (0,0%) have expected count less than 5. The minimum expected count is 36,00.

b. Computed only for a 2x2 table

Main Study

Acting on thinking, feelings, and looking. A restricted maximum likelihood linear mixed-model analysis was run on the average-index values of how much athletes rely on each source when acting, using *Source* and *Game-Action* as fixed effects. *Player* was included in the model as a random effect to model individual differences. We tested the main effect of the *Source* (thinking, looking, feelings), the main effect of the *Game-Action* (1vs1, 1vs2, kicking-

flying-ball, kicking-ground-ball, dribbling, feinting, and dead-ball), as well the interaction effect between them.

Model. Fixed effects: Source (Via) and Actions (Action); Random effects: Players (N)

Model Dimension[a]

		Number of Levels	Covariance Structure	Number of Parameters	Subject Variables
Fixed Effects	Intercept	1		1	
	VIA	3		2	
	Actions	7		6	
	VIA * Actions	21		12	
Random Effects	Intercept[b]	1	Variance Components	1	N
Residual				1	
Total		33		23	

a. Dependent Variable: VIA_SCORE.

b. As of version 11.5, the syntax rules for the RANDOM subcommand have changed. Your command syntax may yield results that differ from those produced by prior versions. If you are using version 11 syntax, please consult the current syntax reference guide for more information.

Information Criteria[a]

-2 Restricted Log Likelihood	3136,392
Akaike's Information Criterion (AIC)	3140,392
Hurvich and Tsai's Criterion (AICC)	3140,401
Bozdogan's Criterion (CAIC)	3152,735
Schwarz's Bayesian Criterion (BIC)	3150,735

The information criteria are displayed in smaller-is-better form.

a. Dependent Variable: VIA_SCORE.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	62	5335,178	,000
VIA	2	1240	5,343	,005

Actions	6	1240	8,901	,000
VIA * Actions	12	1240,000	8,986	,000

a. Dependent Variable: VIA_SCORE.

Estimates of Fixed Effects[a]

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Intercept	4,222222	,104501	770,561	40,404	,000	4,017083	4,427362
[VIA=Feel]	-,777778	,133360	1240	-5,832	,000	-1,039414	-,516141
[VIA=Look]	-,031746	,133360	1240	-,238	,812	-,293383	,229891
[VIA=Think]	0[b]	0	.	.	.	.	.
[Actions=1x1]	-,603175	,133360	1240	-4,523	,000	-,864811	-,341538
[Actions=1x2]	-,976190	,133360	1240	-7,320	,000	-1,237827	-,714554
[Actions=Drible]	-,571429	,133360	1240	-4,285	,000	-,833065	-,309792
[Actions=Feint]	-,904762	,133360	1240	-6,784	,000	-1,166398	-,643125
[Actions=GroundKick]	-,880952	,133360	1240	-6,606	,000	-1,142589	-,619316
[Actions=HighKick]	-,920635	,133360	1240	-6,903	,000	-1,182271	-,658998
[Actions=StopBall]	0[b]	0	.	.	.	.	.
[VIA=Feel] * [Actions=1x1]	,849206	,188600	1240	4,503	,000	,479196	1,219216
[VIA=Feel] * [Actions=1x2]	1,349206	,188600	1240	7,154	,000	,979196	1,719216
[VIA=Feel] * [Actions=Drible]	,666667	,188600	1240	3,535	,000	,296657	1,036677
[VIA=Feel] * [Actions=Feint]	1,365079	,188600	1240	7,238	,000	,995069	1,735089
[VIA=Feel] * [Actions=GroundKick]	,960317	,188600	1240	5,092	,000	,590307	1,330327
[VIA=Feel] * [Actions=HighKick]	1,396825	,188600	1240	7,406	,000	1,026815	1,766835
[VIA=Feel] * [Actions=StopBall]	0[b]	0	.	.	.	.	.
[VIA=Look] * [Actions=1x1]	,023810	,188600	1240	,126	,900	-,346200	,393820
[VIA=Look] * [Actions=1x2]	,246032	,188600	1240	1,305	,192	-,123978	,616042

[VIA=Look] * [Actions=Drible]	,103175	,188600	1240	,547	,584	-,266835	,473185
[VIA=Look] * [Actions=Feint]	-,023810	,188600	1240	-,126	,900	-,393820	,346200
[VIA=Look] * [Actions=GroundKick]	,277778	,188600	1240	1,473	,141	-,092232	,647788
[VIA=Look] * [Actions=HighKick]	,301587	,188600	1240	1,599	,110	-,068423	,671597
[VIA=Look] * [Actions=StopBall]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=1x1]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=1x2]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=Drible]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=Feint]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=GroundKick]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=HighKick]	0[b]	0	.	.	.	.	.
[VIA=Think] * [Actions=StopBall]	0[b]	0	.	.	.	.	.

a. Dependent Variable: VIA_SCORE.

b. This parameter is set to zero because it is redundant.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Residual		,560226	,022499	24,900	,000	,517819	,606105
Intercept [subject = N]	Variance	,127757	,027758	4,603	,000	,083453	,195581

a. Dependent Variable: VIA_SCORE.

Estimates[a]

VIA	Mean	Std. Error	df	95% Confidence Interval

				Lower Bound	Upper Bound
Feel	3,692	,057	111,575	3,578	3,805
Look	3,629	,057	111,575	3,515	3,743
Think	3,528	,057	111,575	3,415	3,642

a. Dependent Variable: VIA_SCORE.

Pairwise Comparisons[a]

						95% Confidence Interval for Difference[c]	
(I) VIA	(J) VIA	Mean Difference (I-J)	Std. Error	df	Sig.[c]	Lower Bound	Upper Bound
Feel	Look	,062	,050	1240	,649	-,058	,183
	Think	,163*	,050	1240	,004	,042	,284
Look	Feel	-,062	,050	1240	,649	-,183	,058
	Think	,101	,050	1240	,137	-,020	,222
Think	Feel	-,163*	,050	1240	,004	-,284	-,042
	Look	-,101	,050	1240	,137	-,222	,020

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. Dependent Variable: VIA_SCORE.

c. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests[a]

Numerator df	Denominator df	F	Sig.
2	1240	5,343	,005

The F tests the effect of VIA. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Dependent Variable: VIA_SCORE.

Estimates[a]

				95% Confidence Interval	
Actions	Mean	Std. Error	df	Lower Bound	Upper Bound
1x1	3,640	,071	244,016	3,501	3,779
1x2	3,508	,071	244,016	3,369	3,647
Drible	3,638	,071	244,016	3,498	3,777
Feint	3,495	,071	244,016	3,356	3,634
GroundKick	3,484	,071	244,016	3,345	3,623
HighKick	3,598	,071	244,016	3,459	3,737
StopBall	3,952	,071	244,016	3,813	4,092

a. Dependent Variable: VIA_SCORE.

Pairwise Comparisons[a]

(I) Actions	(J) Actions	Mean Difference (I-J)	Std. Error	df	Sig.[c]	95% Confidence Interval for Difference[c] Lower Bound	Upper Bound
1x1	1x2	,132	,077	1240	1,000	-,102	,367
	Drible	,003	,077	1240	1,000	-,232	,237
	Feint	,146	,077	1240	1,000	-,089	,380
	GroundKick	,156	,077	1240	,900	-,078	,390
	HighKick	,042	,077	1240	1,000	-,192	,277
	StopBall	-,312*	,077	1240	,001	-,547	-,078
1x2	1x1	-,132	,077	1240	1,000	-,367	,102
	Drible	-,130	,077	1240	1,000	-,364	,105
	Feint	,013	,077	1240	1,000	-,221	,248
	GroundKick	,024	,077	1240	1,000	-,211	,258
	HighKick	-,090	,077	1240	1,000	-,324	,144
	StopBall	-,444*	,077	1240	,000	-,679	-,210
Drible	1x1	-,003	,077	1240	1,000	-,237	,232
	1x2	,130	,077	1240	1,000	-,105	,364
	Feint	,143	,077	1240	1,000	-,092	,377
	GroundKick	,153	,077	1240	,976	-,081	,388
	HighKick	,040	,077	1240	1,000	-,195	,274
	StopBall	-,315*	,077	1240	,001	-,549	-,080
Feint	1x1	-,146	,077	1240	1,000	-,380	,089
	1x2	-,013	,077	1240	1,000	-,248	,221
	Drible	-,143	,077	1240	1,000	-,377	,092
	GroundKick	,011	,077	1240	1,000	-,224	,245
	HighKick	-,103	,077	1240	1,000	-,338	,131
	StopBall	-,458*	,077	1240	,000	-,692	-,223
GroundKick	1x1	-,156	,077	1240	,900	-,390	,078
	1x2	-,024	,077	1240	1,000	-,258	,211
	Drible	-,153	,077	1240	,976	-,388	,081
	Feint	-,011	,077	1240	1,000	-,245	,224
	HighKick	-,114	,077	1240	1,000	-,348	,121
	StopBall	-,468*	,077	1240	,000	-,703	-,234
HighKick	1x1	-,042	,077	1240	1,000	-,277	,192
	1x2	,090	,077	1240	1,000	-,144	,324
	Drible	-,040	,077	1240	1,000	-,274	,195

	Feint	,103	,077	1240	1,000	-,131	,338
	GroundKick	,114	,077	1240	1,000	-,121	,348
	StopBall	-,354*	,077	1240	,000	-,589	-,120
StopBall	1x1	,312*	,077	1240	,001	,078	,547
	1x2	,444*	,077	1240	,000	,210	,679
	Drible	,315*	,077	1240	,001	,080	,549
	Feint	,458*	,077	1240	,000	,223	,692
	GroundKick	,468*	,077	1240	,000	,234	,703
	HighKick	,354*	,077	1240	,000	,120	,589

Based on estimated marginal means

*. The mean difference is significant at the ,05 level.

a. Dependent Variable: VIA_SCORE.

c. Adjustment for multiple comparisons: Bonferroni.

Univariate Tests[a]

Numerator df	Denominator df	F	Sig.
6	1240	8,901	,000

The F tests the effect of Actions. This test is based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Dependent Variable: VIA_SCORE.

3. VIA * Actions[a]

VIA	Actions	Mean	Std. Error	df	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Feel	1x1	3,690	,105	770,561	3,485	3,896
	1x2	3,817	,105	770,561	3,612	4,023
	Drible	3,540	,105	770,561	3,335	3,745
	Feint	3,905	,105	770,561	3,700	4,110
	GroundKick	3,524	,105	770,561	3,319	3,729
	HighKick	3,921	,105	770,561	3,715	4,126
	StopBall	3,444	,105	770,561	3,239	3,650
Look	1x1	3,611	,105	770,561	3,406	3,816
	1x2	3,460	,105	770,561	3,255	3,665
	Drible	3,722	,105	770,561	3,517	3,927
	Feint	3,262	,105	770,561	3,057	3,467
	GroundKick	3,587	,105	770,561	3,382	3,792

	HighKick	3,571	,105	770,561	3,366	3,777
	StopBall	4,190	,105	770,561	3,985	4,396
Think	1x1	3,619	,105	770,561	3,414	3,824
	1x2	3,246	,105	770,561	3,041	3,451
	Drible	3,651	,105	770,561	3,446	3,856
	Feint	3,317	,105	770,561	3,112	3,523
	GroundKick	3,341	,105	770,561	3,136	3,546
	HighKick	3,302	,105	770,561	3,096	3,507
	StopBall	4,222	,105	770,561	4,017	4,427

a. Dependent Variable: VIA_SCORE.

Comparing in-situ game situations that rely more on feelings than thinking as sources

Manova and Univariate Analysis

Effect	Multivariate Tests of Significance (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.014963	625.4011	6	57	0.000000
HFE-HTHI	Wilks	0.269539	25.7453	6	57	0.000000

Effect	Multivariate tests for repeated measure: DV_1 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
HFE-HTHI	Wilks	0.630898	36.27270	1	62	0.000000

Effect	Multivariate tests for repeated measure: DV_2 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
HFE-HTHI	Wilks	0.394528	95.14970	1	62	0.000000

Effect	Multivariate tests for repeated measure: DV_3 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
HFE-HTHI	Wilks	0.630976	36.26045	1	62	0.000000

Effect	Multivariate tests for repeated measure: DV_4 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
HFE-HTHI	Wilks	0.336173	122.4291	1	62	0.000000

Effect	Multivariate tests for repeated measure: DV_5 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
HFE-HTHI	Wilks	0.441243	78.51221	1	62	0.000000

Effect	Multivariate tests for repeated measure: DV_6 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
HFE-HTHI	Wilks	0.520749	57.05938	1	62	0.000000

Effect	Univariate tests for repeated measure: DV_1 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
HFE-HTHI	60.0714	1	60.07143	36.27270	0.000000
Error	102.6786	62	1.65611		

Effect	Univariate tests for repeated measure: DV_2 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
HFE-HTHI	84.19841	1	84.19841	95.14970	0.000000
Error	54.86409	62	0.88490		

Effect	Univariate tests for repeated measure: DV_3 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
HFE-HTHI	32.76240	1	32.76240	36.26045	0.000000
Error	56.01885	62	0.90353		

Effect	Univariate tests for repeated measure: DV_4 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
HFE-HTHI	111.9172	1	111.9172	122.4291	0.000000
Error	56.6766	62	0.9141		

Effect	Univariate tests for repeated measure: DV_5 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
HFE-HTHI	75.83383	1	75.83383	78.51221	0.000000
Error	59.88492	62	0.96589		

Effect	Univariate tests for repeated measure: DV_6 (semantic_High_FeelThink.sta) Sigma-restricted parameterization Effective hypothesis decomposition				
	SS	Degr. of Freedom	MS	F	p
HFE-HTHI	44.34573	1	44.34573	57.05938	0.000000
Error	48.18552	62	0.77719		

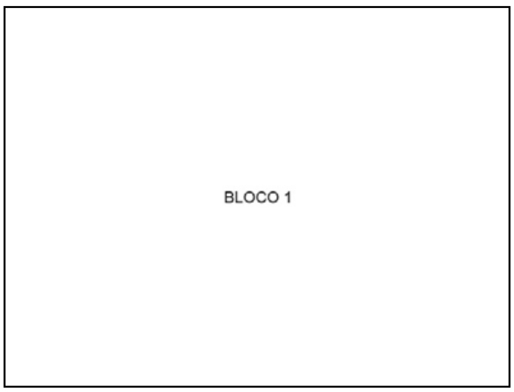
Appendix B

Relying on feelings as information to estimate action capabilities over dynamic events

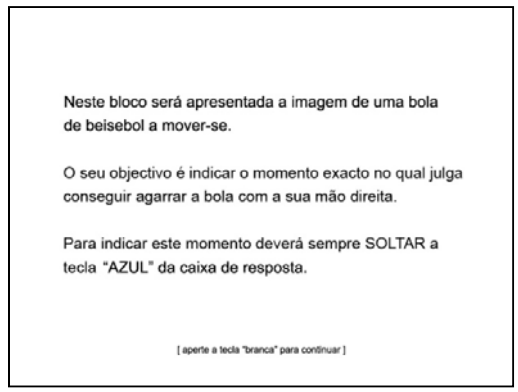
Material

Experiment 1

Screen1

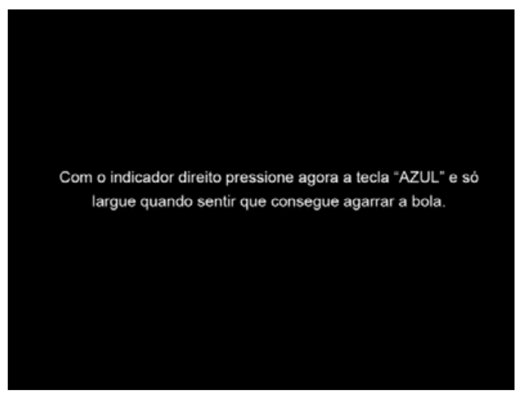


Screen2



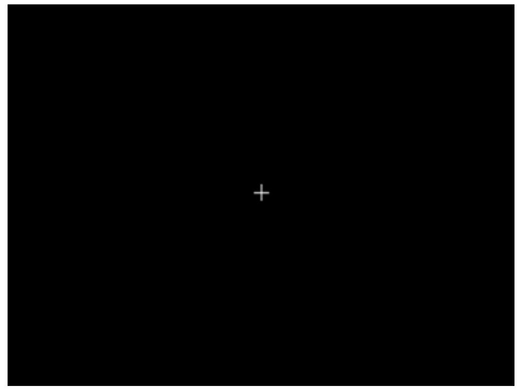
Screen3

Screen4



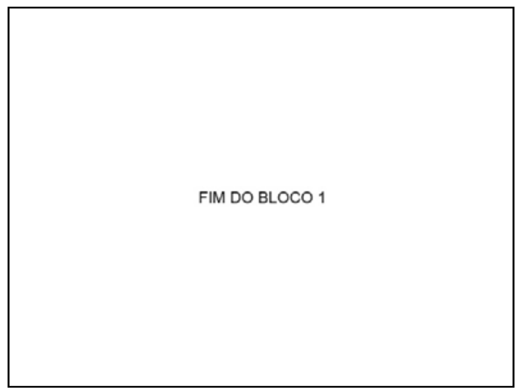
Screen5

Screen6



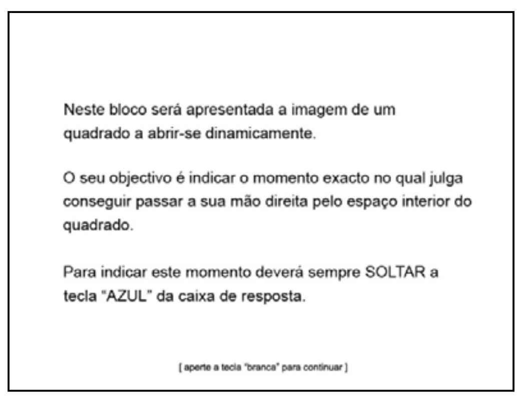
Screen7

Screen8



Screen9

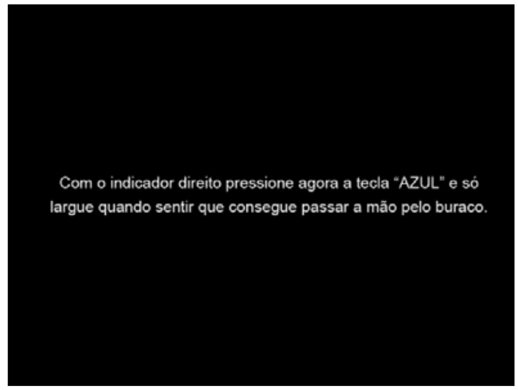
Screen10



Screen11

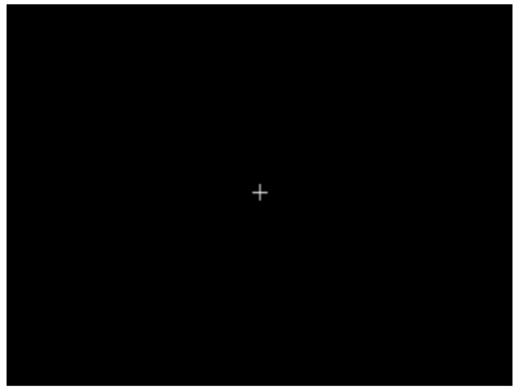
Screen12


Para todas as tentativas deste bloco considere no seu julgamento a posição correta da passar a mão pelo buraco (figura 1).
FIGURA 1
FIGURA 2
[aperte a tecla "branca" para continuar]

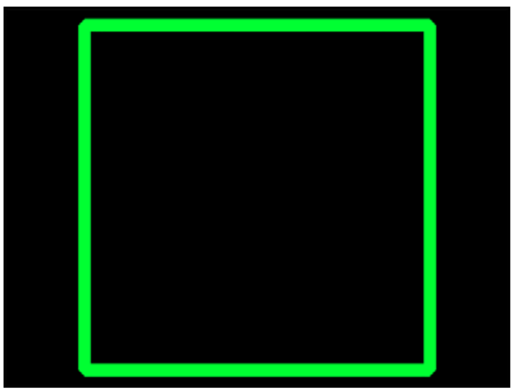

Com o indicador direito pressione agora a tecla "AZUL" e só largue quando sentir que consegue passar a mão pelo buraco.

Screen13

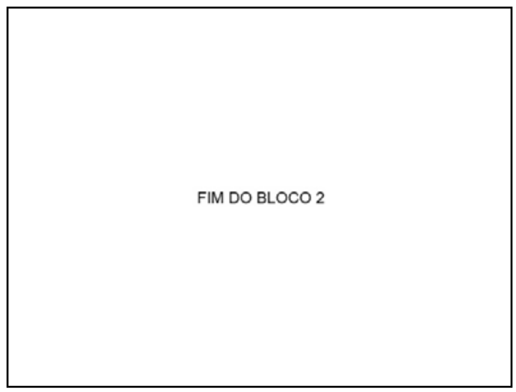
Screen14



Screen15



Screen16

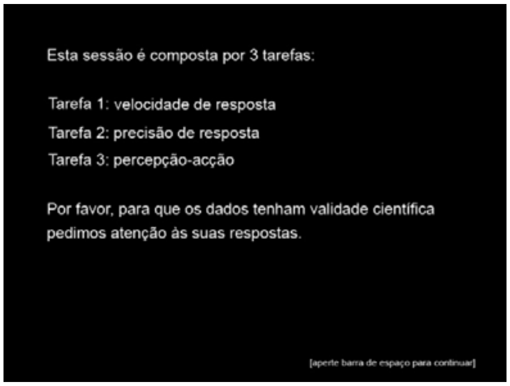


Screen17

Screen18

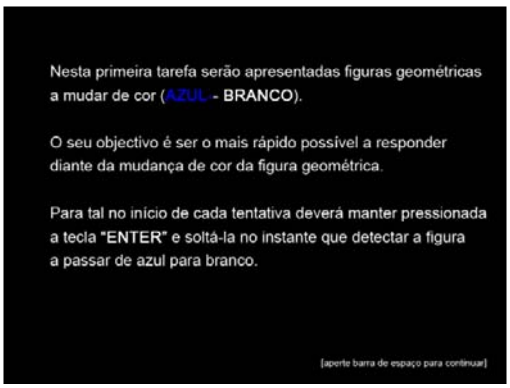
Experiment 2

Screen 1



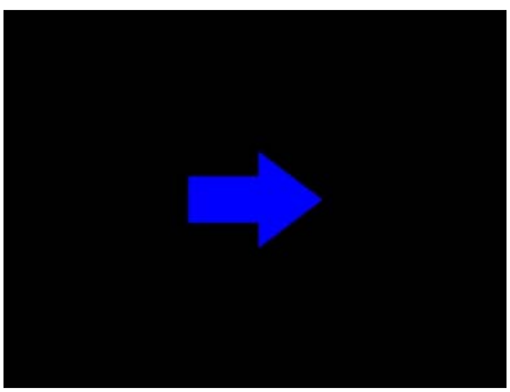
Screen 2

Screen 3

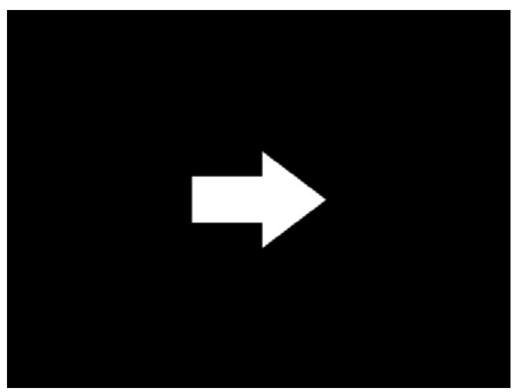


Screen 4

Screen 5



Screen 6



Screen 7

Screen 8

Screen 9

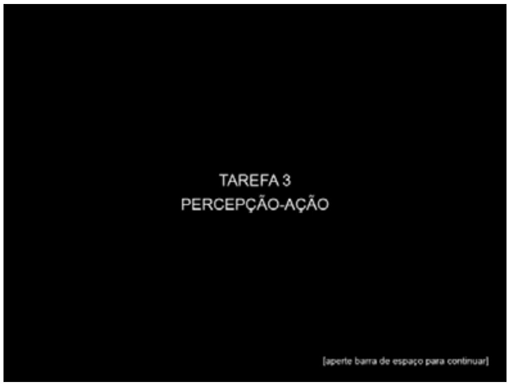
Screen 10

Screen 11

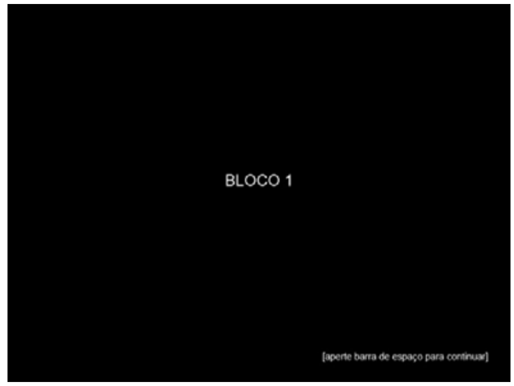
Video File

Screen 12

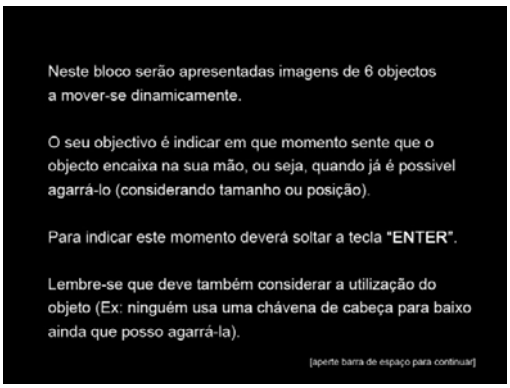
Screen 13



Screen 14



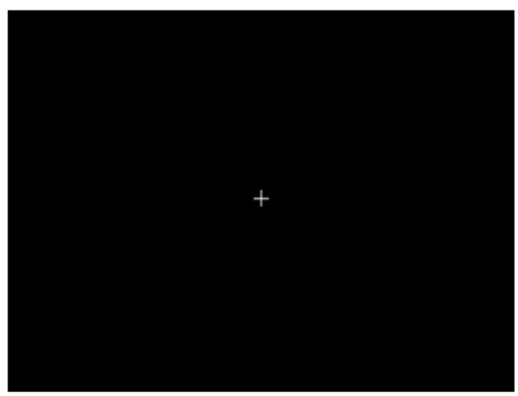
Screen 15



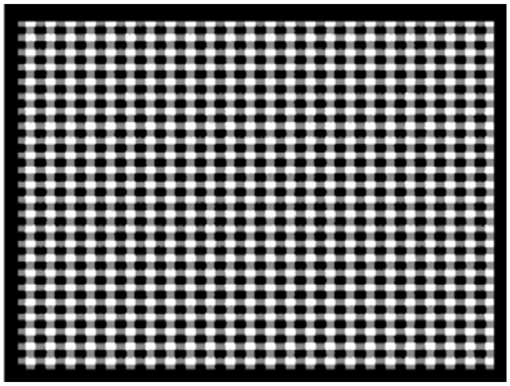
Screen 16

Screen 17

Screen 18



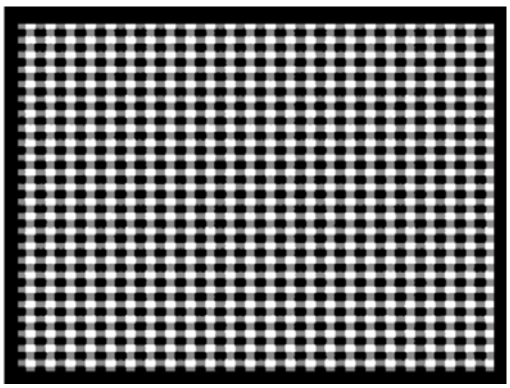
Screen 19



Screen 20

Prime Face

Screen 21

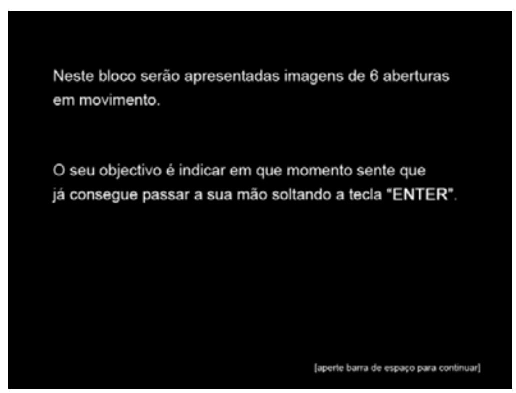


Screen 22

Video File

Screen 23

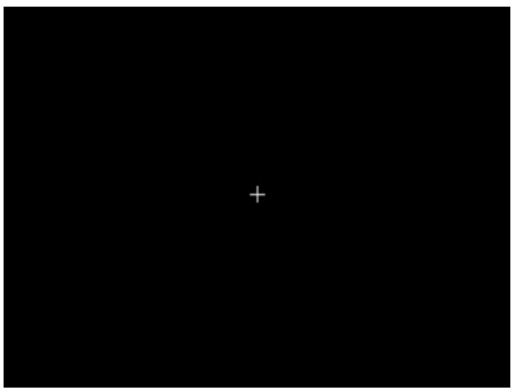
Screen 24



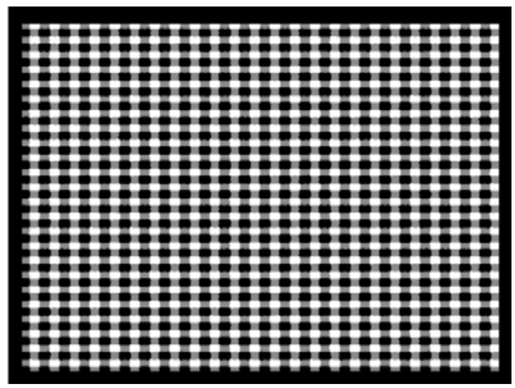
Screen 25

Screen 26

Screen 27



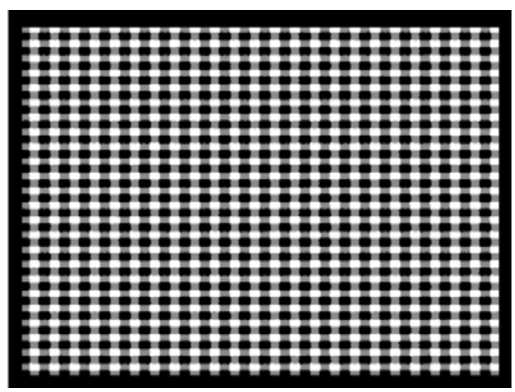
Screen 28



Screen 29

Prime Face

Screen 30

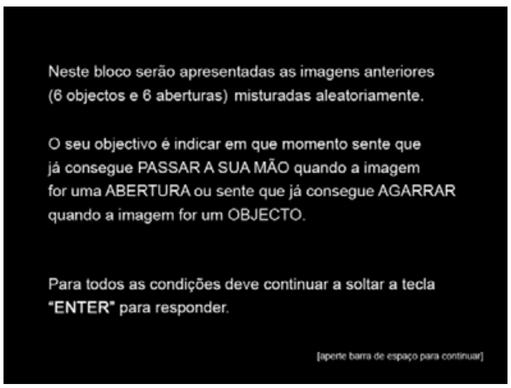


Screen 31

Video File

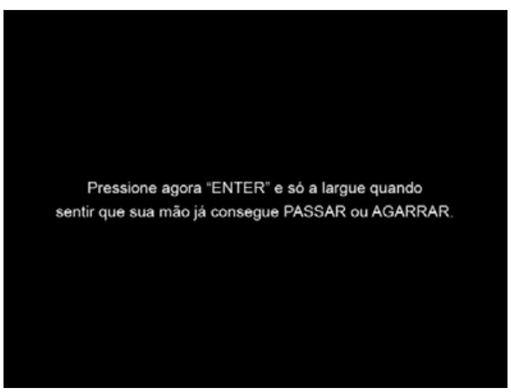
Screen 32

Screen 33

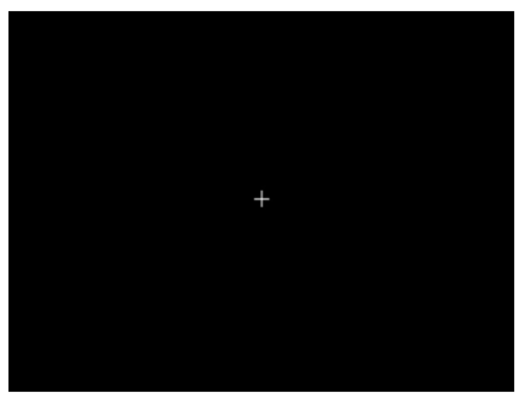


Screen 34

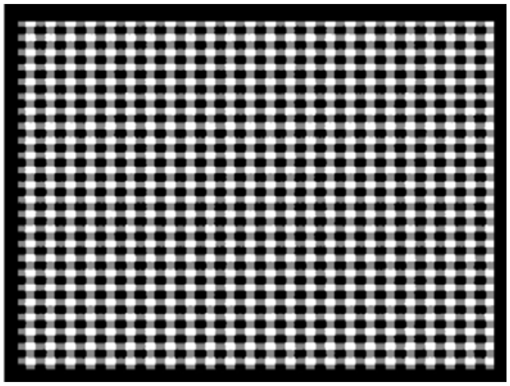
Screen 35



Screen 36



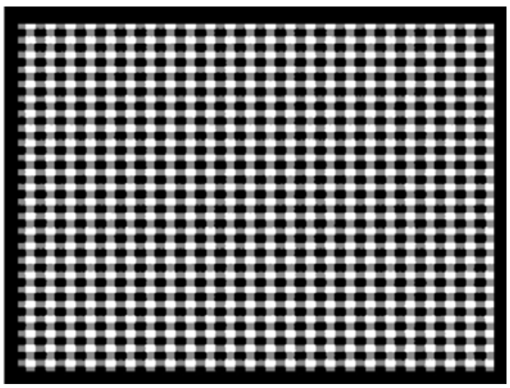
Screen 37



Screen 38

Prime Face

Screen 39

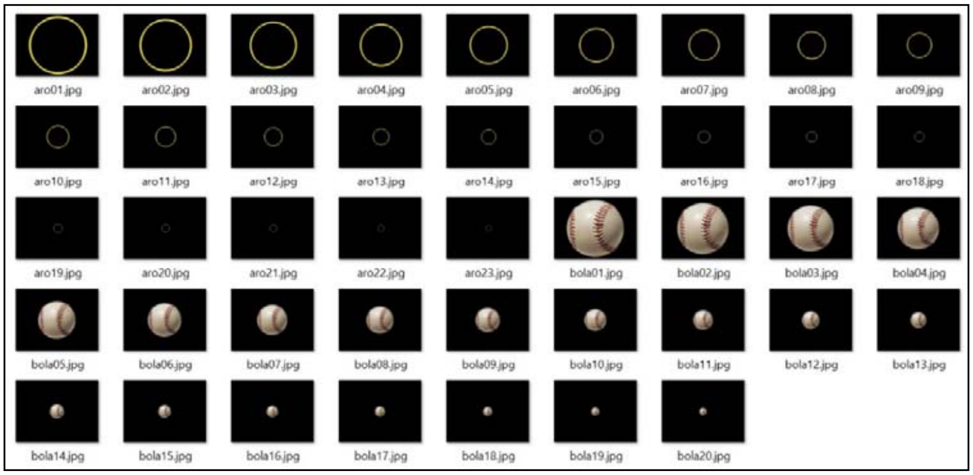


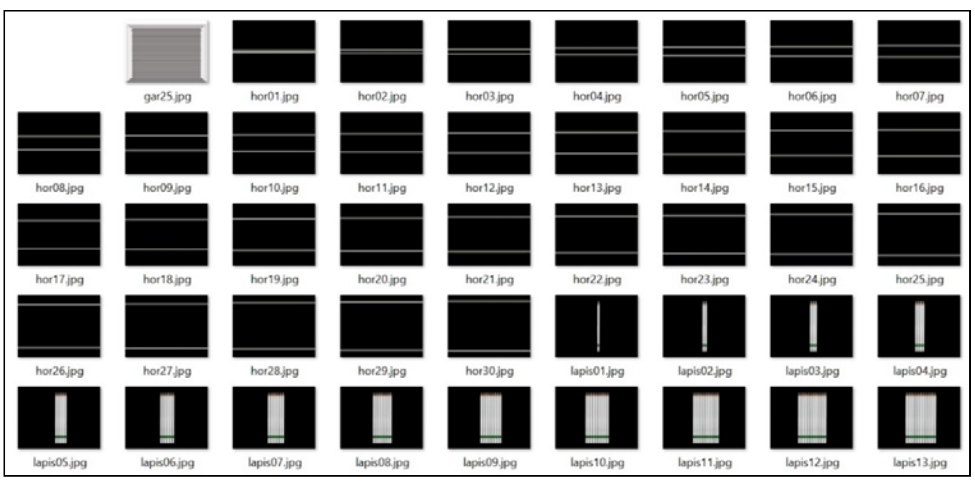
Screen 40

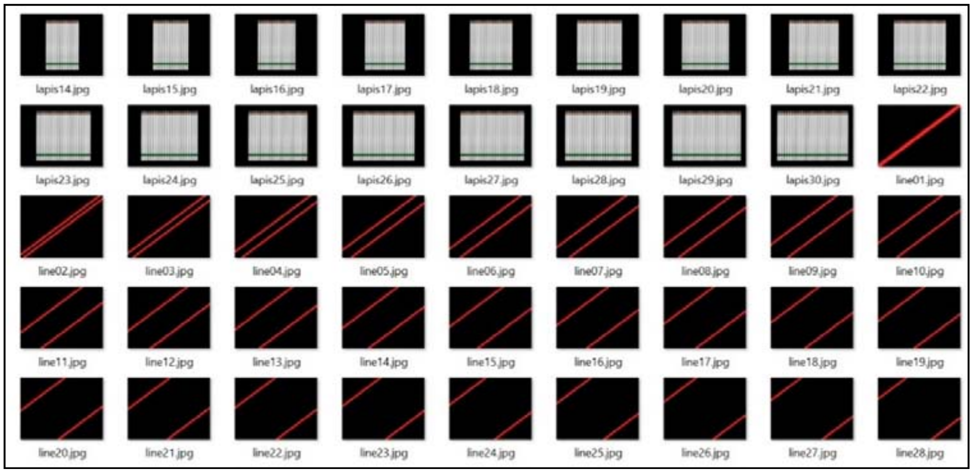
Video File

Screen 41

Images used to create the dynamic events on Experiment 2



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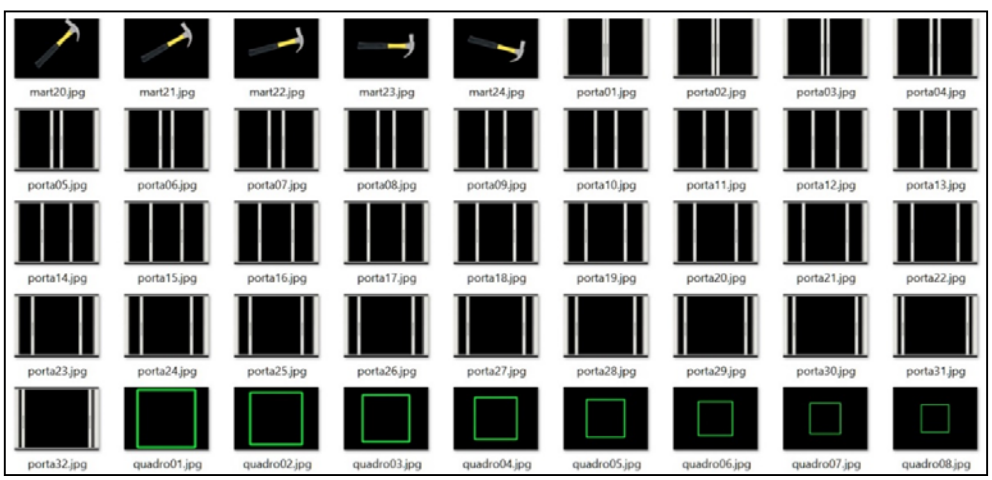
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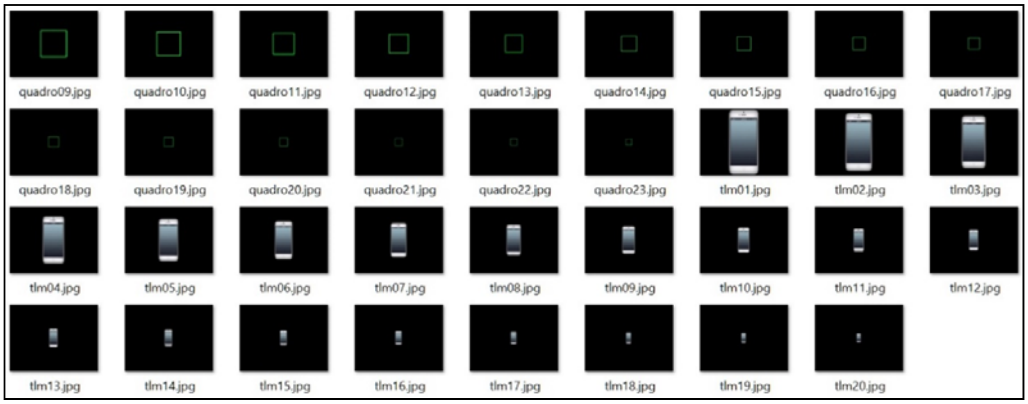
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tlm13.jpg
tlm14.jpg
tlm15.jpg
tlm16.jpg
tlm17.jpg
tlm18.jpg
tlm19.jpg
tlm20.jpg

Happy faces applied on subliminal positive prime in Experiment 2


pos1.jpg


pos2.jpg


pos3.jpg

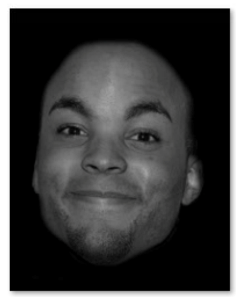

pos6.jpg


pos7.jpg


pos8.jpg


pos4.jpg


pos5.jpg


pos11.jpg


pos9.jpg


pos10.jpg


pos12.jpg

No-emotional faces applied on subliminal neutral prime in Experiment 2


neu1.jpg


neu2.jpg


neu3.jpg


neu6.jpg


neu7.jpg


neu8.jpg


neu4.jpg


neu5.jpg


neu11.jpg

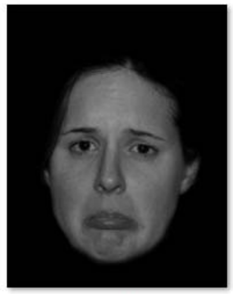

neu9.jpg


neu10.jpg


neu12.jpg

Sad faces applied on subliminal negative prime in Experiment 2


neg1.jpg


neg2.jpg


neg3.jpg

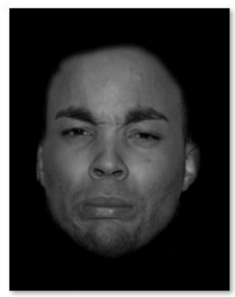

neg6.jpg

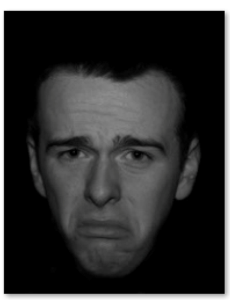

neg7.jpg

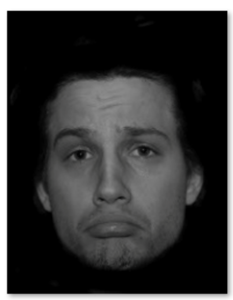

neg8.jpg


neg4.jpg


neg5.jpg


neg11.jpg


neg9.jpg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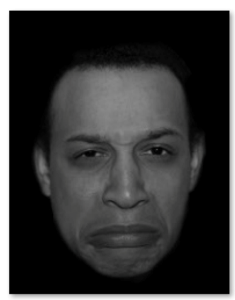

neg12.jpg

Statistical Analysis

Experiment 1

Release-key-moment (RKM) analysis. Two-way mixed ANOVA with 2 *Gender* (female x male) and 2 *Dominant-Hand* (right and left) components as between factors, and 2 *Dynamic-Visual-Event* (shrinking x opening) components as within-factors.

Within-Subjects Factors

Measure: MEASURE_1

RT	Dependent Variable
1	ball_total
2	square_total

Between-Subjects Factors

		N
Hand	Direita	20
	Esquerda	4
Gender	Feminino	13
	Masculino	11

Descriptive Statistics

	Hand	Gender	Mean	Std. Deviation	N
ball_total	Direita	Feminino	422,6393	115,15064	10
		Masculino	408,5280	129,22076	10
		Total	415,5836	119,34354	20
	Esquerda	Feminino	395,9778	65,90958	3
		Masculino	501,5833	.	1
		Total	422,3792	75,39351	4
	Total	Feminino	416,4866	103,94934	13
		Masculino	416,9876	125,75934	11
		Total	416,7162	111,86583	24
square_total	Direita	Feminino	574,0164	76,18851	10
		Masculino	584,4293	126,32496	10
		Total	579,2228	101,67189	20
	Esquerda	Feminino	630,7634	77,37544	3

	Masculino	692,3333	.	1
	Total	646,1559	70,27817	4
Total	Feminino	587,1119	77,26976	13
	Masculino	594,2387	124,18002	11
	Total	590,3783	99,16100	24

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
RT	Sphericity Assumed	184802,904	1	184802,904	40,840	,000	,671
	Greenhouse-Geisser	184802,904	1,000	184802,904	40,840	,000	,671
	Huynh-Feldt	184802,904	1,000	184802,904	40,840	,000	,671
	Lower-bound	184802,904	1,000	184802,904	40,840	,000	,671
RT * Hand	Sphericity Assumed	3148,199	1	3148,199	,696	,414	,034
	Greenhouse-Geisser	3148,199	1,000	3148,199	,696	,414	,034
	Huynh-Feldt	3148,199	1,000	3148,199	,696	,414	,034
	Lower-bound	3148,199	1,000	3148,199	,696	,414	,034
RT * Gender	Sphericity Assumed	124,141	1	124,141	,027	,870	,001
	Greenhouse-Geisser	124,141	1,000	124,141	,027	,870	,001
	Huynh-Feldt	124,141	1,000	124,141	,027	,870	,001
	Lower-bound	124,141	1,000	124,141	,027	,870	,001
RT * Hand * Gender	Sphericity Assumed	1532,750	1	1532,750	,339	,567	,017
	Greenhouse-Geisser	1532,750	1,000	1532,750	,339	,567	,017
	Huynh-Feldt	1532,750	1,000	1532,750	,339	,567	,017
	Lower-bound	1532,750	1,000	1532,750	,339	,567	,017
Error(RT)	Sphericity Assumed	90501,145	20	4525,057			
	Greenhouse-Geisser	90501,145	20,000	4525,057			
	Huynh-Feldt	90501,145	20,000	4525,057			
	Lower-bound	90501,145	20,000	4525,057			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	5780341,354	1	5780341,354	292,199	,000	,936
Hand	17407,081	1	17407,081	,880	,359	,042
Gender	8714,593	1	8714,593	,441	,514	,022
Hand * Gender	9521,059	1	9521,059	,481	,496	,023
Error	395644,159	20	19782,208			

RKM-window. Repeated measure ANOVAs defined by 2 *Task-Goal* (W x WJ) x 2 *Dynamic-Visual-Events* (shrinking x opening) and 11 *Time-Windows* (11 x 100 ms).

Valence composite index (EMGv)

Descriptive Statistics

	Mean	Std. Deviation	N
RT-200_JDBZy	,1326	,34873	24
RT-100_JDBZy	,1325	,40023	24
RT_JDBZy	,0628	,55482	24
RT+100_JDBZy	,0373	,52606	24
RT+200_JDBZy	-,0985	,60953	24
RT+300_JDBZy	-,1175	,66501	24
RT+400_JDBZy	-,3399	,52573	24
RT+500_JDBZy	-,2156	,52422	24
RT+600_JDBZy	-,2565	,63513	24
RT+700_JDBZy	-,2100	,59541	24
RT+800_JDBZy	-,2481	,70535	24
RT-200_JDQZy	,1278	,51100	24
RT-100_JDQZy	-,0257	,53020	24
RT_JDQZy	-,1463	,51037	24
RT+100_JDQZy	-,1681	,62767	24
RT+200_JDQZy	-,1871	,81430	24
RT+300_JDQZy	-,3303	,95233	24
RT+400_JDQZy	-,3674	,92906	24
RT+500_JDQZy	-,2659	,78341	24
RT+600_JDQZy	-,2563	,73112	24

RT+700_JDQZy	-,3970	,81901	24
RT+800_JDQZy	-,3862	,73914	24
RT-200_LKBZy	,1824	,45439	24
RT-100_LKBZy	,0941	,39377	24
RT_LKBZy	,0932	,40229	24
RT+100_LKBZy	,0203	,56897	24
RT+200_LKBZy	,1126	,49715	24
RT+300_LKBZy	,0952	,51462	24
RT+400_LKBZy	-,0051	,50828	24
RT+500_LKBZy	-,0041	,57558	24
RT+600_LKBZy	,0341	,58181	24
RT+700_LKBZy	,1419	,49950	24
RT+800_LKBZy	,1050	,49023	24
RT-200_LKQZy	-,0987	,28918	24
RT-100_LKQZy	-,0119	,38967	24
RT_LKQZy	-,0146	,40425	24
RT+100_LKQZy	-,0698	,48888	24
RT+200_LKQZy	-,1128	,41052	24
RT+300_LKQZy	-,0561	,43099	24
RT+400_LKQZy	-,1314	,44890	24
RT+500_LKQZy	-,0684	,48381	24
RT+600_LKQZy	-,0919	,38753	24
RT+700_LKQZy	-,1969	,55125	24
RT+800_LKQZy	-,2122	,56304	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Task	1,000	,000	0	.	1,000	1,000	1,000
Event	1,000	,000	0	.	1,000	1,000	1,000
TWin	,000	153,736	54	,000	,403	,500	,100
Task * Event	1,000	,000	0	.	1,000	1,000	1,000
Task * TWin	,001	139,824	54	,000	,404	,502	,100
Event * TWin	,007	97,010	54	,000	,467	,601	,100
Task * Event * TWin	,002	120,202	54	,000	,491	,640	,100

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Task + Event + TWin + Task * Event + Task * TWin + Event * TWin + Task * Event * TWin
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Task	Sphericity Assumed	6,043	1	6,043	3,452	,076	,131
	Greenhouse-Geisser	6,043	1,000	6,043	3,452	,076	,131
	Huynh-Feldt	6,043	1,000	6,043	3,452	,076	,131
	Lower-bound	6,043	1,000	6,043	3,452	,076	,131
Error(Task)	Sphericity Assumed	40,257	23	1,750			
	Greenhouse-Geisser	40,257	23,000	1,750			
	Huynh-Feldt	40,257	23,000	1,750			
	Lower-bound	40,257	23,000	1,750			
Event	Sphericity Assumed	5,641	1	5,641	3,876	,061	,144
	Greenhouse-Geisser	5,641	1,000	5,641	3,876	,061	,144
	Huynh-Feldt	5,641	1,000	5,641	3,876	,061	,144
	Lower-bound	5,641	1,000	5,641	3,876	,061	,144
Error(Event)	Sphericity Assumed	33,467	23	1,455			
	Greenhouse-Geisser	33,467	23,000	1,455			
	Huynh-Feldt	33,467	23,000	1,455			
	Lower-bound	33,467	23,000	1,455			
TWin	Sphericity Assumed	9,066	10	,907	4,198	,000	,154
	Greenhouse-Geisser	9,066	4,031	2,249	4,198	,004	,154
	Huynh-Feldt	9,066	4,995	1,815	4,198	,002	,154
	Lower-bound	9,066	1,000	9,066	4,198	,052	,154

Error(TWin)	Sphericity Assumed	49,670	230	,216			
	Greenhouse-Geisser	49,670	92,724	,536			
	Huynh-Feldt	49,670	114,894	,432			
	Lower-bound	49,670	23,000	2,160			
Task * Event	Sphericity Assumed	,232	1	,232	,155	,697	,007
	Greenhouse-Geisser	,232	1,000	,232	,155	,697	,007
	Huynh-Feldt	,232	1,000	,232	,155	,697	,007
	Lower-bound	,232	1,000	,232	,155	,697	,007
Error(Task*Event)	Sphericity Assumed	34,429	23	1,497			
	Greenhouse-Geisser	34,429	23,000	1,497			
	Huynh-Feldt	34,429	23,000	1,497			
	Lower-bound	34,429	23,000	1,497			
Task * TWin	Sphericity Assumed	3,953	10	,395	2,292	,014	,091
	Greenhouse-Geisser	3,953	4,045	,977	2,292	,065	,091
	Huynh-Feldt	3,953	5,015	,788	2,292	,050	,091
	Lower-bound	3,953	1,000	3,953	2,292	,144	,091
Error(Task*TWin)	Sphericity Assumed	39,663	230	,172			
	Greenhouse-Geisser	39,663	93,024	,426			
	Huynh-Feldt	39,663	115,353	,344			
	Lower-bound	39,663	23,000	1,724			
Event * TWin	Sphericity Assumed	1,000	10	,100	,834	,596	,035
	Greenhouse-Geisser	1,000	4,670	,214	,834	,522	,035
	Huynh-Feldt	1,000	6,006	,166	,834	,546	,035
	Lower-bound	1,000	1,000	1,000	,834	,371	,035
Error(Event*TWin)	Sphericity Assumed	27,560	230	,120			
	Greenhouse-Geisser	27,560	107,413	,257			

	Huynh-Feldt	27,560	138,130	,200			
	Lower-bound	27,560	23,000	1,198			
Task * Event * TWin	Sphericity Assumed	1,004	10	,100	,879	,553	,037
	Greenhouse-Geisser	1,004	4,907	,205	,879	,496	,037
	Huynh-Feldt	1,004	6,399	,157	,879	,517	,037
	Lower-bound	1,004	1,000	1,004	,879	,358	,037
Error(Task*Event *TWin)	Sphericity Assumed	26,264	230	,114			
	Greenhouse-Geisser	26,264	112,869	,233			
	Huynh-Feldt	26,264	147,179	,178			
	Lower-bound	26,264	23,000	1,142			

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Intercept	7,543	1	7,543	2,136	,157	,085
Error	81,221	23	3,531			

Corrugator Supercillis (EMGc)

Descriptive Statistics

	Mean	Std. Deviation	N
RT-200_JDBCo	-,1369	,29077	24
RT-100_JDBCo	-,0419	,27269	24
RT_JDBCo	,0451	,41201	24
RT+100_JDBCo	,1798	,53074	24
RT+200_JDBCo	,2642	,50052	24
RT+300_JDBCo	,2236	,54288	24
RT+400_JDBCo	,3460	,47612	24
RT+500_JDBCo	,2995	,53917	24
RT+600_JDBCo	,3900	,49499	24
RT+700_JDBCo	,3068	,41967	24
RT+800_JDBCo	,2747	,48918	24
RT-200_JDQCo	,0767	,31854	24
RT-100_JDQCo	,1120	,31296	24
RT_JDQCo	,2852	,34791	24
RT+100_JDQCo	,3855	,40672	24
RT+200_JDQCo	,3945	,49881	24
RT+300_JDQCo	,4390	,57946	24
RT+400_JDQCo	,3899	,64576	24
RT+500_JDQCo	,3172	,50930	24
RT+600_JDQCo	,3297	,48773	24
RT+700_JDQCo	,4295	,51018	24
RT+800_JDQCo	,3759	,52911	24
RT-200_LKBCo	-,1346	,29455	24
RT-100_LKBCo	-,0165	,28711	24
RT_LKBCo	,0604	,32774	24
RT+100_LKBCo	,1159	,34660	24
RT+200_LKBCo	,0188	,34527	24
RT+300_LKBCo	,0298	,32673	24
RT+400_LKBCo	,1034	,36724	24
RT+500_LKBCo	,0682	,45099	24
RT+600_LKBCo	,0397	,49749	24
RT+700_LKBCo	-,0003	,52231	24
RT+800_LKBCo	-,0193	,51564	24
RT-200_LKQCo	,1346	,31038	24
RT-100_LKQCo	,0802	,28559	24
RT_LKQCo	,0891	,29931	24
RT+100_LKQCo	,1726	,40612	24
RT+200_LKQCo	,2563	,41688	24

RT+300_LKQCo	,2294	,40098	24
RT+400_LKQCo	,2587	,33495	24
RT+500_LKQCo	,1864	,40469	24
RT+600_LKQCo	,1922	,32217	24
RT+700_LKQCo	,2257	,49141	24
RT+800_LKQCo	,3061	,51312	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Task	1,000	,000	0	.	1,000	1,000	1,000
Event	1,000	,000	0	.	1,000	1,000	1,000
TWin	,001	137,201	54	,000	,384	,471	,100
Task * Event	1,000	,000	0	.	1,000	1,000	1,000
Task * TWin	,000	173,565	54	,000	,328	,389	,100
Event * TWin	,003	115,776	54	,000	,467	,600	,100
Task * Event * TWin	,001	126,766	54	,000	,513	,678	,100

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Task + Event + TWin + Task * Event + Task * TWin + Event * TWin + Task * Event * TWin

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Task	Sphericity Assumed	5,901	1	5,901	4,687	,041
	Greenhouse-Geisser	5,901	1,000	5,901	4,687	,041
	Huynh-Feldt	5,901	1,000	5,901	4,687	,041
	Lower-bound	5,901	1,000	5,901	4,687	,041
Error(Task)	Sphericity Assumed	28,957	23	1,259		
	Greenhouse-Geisser	28,957	23,000	1,259		
	Huynh-Feldt	28,957	23,000	1,259		
	Lower-bound	28,957	23,000	1,259		
Event	Sphericity Assumed	5,762	1	5,762	5,341	,030

	Greenhouse-Geisser	5,762	1,000	5,762	5,341	,030
	Huynh-Feldt	5,762	1,000	5,762	5,341	,030
	Lower-bound	5,762	1,000	5,762	5,341	,030
Error(Event)	Sphericity Assumed	24,813	23	1,079		
	Greenhouse-Geisser	24,813	23,000	1,079		
	Huynh-Feldt	24,813	23,000	1,079		
	Lower-bound	24,813	23,000	1,079		
TWin	Sphericity Assumed	8,622	10	,862	8,505	,000
	Greenhouse-Geisser	8,622	3,843	2,244	8,505	,000
	Huynh-Feldt	8,622	4,710	1,831	8,505	,000
	Lower-bound	8,622	1,000	8,622	8,505	,008
Error(TWin)	Sphericity Assumed	23,317	230	,101		
	Greenhouse-Geisser	23,317	88,383	,264		
	Huynh-Feldt	23,317	108,324	,215		
	Lower-bound	23,317	23,000	1,014		
Task * Event	Sphericity Assumed	,127	1	,127	,155	,697
	Greenhouse-Geisser	,127	1,000	,127	,155	,697
	Huynh-Feldt	,127	1,000	,127	,155	,697
	Lower-bound	,127	1,000	,127	,155	,697
Error(Task*Event)	Sphericity Assumed	18,760	23	,816		
	Greenhouse-Geisser	18,760	23,000	,816		
	Huynh-Feldt	18,760	23,000	,816		
	Lower-bound	18,760	23,000	,816		
Task * TWin	Sphericity Assumed	2,049	10	,205	1,914	,044
	Greenhouse-Geisser	2,049	3,278	,625	1,914	,129
	Huynh-Feldt	2,049	3,888	,527	1,914	,117
	Lower-bound	2,049	1,000	2,049	1,914	,180
Error(Task*TWin)	Sphericity Assumed	24,626	230	,107		
	Greenhouse-Geisser	24,626	75,395	,327		
	Huynh-Feldt	24,626	89,417	,275		
	Lower-bound	24,626	23,000	1,071		
Event * TWin	Sphericity Assumed	,927	10	,093	1,285	,240
	Greenhouse-Geisser	,927	4,666	,199	1,285	,277
	Huynh-Feldt	,927	5,999	,155	1,285	,268
	Lower-bound	,927	1,000	,927	1,285	,269
Error(Event*TWin)	Sphericity Assumed	16,598	230	,072		
	Greenhouse-Geisser	16,598	107,316	,155		
	Huynh-Feldt	16,598	137,971	,120		
	Lower-bound	16,598	23,000	,722		
Task * Event * TWin	Sphericity Assumed	1,156	10	,116	1,558	,120
	Greenhouse-Geisser	1,156	5,130	,225	1,558	,176

	Huynh-Feldt	1,156	6,778	,171	1,558	,154
	Lower-bound	1,156	1,000	1,156	1,558	,224
Error(Task*Event*TWin)	Sphericity Assumed	17,058	230	,074		
	Greenhouse-Geisser	17,058	117,988	,145		
	Huynh-Feldt	17,058	155,886	,109		
	Lower-bound	17,058	23,000	,742		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	35,636	1	35,636	22,905	,000
Error	35,784	23	1,556		

Zygomaticus Major (EMGz)

Descriptive Statistics

	Mean	Std. Deviation	N
RT-200_JDBZy	-,0044	,18640	24
RT-100_JDBZy	,0905	,28943	24
RT_JDBZy	,1080	,37651	24
RT+100_JDBZy	,2171	,45749	24
RT+200_JDBZy	,1657	,50804	24
RT+300_JDBZy	,1061	,47182	24
RT+400_JDBZy	,0062	,46255	24
RT+500_JDBZy	,0840	,38102	24
RT+600_JDBZy	,1335	,38978	24
RT+700_JDBZy	,0968	,33863	24
RT+800_JDBZy	,0265	,42980	24
RT-200_JDQZy	,2045	,47752	24
RT-100_JDQZy	,0863	,41204	24
RT_JDQZy	,1390	,37538	24
RT+100_JDQZy	,2174	,48687	24
RT+200_JDQZy	,2074	,56870	24
RT+300_JDQZy	,1086	,61882	24
RT+400_JDQZy	,0225	,65073	24
RT+500_JDQZy	,0512	,57820	24
RT+600_JDQZy	,0734	,50738	24

RT+700_JDQZy	,0325	,58384	24
RT+800_JDQZy	-,0103	,60233	24
RT-200_LKBZy	,0478	,30302	24
RT-100_LKBZy	,0776	,29668	24
RT_LKBZy	,1536	,31864	24
RT+100_LKBZy	,1361	,34544	24
RT+200_LKBZy	,1314	,28273	24
RT+300_LKBZy	,1249	,32060	24
RT+400_LKBZy	,0983	,38919	24
RT+500_LKBZy	,0641	,38011	24
RT+600_LKBZy	,0737	,36987	24
RT+700_LKBZy	,1415	,33645	24
RT+800_LKBZy	,0857	,34977	24
RT-200_LKQZy	,0359	,32667	24
RT-100_LKQZy	,0684	,35372	24
RT_LKQZy	,0744	,37091	24
RT+100_LKQZy	,1028	,35864	24
RT+200_LKQZy	,1436	,37114	24
RT+300_LKQZy	,1733	,33952	24
RT+400_LKQZy	,1272	,33627	24
RT+500_LKQZy	,1179	,29393	24
RT+600_LKQZy	,1004	,29982	24
RT+700_LKQZy	,0288	,32300	24
RT+800_LKQZy	,0939	,32261	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Task	1,000	,000	0	.	1,000	1,000	1,000
Event	1,000	,000	0	.	1,000	1,000	1,000
TWin	,000	162,566	54	,000	,367	,445	,100
Task * Event	1,000	,000	0	.	1,000	1,000	1,000
Task * TWin	,001	137,786	54	,000	,391	,481	,100
Event * TWin	,001	140,764	54	,000	,384	,470	,100
Task * Event * TWin	,007	97,545	54	,000	,554	,750	,100

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Task + Event + TWin + Task * Event + Task * TWin + Event * TWin + Task * Event * TWin
b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Task	Sphericity Assumed	,001	1	,001	,001	,977
	Greenhouse-Geisser	,001	1,000	,001	,001	,977
	Huynh-Feldt	,001	1,000	,001	,001	,977
	Lower-bound	,001	1,000	,001	,001	,977
Error(Task)	Sphericity Assumed	23,306	23	1,013		
	Greenhouse-Geisser	23,306	23,000	1,013		
	Huynh-Feldt	23,306	23,000	1,013		
	Lower-bound	23,306	23,000	1,013		
Event	Sphericity Assumed	,001	1	,001	,001	,974
	Greenhouse-Geisser	,001	1,000	,001	,001	,974
	Huynh-Feldt	,001	1,000	,001	,001	,974
	Lower-bound	,001	1,000	,001	,001	,974
Error(Event)	Sphericity Assumed	13,415	23	,583		
	Greenhouse-Geisser	13,415	23,000	,583		
	Huynh-Feldt	13,415	23,000	,583		
	Lower-bound	13,415	23,000	,583		
TWin	Sphericity Assumed	1,525	10	,153	1,458	,156
	Greenhouse-Geisser	1,525	3,670	,416	1,458	,226
	Huynh-Feldt	1,525	4,453	,343	1,458	,216
	Lower-bound	1,525	1,000	1,525	1,458	,240

Error(TWin)	Sphericity Assumed	24,065	230	,105		
	Greenhouse-Geisser	24,065	84,410	,285		
	Huynh-Feldt	24,065	102,424	,235		
	Lower-bound	24,065	23,000	1,046		
Task * Event	Sphericity Assumed	,016	1	,016	,020	,889
	Greenhouse-Geisser	,016	1,000	,016	,020	,889
	Huynh-Feldt	,016	1,000	,016	,020	,889
	Lower-bound	,016	1,000	,016	,020	,889
Error(Task*Event)	Sphericity Assumed	18,190	23	,791		
	Greenhouse-Geisser	18,190	23,000	,791		
	Huynh-Feldt	18,190	23,000	,791		
	Lower-bound	18,190	23,000	,791		
Task * TWin	Sphericity Assumed	,840	10	,084	,859	,573
	Greenhouse-Geisser	,840	3,910	,215	,859	,490
	Huynh-Feldt	,840	4,811	,175	,859	,508
	Lower-bound	,840	1,000	,840	,859	,364
Error(Task*TWin)	Sphericity Assumed	22,490	230	,098		
	Greenhouse-Geisser	22,490	89,932	,250		
	Huynh-Feldt	22,490	110,654	,203		
	Lower-bound	22,490	23,000	,978		
Event * TWin	Sphericity Assumed	,501	10	,050	,721	,704
	Greenhouse-Geisser	,501	3,836	,131	,721	,574
	Huynh-Feldt	,501	4,699	,107	,721	,601
	Lower-bound	,501	1,000	,501	,721	,405
Error(Event*TWin)	Sphericity Assumed	15,998	230	,070		
	Greenhouse-Geisser	15,998	88,224	,181		
	Huynh-Feldt	15,998	108,086	,148		
	Lower-bound	15,998	23,000	,696		

Task * Event * TWin	Sphericity Assumed	,491	10	,049	,986	,456
	Greenhouse-Geisser	,491	5,538	,089	,986	,434
	Huynh-Feldt	,491	7,497	,066	,986	,446
	Lower-bound	,491	1,000	,491	,986	,331
Error(Task*Event*TWin)	Sphericity Assumed	11,454	230	,050		
	Greenhouse-Geisser	11,454	127,380	,090		
	Huynh-Feldt	11,454	172,441	,066		
	Lower-bound	11,454	23,000	,498		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	10,388	1	10,388	5,593	,027
Error	42,715	23	1,857		

EMG analysis of END-window. A repeated measure ANOVA 2 *Task-Goal* (W x WJ) x 2 *Dynamic-Visual-Events* (shrinking x opening) and 7 *Time-Windows* (7 x 100 ms) as within-subject factors.

Valence composite index (EMGv)

Descriptive Statistics

	Mean	Std. Deviation	N
100-RTEndB	,1325	,40023	24
RTEndB	,0628	,55482	24
RTEnd+100B	,0373	,52606	24
RTEnd+200B	-,0985	,60953	24
RTEnd+300B	-,1175	,66501	24
RTEnd+400B	-,3399	,52573	24
RTEnd+500B	-,2156	,52422	24
100-RTEndQ	-,0257	,53020	24

RTEndQ	-,1463	,51037	24
RTEnd+100Q	-,1681	,62767	24
RTEnd+200Q	-,1871	,81430	24
RTEnd+300Q	-,3303	,95233	24
RTEnd+400Q	-,3674	,92906	24
RTEnd+500Q	-,2659	,78341	24
100-VdEndB	-,0502	,52454	24
VdEndB	-,0147	,53151	24
VdEnd+100B	,0384	,55926	24
VdEnd+200B	,1648	,51460	24
VdEnd+300B	,1643	,51436	24
VdEnd+400B	-,0222	,49387	24
VdEnd+500B	-,0058	,56325	24
100-VdEndQ	-,1176	,43127	24
VdEndQ	-,0977	,44581	24
VdEnd+100Q	-,1387	,48000	24
VdEnd+200Q	-,0579	,49404	24
VdEnd+300Q	-,0682	,43204	24
VdEnd+400Q	-,1381	,49364	24
VdEnd+500Q	-,2849	,56506	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
End	1,000	,000	0	.	1,000	1,000	1,000
Event	1,000	,000	0	.	1,000	1,000	1,000
TWin	,007	103,758	20	,000	,359	,398	,167
End * Event	1,000	,000	0	.	1,000	1,000	1,000
End * TWin	,061	58,013	20	,000	,561	,668	,167
Event * TWin	,058	59,032	20	,000	,499	,582	,167
End * Event * TWin	,155	38,685	20	,008	,670	,830	,167

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: End + Event + TWin + End * Event + End * TWin + Event * TWin + End * Event * TWin

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
End	Sphericity Assumed	1,682	1	1,682	2,085	,162
	Greenhouse-Geisser	1,682	1,000	1,682	2,085	,162
	Huynh-Feldt	1,682	1,000	1,682	2,085	,162
	Lower-bound	1,682	1,000	1,682	2,085	,162
Error(End)	Sphericity Assumed	18,560	23	,807		
	Greenhouse-Geisser	18,560	23,000	,807		
	Huynh-Feldt	18,560	23,000	,807		
	Lower-bound	18,560	23,000	,807		
Event	Sphericity Assumed	3,888	1	3,888	3,524	,073
	Greenhouse-Geisser	3,888	1,000	3,888	3,524	,073
	Huynh-Feldt	3,888	1,000	3,888	3,524	,073
	Lower-bound	3,888	1,000	3,888	3,524	,073
Error(Event)	Sphericity Assumed	25,378	23	1,103		
	Greenhouse-Geisser	25,378	23,000	1,103		
	Huynh-Feldt	25,378	23,000	1,103		
	Lower-bound	25,378	23,000	1,103		
TWin	Sphericity Assumed	3,543	6	,591	2,778	,014
	Greenhouse-Geisser	3,543	2,157	1,643	2,778	,068
	Huynh-Feldt	3,543	2,388	1,484	2,778	,062
	Lower-bound	3,543	1,000	3,543	2,778	,109
Error(TWin)	Sphericity Assumed	29,338	138	,213		
	Greenhouse-Geisser	29,338	49,607	,591		
	Huynh-Feldt	29,338	54,913	,534		
	Lower-bound	29,338	23,000	1,276		

End * Event	Sphericity Assumed	,044	1	,044	,041	,841
	Greenhouse-Geisser	,044	1,000	,044	,041	,841
	Huynh-Feldt	,044	1,000	,044	,041	,841
	Lower-bound	,044	1,000	,044	,041	,841
Error(End*Event)	Sphericity Assumed	24,512	23	1,066		
	Greenhouse-Geisser	24,512	23,000	1,066		
	Huynh-Feldt	24,512	23,000	1,066		
	Lower-bound	24,512	23,000	1,066		
End * TWin	Sphericity Assumed	3,493	6	,582	3,042	,008
	Greenhouse-Geisser	3,493	3,364	1,038	3,042	,029
	Huynh-Feldt	3,493	4,010	,871	3,042	,021
	Lower-bound	3,493	1,000	3,493	3,042	,094
Error(End*TWin)	Sphericity Assumed	26,406	138	,191		
	Greenhouse-Geisser	26,406	77,382	,341		
	Huynh-Feldt	26,406	92,240	,286		
	Lower-bound	26,406	23,000	1,148		
Event * TWin	Sphericity Assumed	,354	6	,059	,457	,839
	Greenhouse-Geisser	,354	2,996	,118	,457	,713
	Huynh-Feldt	,354	3,494	,101	,457	,742
	Lower-bound	,354	1,000	,354	,457	,506
Error(Event*TWin)	Sphericity Assumed	17,785	138	,129		
	Greenhouse-Geisser	17,785	68,899	,258		
	Huynh-Feldt	17,785	80,361	,221		
	Lower-bound	17,785	23,000	,773		
End * Event * TWin	Sphericity Assumed	,577	6	,096	,986	,437
	Greenhouse-Geisser	,577	4,023	,143	,986	,420
	Huynh-Feldt	,577	4,982	,116	,986	,429
	Lower-bound	,577	1,000	,577	,986	,331

Error(End*Event*TWin)	Sphericity Assumed	13,457	138	,098
	Greenhouse-Geisser	13,457	92,523	,145
	Huynh-Feldt	13,457	114,587	,117
	Lower-bound	13,457	23,000	,585

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	6,057	1	6,057	2,086	,162
Error	66,788	23	2,904		

Corrugator Supercillis (EMGc)

Descriptive Statistics

	Mean	Std. Deviation	N
100-RTEndB	-,0419	,27269	24
RTEndB	,0451	,41201	24
RTEnd+100B	,1798	,53074	24
RTEnd+200B	,2642	,50052	24
RTEnd+300B	,2236	,54288	24
RTEnd+400B	,3460	,47612	24
RTEnd+500B	,2995	,53917	24
100-RTEndQ	,1120	,31296	24
RTEndQ	,2852	,34791	24
RTEnd+100Q	,3855	,40672	24
RTEnd+200Q	,3945	,49881	24
RTEnd+300Q	,4390	,57946	24
RTEnd+400Q	,3899	,64576	24
RTEnd+500Q	,3172	,50930	24
100-VdEndB	,1236	,36771	24
VdEndB	,1374	,41169	24
VdEnd+100B	,0481	,40012	24
VdEnd+200B	-,0437	,52384	24
VdEnd+300B	-,0794	,50955	24
VdEnd+400B	,0831	,43864	24

VdEnd+500B	,0896	,52365	24
100-VdEndQ	,2269	,42627	24
VdEndQ	,2584	,41493	24
VdEnd+100Q	,2684	,41416	24
VdEnd+200Q	,1962	,37354	24
VdEnd+300Q	,1356	,32506	24
VdEnd+400Q	,1698	,42514	24
VdEnd+500Q	,3780	,51963	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
End	1,000	,000	0	.	1,000	1,000	1,000
Event	1,000	,000	0	.	1,000	1,000	1,000
TWin	,019	82,496	20	,000	,447	,512	,167
End * Event	1,000	,000	0	.	1,000	1,000	1,000
End * TWin	,051	61,918	20	,000	,593	,716	,167
Event * TWin	,092	49,630	20	,000	,597	,721	,167
End * Event * TWin	,296	25,285	20	,196	,707	,887	,167

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: End + Event + TWin + End * Event + End * TWin + Event * TWin + End * Event * TWin

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
End	Sphericity Assumed	2,327	1	2,327	3,041	,095
	Greenhouse-Geisser	2,327	1,000	2,327	3,041	,095
	Huynh-Feldt	2,327	1,000	2,327	3,041	,095
	Lower-bound	2,327	1,000	2,327	3,041	,095
Error(End)	Sphericity Assumed	17,600	23	,765		

	Greenhouse-Geisser	17,600	23,000	,765		
	Huynh-Feldt	17,600	23,000	,765		
	Lower-bound	17,600	23,000	,765		
Event	Sphericity Assumed	4,461	1	4,461	4,989	,036
	Greenhouse-Geisser	4,461	1,000	4,461	4,989	,036
	Huynh-Feldt	4,461	1,000	4,461	4,989	,036
	Lower-bound	4,461	1,000	4,461	4,989	,036
Error(Event)	Sphericity Assumed	20,569	23	,894		
	Greenhouse-Geisser	20,569	23,000	,894		
	Huynh-Feldt	20,569	23,000	,894		
	Lower-bound	20,569	23,000	,894		
TWin	Sphericity Assumed	1,674	6	,279	2,339	,035
	Greenhouse-Geisser	1,674	2,683	,624	2,339	,089
	Huynh-Feldt	1,674	3,071	,545	2,339	,079
	Lower-bound	1,674	1,000	1,674	2,339	,140
Error(TWin)	Sphericity Assumed	16,465	138	,119		
	Greenhouse-Geisser	16,465	61,703	,267		
	Huynh-Feldt	16,465	70,623	,233		
	Lower-bound	16,465	23,000	,716		
End * Event	Sphericity Assumed	,062	1	,062	,087	,771
	Greenhouse-Geisser	,062	1,000	,062	,087	,771
	Huynh-Feldt	,062	1,000	,062	,087	,771
	Lower-bound	,062	1,000	,062	,087	,771
Error(End*Event)	Sphericity Assumed	16,327	23	,710		
	Greenhouse-Geisser	16,327	23,000	,710		
	Huynh-Feldt	16,327	23,000	,710		
	Lower-bound	16,327	23,000	,710		
End * TWin	Sphericity Assumed	3,820	6	,637	6,483	,000

	Greenhouse-Geisser	3,820	3,561	1,073	6,483	,000
	Huynh-Feldt	3,820	4,293	,890	6,483	,000
	Lower-bound	3,820	1,000	3,820	6,483	,018
Error(End*TWin)	Sphericity Assumed	13,551	138	,098		
	Greenhouse-Geisser	13,551	81,898	,165		
	Huynh-Feldt	13,551	98,747	,137		
	Lower-bound	13,551	23,000	,589		
Event * TWin	Sphericity Assumed	,404	6	,067	,906	,493
	Greenhouse-Geisser	,404	3,582	,113	,906	,456
	Huynh-Feldt	,404	4,324	,094	,906	,469
	Lower-bound	,404	1,000	,404	,906	,351
Error(Event*TWin)	Sphericity Assumed	10,266	138	,074		
	Greenhouse-Geisser	10,266	82,377	,125		
	Huynh-Feldt	10,266	99,444	,103		
	Lower-bound	10,266	23,000	,446		
End * Event * TWin	Sphericity Assumed	,564	6	,094	1,849	,094
	Greenhouse-Geisser	,564	4,243	,133	1,849	,122
	Huynh-Feldt	,564	5,322	,106	1,849	,104
	Lower-bound	,564	1,000	,564	1,849	,187
Error(End*Event*TWin)	Sphericity Assumed	7,010	138	,051		
	Greenhouse-Geisser	7,010	97,580	,072		
	Huynh-Feldt	7,010	122,401	,057		
	Lower-bound	7,010	23,000	,305		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	27,184	1	27,184	18,183	,000

Error	34,386	23	1,495

Zygomaticus Major (EMGz)

Descriptive Statistics

	Mean	Std. Deviation	N
100-RTEndB	,0905	,28943	24
RTEndB	,1080	,37651	24
RTEnd+100B	,2171	,45749	24
RTEnd+200B	,1657	,50804	24
RTEnd+300B	,1061	,47182	24
RTEnd+400B	,0062	,46255	24
RTEnd+500B	,0840	,38102	24
100-RTEndQ	,0863	,41204	24
RTEndQ	,1390	,37538	24
RTEnd+100Q	,2174	,48687	24
RTEnd+200Q	,2074	,56870	24
RTEnd+300Q	,1086	,61882	24
RTEnd+400Q	,0225	,65073	24
RTEnd+500Q	,0512	,57820	24
100-VdEndB	,0735	,35345	24
VdEndB	,1227	,33080	24
VdEnd+100B	,0865	,40446	24
VdEnd+200B	,1210	,28855	24
VdEnd+300B	,0848	,34815	24
VdEnd+400B	,0609	,45565	24
VdEnd+500B	,0838	,36660	24
100-VdEndQ	,1093	,34817	24
VdEndQ	,1607	,34722	24
VdEnd+100Q	,1296	,32188	24
VdEnd+200Q	,1384	,33196	24
VdEnd+300Q	,0673	,29199	24
VdEnd+400Q	,0317	,30943	24
VdEnd+500Q	,0931	,30693	24

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
End	1,000	,000	0	.	1,000	1,000	1,000
Event	1,000	,000	0	.	1,000	1,000	1,000
TWin	,043	65,161	20	,000	,464	,535	,167
End * Event	1,000	,000	0	.	1,000	1,000	1,000
End * TWin	,031	71,924	20	,000	,487	,565	,167
Event * TWin	,074	54,154	20	,000	,478	,554	,167
End * Event * TWin	,063	57,329	20	,000	,497	,579	,167

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: End + Event + TWin + End * Event + End * TWin + Event * TWin + End * Event * TWin

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
End	Sphericity Assumed	,052	1	,052	,076	,785
	Greenhouse-Geisser	,052	1,000	,052	,076	,785
	Huynh-Feldt	,052	1,000	,052	,076	,785
	Lower-bound	,052	1,000	,052	,076	,785
Error(End)	Sphericity Assumed	15,821	23	,688		
	Greenhouse-Geisser	15,821	23,000	,688		
	Huynh-Feldt	15,821	23,000	,688		
	Lower-bound	15,821	23,000	,688		
Event	Sphericity Assumed	,020	1	,020	,037	,849
	Greenhouse-Geisser	,020	1,000	,020	,037	,849
	Huynh-Feldt	,020	1,000	,020	,037	,849

	Lower-bound	,020	1,000	,020	,037	,849
Error(Event)	Sphericity Assumed	12,290	23	,534		
	Greenhouse-Geisser	12,290	23,000	,534		
	Huynh-Feldt	12,290	23,000	,534		
	Lower-bound	12,290	23,000	,534		
TWin	Sphericity Assumed	1,306	6	,218	2,346	,034
	Greenhouse-Geisser	1,306	2,785	,469	2,346	,085
	Huynh-Feldt	1,306	3,207	,407	2,346	,076
	Lower-bound	1,306	1,000	1,306	2,346	,139
Error(TWin)	Sphericity Assumed	12,806	138	,093		
	Greenhouse-Geisser	12,806	64,048	,200		
	Huynh-Feldt	12,806	73,764	,174		
	Lower-bound	12,806	23,000	,557		
End * Event	Sphericity Assumed	,002	1	,002	,002	,963
	Greenhouse-Geisser	,002	1,000	,002	,002	,963
	Huynh-Feldt	,002	1,000	,002	,002	,963
	Lower-bound	,002	1,000	,002	,002	,963
Error(End*Event)	Sphericity Assumed	15,600	23	,678		
	Greenhouse-Geisser	15,600	23,000	,678		
	Huynh-Feldt	15,600	23,000	,678		
	Lower-bound	15,600	23,000	,678		
End * TWin	Sphericity Assumed	,378	6	,063	,603	,728
	Greenhouse-Geisser	,378	2,921	,129	,603	,611
	Huynh-Feldt	,378	3,392	,111	,603	,635
	Lower-bound	,378	1,000	,378	,603	,445
Error(End*TWin)	Sphericity Assumed	14,422	138	,105		
	Greenhouse-Geisser	14,422	67,191	,215		
	Huynh-Feldt	14,422	78,022	,185		

	Lower-bound	14,422	23,000	,627		
Event * TWin	Sphericity Assumed	,053	6	,009	,196	,977
	Greenhouse-Geisser	,053	2,870	,018	,196	,891
	Huynh-Feldt	,053	3,322	,016	,196	,915
	Lower-bound	,053	1,000	,053	,196	,662
Error(Event*TWin)	Sphericity Assumed	6,176	138	,045		
	Greenhouse-Geisser	6,176	66,006	,094		
	Huynh-Feldt	6,176	76,410	,081		
	Lower-bound	6,176	23,000	,269		
End * Event * TWin	Sphericity Assumed	,048	6	,008	,195	,978
	Greenhouse-Geisser	,048	2,981	,016	,195	,899
	Huynh-Feldt	,048	3,473	,014	,195	,922
	Lower-bound	,048	1,000	,048	,195	,663
Error(End*Event*TWin)	Sphericity Assumed	5,714	138	,041		
	Greenhouse-Geisser	5,714	68,555	,083		
	Huynh-Feldt	5,714	79,889	,072		
	Lower-bound	5,714	23,000	,248		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	7,577	1	7,577	5,569	,027
Error	31,290	23	1,360		

Experiment 2

A repeated measure ANOVA with 2 *Task-Condition* (order x random), 2 *Action-Judgment* (grasp-ability x pass-ability) and 3 *Valence* (neutral, positive and negative) components as within-subject factors were applied to the *RTI* values.

Descriptive Statistics

	Mean	Std. Deviation	N
O_GI_Ng	519,0615	72,95412	84
O_GI_N	511,2808	72,91204	84
O_GI_P	519,1449	71,50290	84
O_FI_Ng	564,2462	115,96972	84
O_FI_N	560,6082	125,08537	84
O_FI_P	565,6185	119,96334	84
A_GI_Ng	541,5435	67,64023	84
A_GI_N	532,8658	68,82785	84
A_GI_P	536,3349	72,51064	84
A_FI_Ng	576,4890	120,36582	84
A_FI_N	568,46	114,846	84
A_FI_P	567,4561	110,70480	84

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
OA	1,000	,000	0	.	1,000	1,000	1,000
GF	1,000	,000	0	.	1,000	1,000	1,000
NGNP	,884	10,121	2	,006	,896	,914	,500
OA * GF	1,000	,000	0	.	1,000	1,000	1,000
OA * NGNP	,852	13,145	2	,001	,871	,888	,500
GF * NGNP	,985	1,236	2	,539	,985	1,000	,500
OA * GF * NGNP	,996	,304	2	,859	,996	1,000	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept

Within Subjects Design: OA + GF + NGNP + OA * GF + OA * NGNP + GF * NGNP + OA * GF * NGNP

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
OA	Sphericity Assumed	48442,646	1	48442,646	12,620	,001
	Greenhouse-Geisser	48442,646	1,000	48442,646	12,620	,001
	Huynh-Feldt	48442,646	1,000	48442,646	12,620	,001
	Lower-bound	48442,646	1,000	48442,646	12,620	,001
Error(OA)	Sphericity Assumed	318611,451	83	3838,692		
	Greenhouse-Geisser	318611,451	83,000	3838,692		
	Huynh-Feldt	318611,451	83,000	3838,692		
	Lower-bound	318611,451	83,000	3838,692		
GF	Sphericity Assumed	412140,216	1	412140,216	8,670	,004
	Greenhouse-Geisser	412140,216	1,000	412140,216	8,670	,004
	Huynh-Feldt	412140,216	1,000	412140,216	8,670	,004
	Lower-bound	412140,216	1,000	412140,216	8,670	,004
Error(GF)	Sphericity Assumed	3945540,450	83	47536,632		
	Greenhouse-Geisser	3945540,450	83,000	47536,632		
	Huynh-Feldt	3945540,450	83,000	47536,632		
	Lower-bound	3945540,450	83,000	47536,632		
NGNP	Sphericity Assumed	8328,913	2	4164,456	3,610	,029
	Greenhouse-Geisser	8328,913	1,792	4648,008	3,610	,034
	Huynh-Feldt	8328,913	1,829	4554,030	3,610	,033
	Lower-bound	8328,913	1,000	8328,913	3,610	,061
Error(NGNP)	Sphericity Assumed	191485,698	166	1153,528		
	Greenhouse-Geisser	191485,698	148,730	1287,469		

	Huynh-Feldt	191485,698	151,800	1261,438		
	Lower-bound	191485,698	83,000	2307,057		
OA * GF	Sphericity Assumed	10825,189	1	10825,189	2,442	,122
	Greenhouse-Geisser	10825,189	1,000	10825,189	2,442	,122
	Huynh-Feldt	10825,189	1,000	10825,189	2,442	,122
	Lower-bound	10825,189	1,000	10825,189	2,442	,122
Error(OA*GF)	Sphericity Assumed	367909,785	83	4432,648		
	Greenhouse-Geisser	367909,785	83,000	4432,648		
	Huynh-Feldt	367909,785	83,000	4432,648		
	Lower-bound	367909,785	83,000	4432,648		
OA * NGNP	Sphericity Assumed	2678,971	2	1339,485	1,213	,300
	Greenhouse-Geisser	2678,971	1,742	1537,885	1,213	,296
	Huynh-Feldt	2678,971	1,776	1508,299	1,213	,297
	Lower-bound	2678,971	1,000	2678,971	1,213	,274
Error(OA*NGNP)	Sphericity Assumed	183303,371	166	1104,237		
	Greenhouse-Geisser	183303,371	144,585	1267,792		
	Huynh-Feldt	183303,371	147,421	1243,403		
	Lower-bound	183303,371	83,000	2208,474		
GF * NGNP	Sphericity Assumed	581,409	2	290,704	,260	,771
	Greenhouse-Geisser	581,409	1,971	295,055	,260	,768
	Huynh-Feldt	581,409	2,000	290,704	,260	,771
	Lower-bound	581,409	1,000	581,409	,260	,611
Error(GF*NGNP)	Sphericity Assumed	185558,404	166	1117,822		
	Greenhouse-Geisser	185558,404	163,553	1134,549		
	Huynh-Feldt	185558,404	166,000	1117,822		
	Lower-bound	185558,404	83,000	2235,643		
OA * GF * NGNP	Sphericity Assumed	286,849	2	143,424	,133	,876
	Greenhouse-Geisser	286,849	1,993	143,956	,133	,875

	Huynh-Feldt	286,849	2,000	143,424	,133	,876
	Lower-bound	286,849	1,000	286,849	,133	,716
Error(OA*GF*NGNP)	Sphericity Assumed	178962,605	166	1078,088		
	Greenhouse-Geisser	178962,605	165,388	1082,080		
	Huynh-Feldt	178962,605	166,000	1078,088		
	Lower-bound	178962,605	83,000	2156,176		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	301520802,597	1	301520802,597	6150,269	,000
Error	4069127,103	83	49025,628		

Appendix C

To touch or not to touch? Feelings as non-visual information for perceived reach-ability

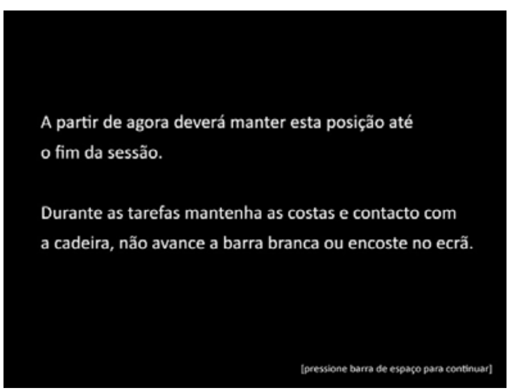
Material

Study 1

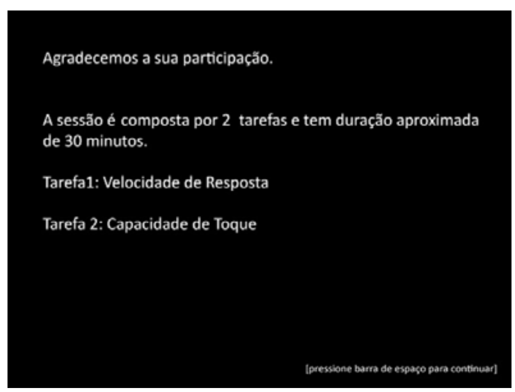
Screen1

Screen2

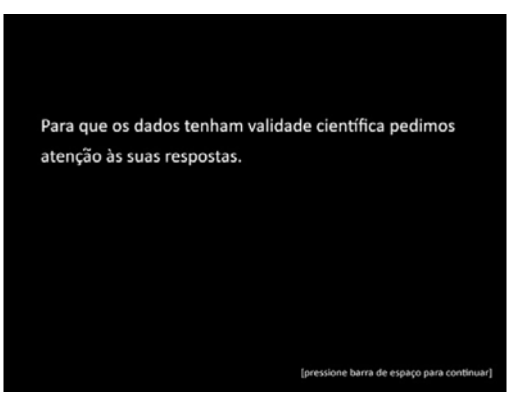
Screen3



Screen4

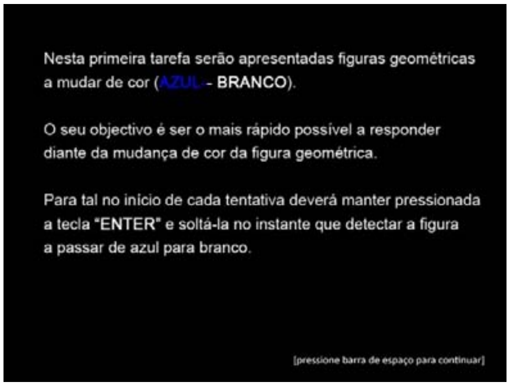


Screen5



Screen6

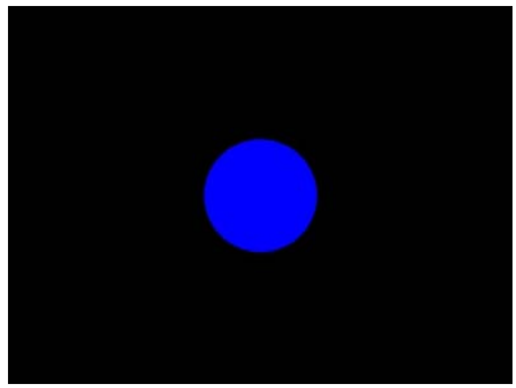
Screen7



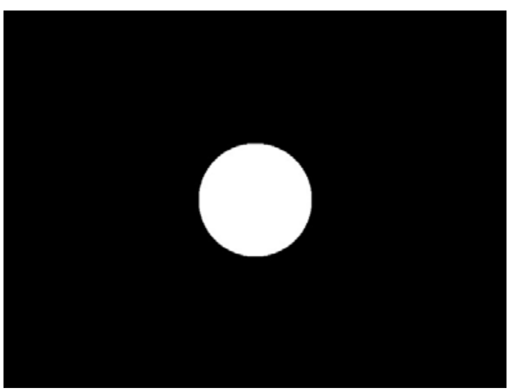
Screen8

Screen9

Screen10



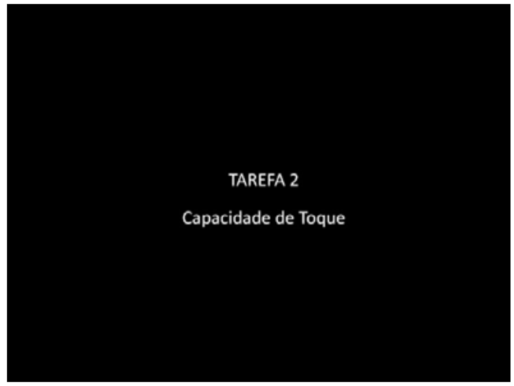
Screen11



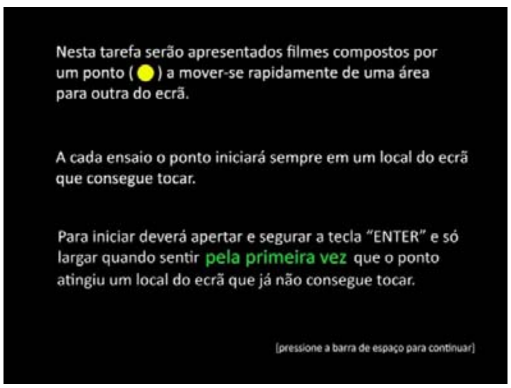
Screen12

Screen13

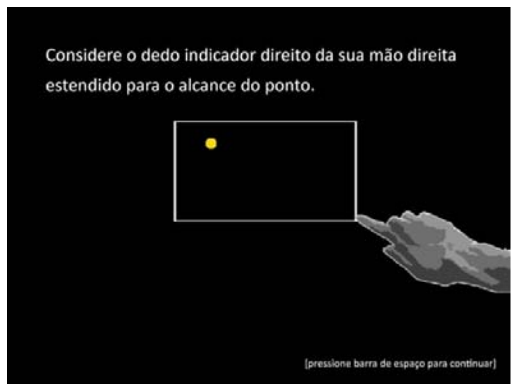
Screen14



Screen15

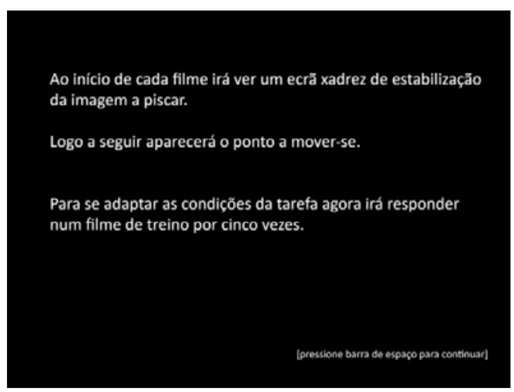


Screen16



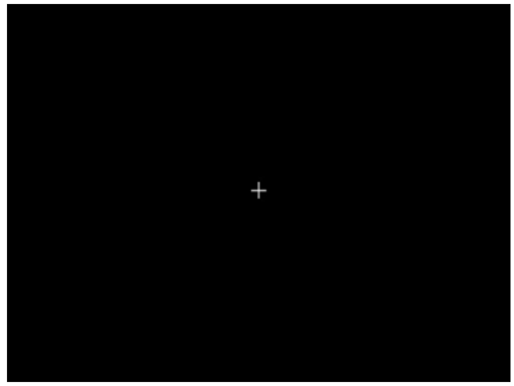
Screen17

Screen18

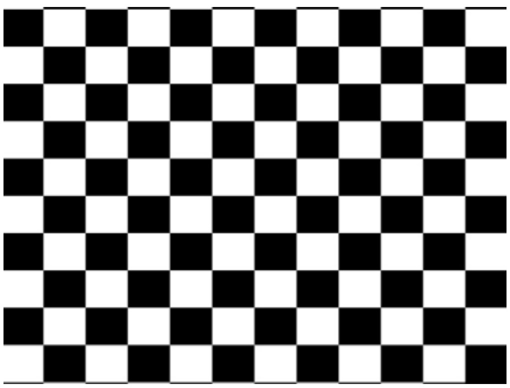


Screen19

Screen20



Screen21



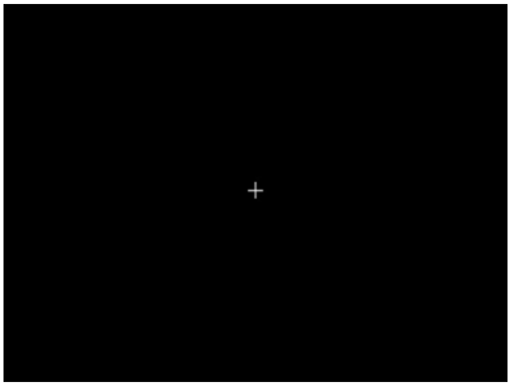
Screen22

Video File (Training Task)

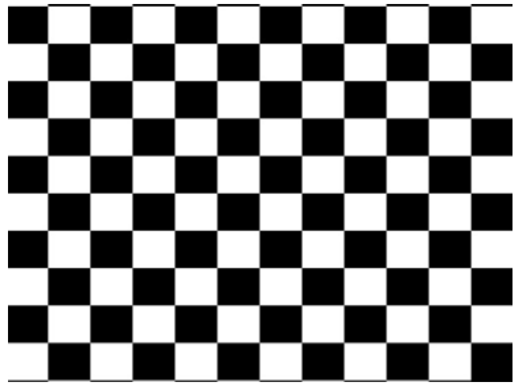
Screen23

Screen24

Screen25

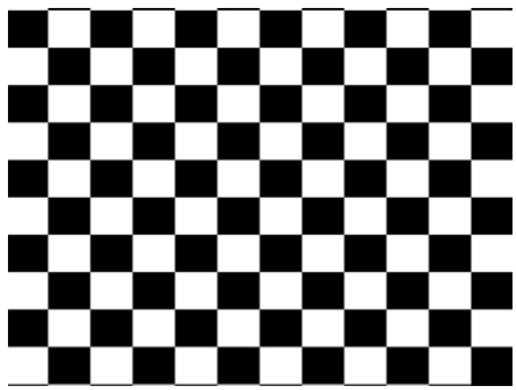


Screen26



Screen27

Screen28



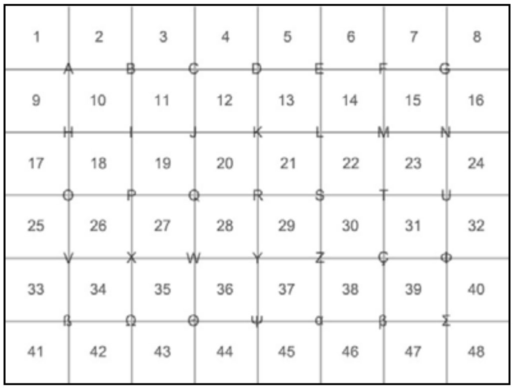
Screen29

Video File (Training Task)

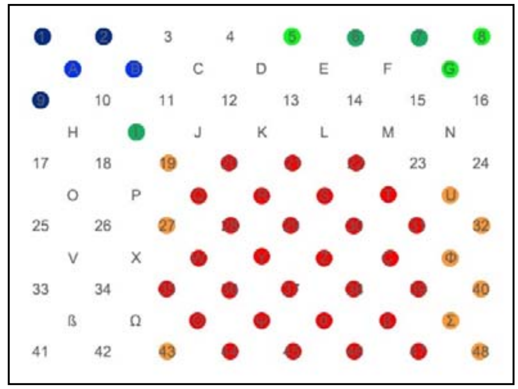
Screen30

Pre-tested of real touch areas of the computer screen

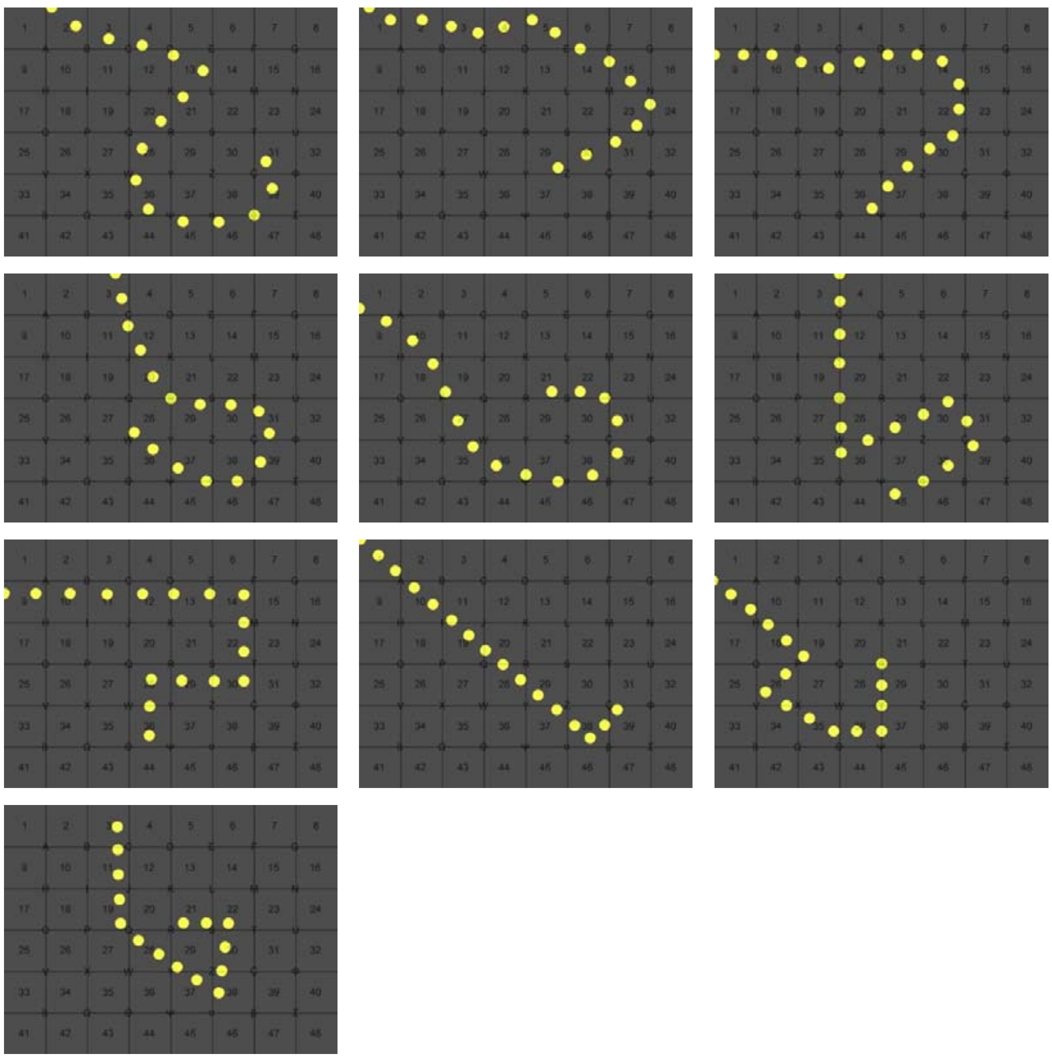
Computer Screen



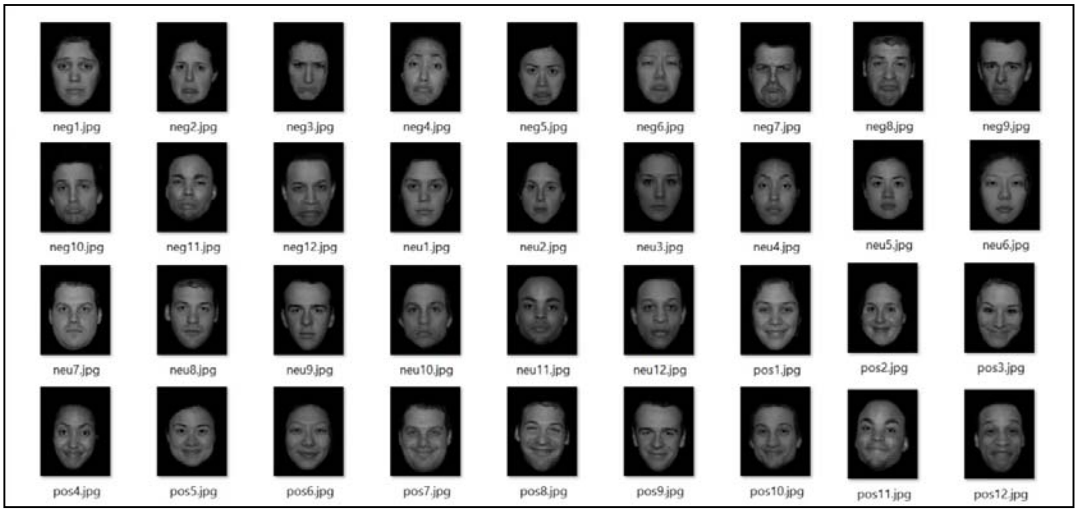
Pre-Test Areas



The 10 dot-movie films trajectories



Prime Faces



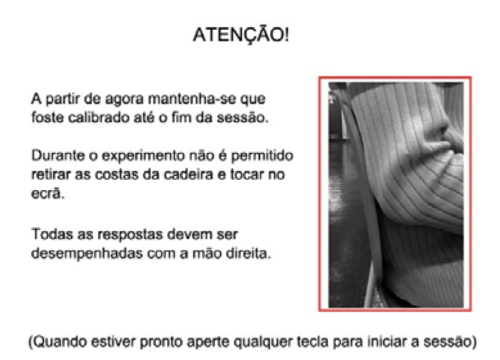
Study 2

Screen1

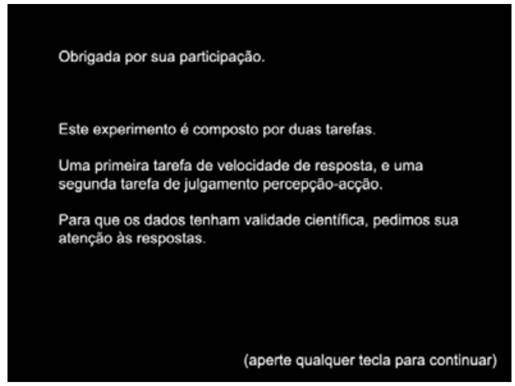
ISPA
INSTITUTO UNIVERSITÁRIO

Screen2

Screen3

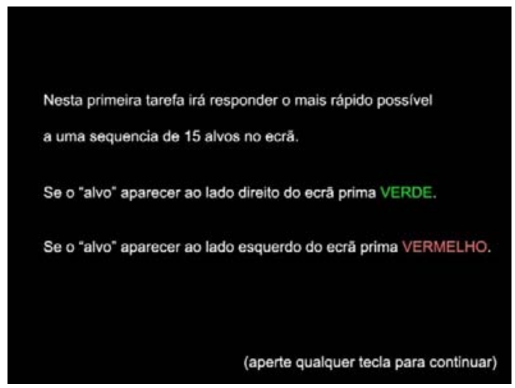


Screen4

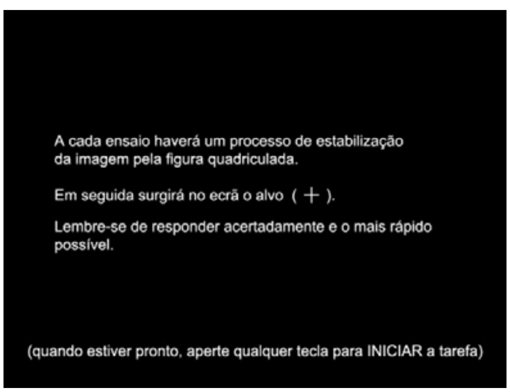


Screen5

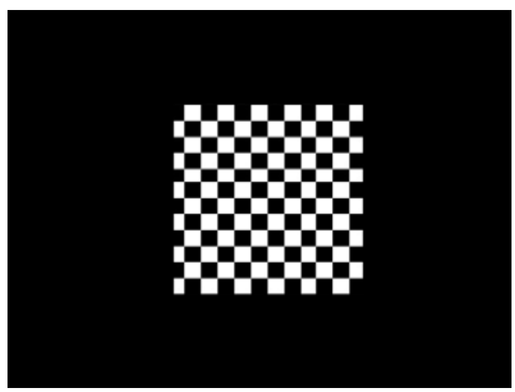
Screen6



Screen7

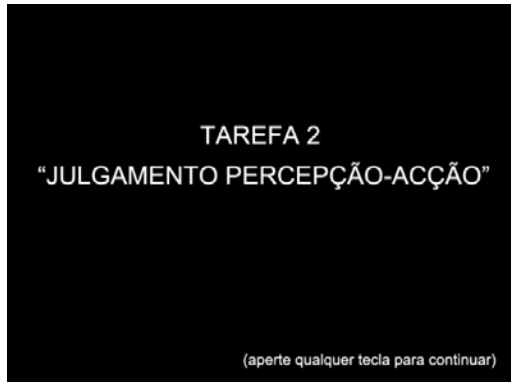


Screen8

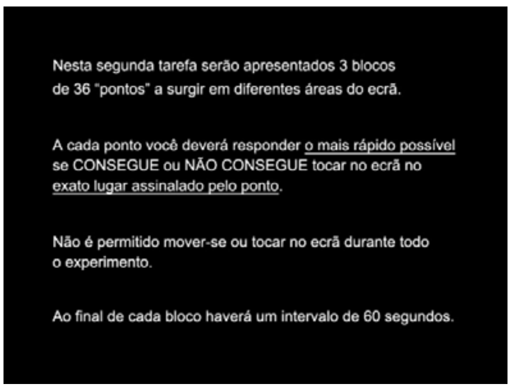


Screen9

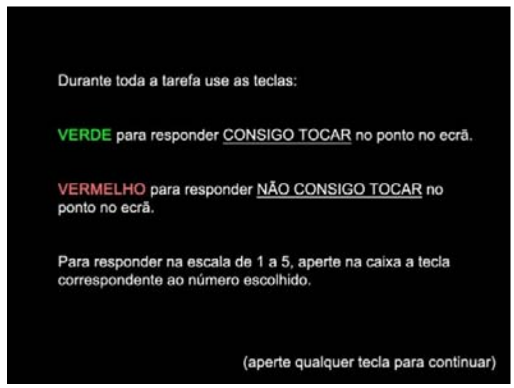
Screen10



Screen11



Screen12



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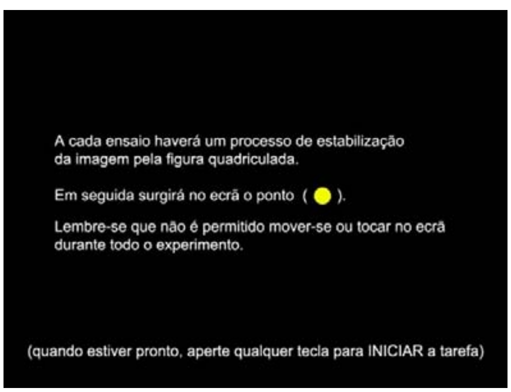

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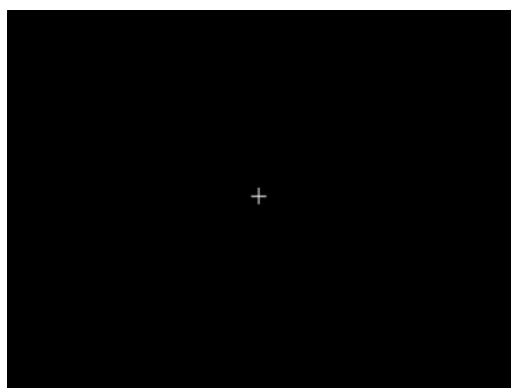
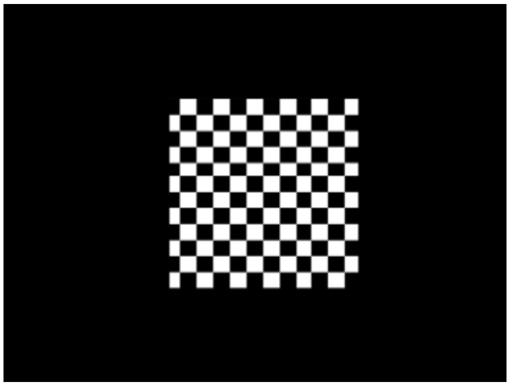
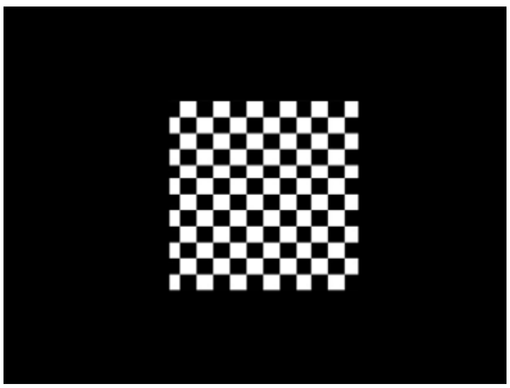


Screen15

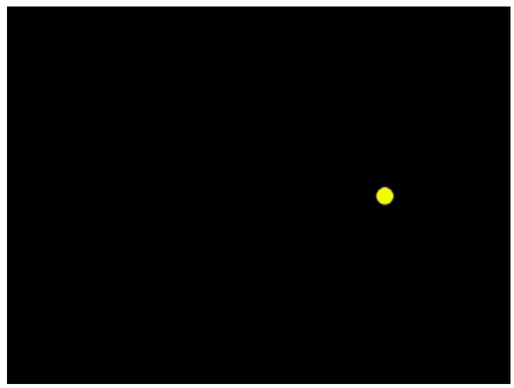


Screen16

Screen17



Screen18

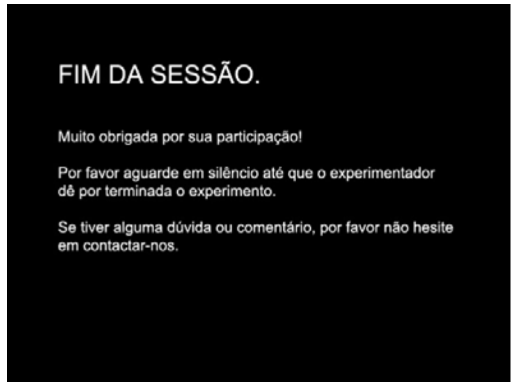


Screen19

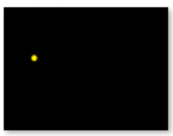
Screen20

Screen21

Screen22



36 Dots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A2.jpg


A3.jpg

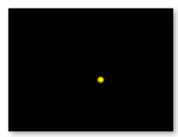

A4.jpg


A5.jpg


A10.jpg


A11.jpg


A12.jpg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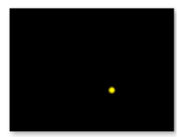
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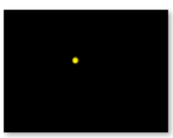
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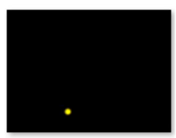
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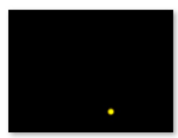
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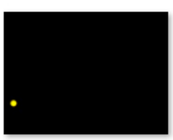
A23.jpg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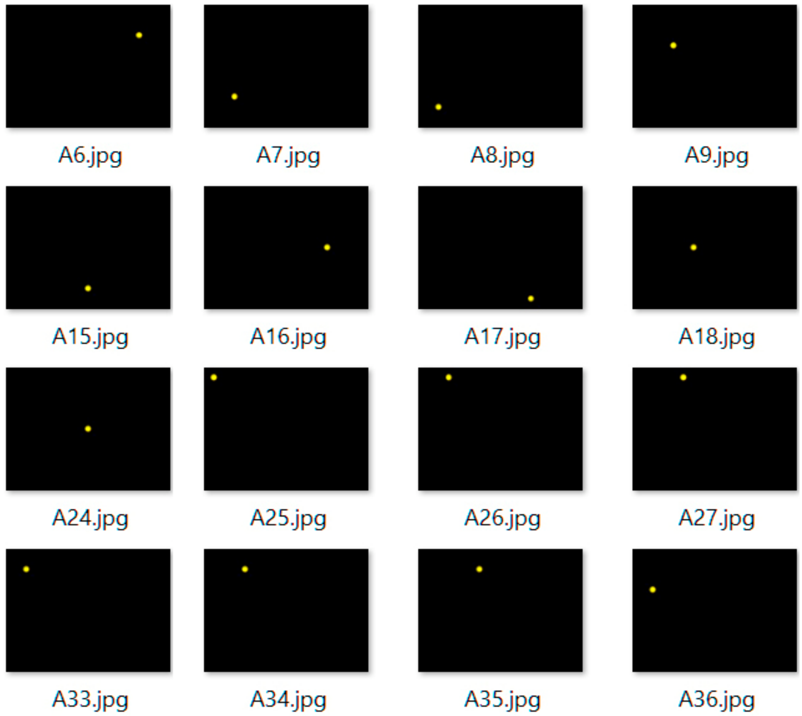
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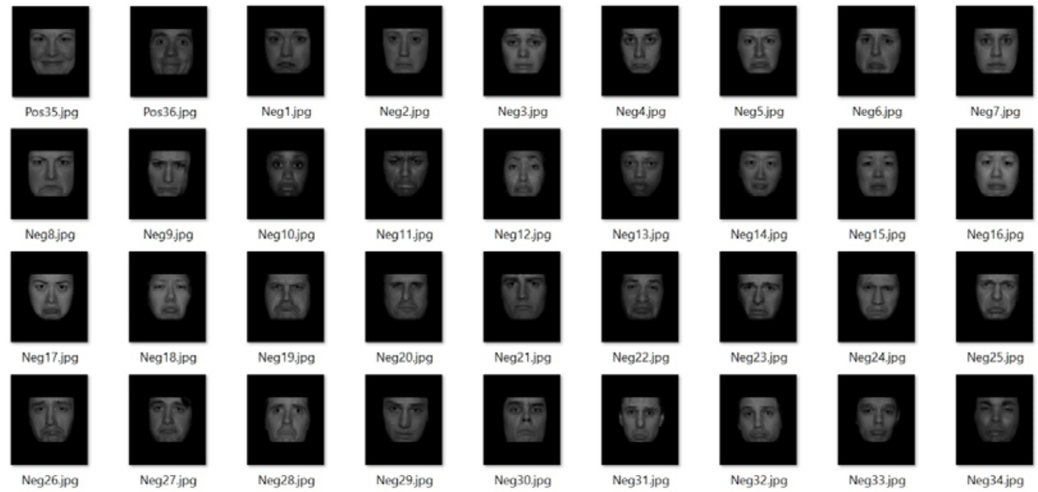
A33.jpg
A34.jpg
A35.jpg
A36.jpg

36 Happy, Sad and Neutral Prime Faces



Statistical Analysis

Study 1

Release-key-time. The RTI values were subject to a repeated ANOVA with 3 Blocks (block1, block2, block3) and 3 Primes (neutral, positive and negative) as within-factors.

Within-Subjects Factors

Measure: MEASURE_1

Blocks	NGNP	Dependent Variable
1	1	Bl1Ng
	2	Bl1N
	3	Bl1P
2	1	Bl2Ng
	2	Bl2N
	3	Bl2P
3	1	Bl3Ng
	2	Bl3N
	3	Bl3P

Descriptive Statistics

	Mean	Std. Deviation	N
Bl1Ng	1839,644	244,4396	23
Bl1N	1809,776	276,7294	23
Bl1P	1838,363	234,3850	23
Bl2Ng	1896,45	234,322	23
Bl2N	1846,553	232,1314	23
Bl2P	1887,277	288,6381	23
Bl3Ng	1860,209	290,0688	23
Bl3N	1834,609	295,0036	23
Bl3P	1842,076	285,0645	23

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

		df	Sig.	Epsilon[b]

Within Subjects Effect	Mauchly's W	Approx. Chi-Square			Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Blocks	,554	12,416	2	,002	,691	,723	,500
NGNP	,978	,462	2	,794	,979	1,000	,500
Blocks * NGNP	,711	6,969	9	,642	,878	1,000	,250

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Blocks + NGNP + Blocks * NGNP

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Blocks	Sphericity Assumed	80348,183	2	40174,091	1,040	,362
	Greenhouse-Geisser	80348,183	1,383	58106,022	1,040	,341
	Huynh-Feldt	80348,183	1,446	55581,519	1,040	,344
	Lower-bound	80348,183	1,000	80348,183	1,040	,319
Error(Blocks)	Sphericity Assumed	1700044,274	44	38637,370		
	Greenhouse-Geisser	1700044,274	30,421	55883,377		
	Huynh-Feldt	1700044,274	31,803	53455,440		
	Lower-bound	1700044,274	22,000	77274,740		
NGNP	Sphericity Assumed	45527,799	2	22763,900	5,049	,011
	Greenhouse-Geisser	45527,799	1,957	23259,731	5,049	,011
	Huynh-Feldt	45527,799	2,000	22763,900	5,049	,011
	Lower-bound	45527,799	1,000	45527,799	5,049	,035
Error(NGNP)	Sphericity Assumed	198395,288	44	4508,984		
	Greenhouse-Geisser	198395,288	43,062	4607,196		
	Huynh-Feldt	198395,288	44,000	4508,984		
	Lower-bound	198395,288	22,000	9017,968		
Blocks * NGNP	Sphericity Assumed	8014,323	4	2003,581	,213	,931
	Greenhouse-Geisser	8014,323	3,513	2281,637	,213	,913
	Huynh-Feldt	8014,323	4,000	2003,581	,213	,931
	Lower-bound	8014,323	1,000	8014,323	,213	,649
Error(Blocks*NGNP)	Sphericity Assumed	829142,761	88	9422,077		
	Greenhouse-Geisser	829142,761	77,276	10729,671		
	Huynh-Feldt	829142,761	88,000	9422,077		
	Lower-bound	829142,761	22,000	37688,307		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	708879917,948	1	708879917,948	1385,024	,000
Error	11259993,279	22	511817,876		

Study 2

Hits. Hit values were subject to a mixed ANOVA with 2 *Conditions* (free x constraint) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor.

Within-Subjects Factors

Measure: MEASURE_1

NPNG	Dependent Variable
1	Hits_N
2	Hits_P
3	Hits_Ng

Between-Subjects Factors

		N
Condicao	combarra	21
	sembarra	21

Descriptive Statistics

	Condicao	Mean	Std. Deviation	N
Hits_N	combarra	,9444	,08471	21
	sembarra	,9365	,07409	21
	Total	,9405	,07870	42
Hits_P	combarra	,88	,133	21
	sembarra	,92	,107	21
	Total	,90	,121	42
Hits_Ng	combarra	,89	,137	21
	sembarra	,90	,114	21

Total	,90	,125	42

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
NPNG	,866	5,599	2	,061	,882	,943	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Condicao

Within Subjects Design: NPNG

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
NPNG	Sphericity Assumed	,049	2	,024	3,888	,024
	Greenhouse-Geisser	,049	1,764	,028	3,888	,030
	Huynh-Feldt	,049	1,885	,026	3,888	,027
	Lower-bound	,049	1,000	,049	3,888	,056
NPNG * Condicao	Sphericity Assumed	,012	2	,006	,981	,379
	Greenhouse-Geisser	,012	1,764	,007	,981	,371
	Huynh-Feldt	,012	1,885	,007	,981	,376
	Lower-bound	,012	1,000	,012	,981	,328
Error(NPNG)	Sphericity Assumed	,504	80	,006		
	Greenhouse-Geisser	,504	70,564	,007		
	Huynh-Feldt	,504	75,418	,007		
	Lower-bound	,504	40,000	,013		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	104,960	1	104,960	4331,135	,000
Condicao	,006	1	,006	,227	,636
Error	,969	40	,024		

False-Alarms. False-alarm values were subject to a mixed ANOVA with 2 *Conditions* (free x constraint) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor.

Within-Subjects Factors

Measure: MEASURE_1

NPNG	Dependent Variable
1	FA__N
2	FA_P
3	FA_Ng

Between-Subjects Factors

		N
Condicao	combarra	21
	sembarra	21

Descriptive Statistics

	Condicao	Mean	Std. Deviation	N
FA__N	combarra	,16	,186	21
	sembarra	,10	,108	21
	Total	,13	,153	42
FA_P	combarra	,17	,190	21
	sembarra	,08	,087	21
	Total	,12	,152	42
FA_Ng	combarra	,17063492063492	,163461239196259	21
	sembarra	,07539682539683	,069245747486568	21
	Total	,12301587301587	,133025680679416	42

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect			df	Sig.		Epsilon[b]	

	Mauchly's W	Approx. Chi-Square			Greenhouse-Geisser	Huynh-Feldt	Lower-bound
NPNG	,984	,636	2	,728	,984	1,000	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Condicao

Within Subjects Design: NPNG

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
NPNG	Sphericity Assumed	,001	2	,001	,066	,936
	Greenhouse-Geisser	,001	1,968	,001	,066	,934
	Huynh-Feldt	,001	2,000	,001	,066	,936
	Lower-bound	,001	1,000	,001	,066	,798
NPNG * Condicao	Sphericity Assumed	,009	2	,004	,403	,670
	Greenhouse-Geisser	,009	1,968	,004	,403	,667
	Huynh-Feldt	,009	2,000	,004	,403	,670
	Lower-bound	,009	1,000	,009	,403	,529
Error(NPNG)	Sphericity Assumed	,865	80	,011		
	Greenhouse-Geisser	,865	78,727	,011		
	Huynh-Feldt	,865	80,000	,011		
	Lower-bound	,865	40,000	,022		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	2,011	1	2,011	51,281	,000
Condicao	,192	1	,192	4,893	,033
Error	1,568	40	,039		

Sensitiveness (d'). Sensitiveness values were subject to a mixed ANOVA with 2 *Conditions* (free x constrain) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor

Within-Subjects Factors

Measure: MEASURE_1

NPNG	Dependent Variable
1	d_N
2	d_P
3	d_Ng

Between-Subjects Factors

		N
Condicao	combarra	21
	sembarra	21

Descriptive Statistics

	Condicao	Mean	Std. Deviation	N
d'_N	combarra	2,6348	,86138	21
	sembarra	2,7659	,64007	21
	Total	2,7004	,75246	42
d'_P	combarra	2,3410	,91064	21
	sembarra	2,8109	,64118	21
	Total	2,5759	,81340	42
d'_Ng	combarra	2,3748	,55856	21
	sembarra	2,7483	,61703	21
	Total	2,5616	,61127	42

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
NPNG	Sphericity Assumed	,489	2	,245	1,010	,369
	Greenhouse-Geisser	,489	1,987	,246	1,010	,368
	Huynh-Feldt	,489	2,000	,245	1,010	,369
	Lower-bound	,489	1,000	,489	1,010	,321
NPNG * Condicao	Sphericity Assumed	,640	2	,320	1,321	,273
	Greenhouse-Geisser	,640	1,987	,322	1,321	,273
	Huynh-Feldt	,640	2,000	,320	1,321	,273
	Lower-bound	,640	1,000	,640	1,321	,257
Error(NPNG)	Sphericity Assumed	19,375	80	,242		
	Greenhouse-Geisser	19,375	79,485	,244		
	Huynh-Feldt	19,375	80,000	,242		
	Lower-bound	19,375	40,000	,484		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	860,050	1	860,050	812,897	,000
Condicao	3,325	1	3,325	3,143	,084
Error	42,320	40	1,058		

Bias on estimate reach-ability (c'). The values of the criterion (*c'*) adopted by the participants when estimating a dot as touchable or not touchable were subject to a mixed ANOVA with 2 *Conditions* (free x constraint) as between factor and 3 *Primes* (neutral, positive and negative) as within-factor.

Within-Subjects Factors

Measure: MEASURE_1

NPNG	Dependent Variable
1	c_N
2	c_P
3	c_Ng

Between-Subjects Factors

		N
Condicao	combarra	21
	sembarra	21

Descriptive Statistics

	Condicao	Mean	Std. Deviation	N
c'_N	combarra	-,6023	,24671	21
	sembarra	-,5057	,19395	21
	Total	-,5540	,22457	42
c'_P	combarra	-,4449	,32530	21
	sembarra	-,4620	,25928	21
	Total	-,4534	,29067	42
c'_Ng	combarra	-,4344	,37337	21
	sembarra	-,3997	,28569	21
	Total	-,4170	,32882	42

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

					Epsilon[b]		
Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Greenhouse-Geisser	Huynh-Feldt	Lower-bound
NPNG	,795	8,929	2	,012	,830	,883	,500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept + Condicao

Within Subjects Design: NPNG

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
NPNG	Sphericity Assumed	,423	2	,211	4,572	,013
	Greenhouse-Geisser	,423	1,660	,255	4,572	,019
	Huynh-Feldt	,423	1,767	,239	4,572	,017
	Lower-bound	,423	1,000	,423	4,572	,039
NPNG * Condicao	Sphericity Assumed	,068	2	,034	,737	,482
	Greenhouse-Geisser	,068	1,660	,041	,737	,459
	Huynh-Feldt	,068	1,767	,039	,737	,467
	Lower-bound	,068	1,000	,068	,737	,396
Error(NPNG)	Sphericity Assumed	3,697	80	,046		
	Greenhouse-Geisser	3,697	66,411	,056		
	Huynh-Feldt	3,697	70,664	,052		
	Lower-bound	3,697	40,000	,092		

Tests of Between-Subjects Effects

Measure: MEASURE_1

Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	28,406	1	28,406	184,639	,000
Condicao	,046	1	,046	,297	,589
Error	6,154	40	,154		