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INSTITUTO DE CIÊNCIAS DA SAÚDE
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PAIN REPORTING ACCURACY AND ABILITY TO ACCURATELY REPORT OTHER BODILY SENSATIONS IN DANCERS

Dissertação apresentada à Universidade Católica Portuguesa para obtenção do grau de mestre em

Neuropsicologia

Por

Diogo Manuel Garanito Mendonça

Lisboa, 2019

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Sob a orientação de Rita Canaipa, PhD e Roi Treister, PhD

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Abstract

Pain is a highly subjective experience. Researchers and clinicians have been struggling to measure pain, the effect of drugs and other therapies. One of the reasons for these difficulties is thought to be the high variability in pain reporting. Focused Analgesia Selection Test (FAST), was developed to assess pain reporting skills, and thus to discriminate between those that experience pain in accordance with the pain stimulation, and those that experience pain very differently from the external stimulation applied. Underlying differences in pain reporting could be explained through accuracy in other bodily sensations as well. Previous research has shown that in normal population pain accuracy is related to accuracy in the same modality but not between different interoception modalities, suggesting that accuracy is not cross-modal skill. Dancers are known to withstand and perceive pain differently and to have higher interoceptive accuracy comparing to non-dancers. Thus, the aim of the current study was to investigate if in dancers there were relations between pain reporting accuracy the accuracy in different modalities, i.e., interoception and taste. Thirty-three undergraduate and graduate dance students were recruited from a graduate school of dance. They were assessed with FAST procedure, heartbeat detection task and taste perception task. Psychological characteristics and a neuropsychological memory task were also assessed. The results showed significant relations between reporting accuracy within the same modality (taste), but no relations between different sensorial modalities. There were no relations between pain sensitivity and the pain reporting skills, but it was found that the years of dance practice were related to a higher pain reporting accuracy. Our data suggest that reporting accuracy is mostly a within modality characteristic, but further studies are needed to fully understand how higher practice related to body functions can increase accuracy in sensorial modalities.

Keywords: Pain; Interoception; Accuracy; Dancers

Resumo

A dor é uma experiência bastante subjetiva. Investigadores e médicos apresentam dificuldade na sua medição, no efeito real da medicação e noutras terapias. Uma das razões para estas dificuldades acredita-se estar relacionada com a grande variabilidade no reportar a dor. Focused Analgesia Selection Test (FAST) foi desenvolvido para medir a capacidade de reportar a dor, e assim discriminar entre os indivíduos que experienciam a dor de forma proporcional ao estímulo da dor, e aqueles que experienciam a dor de forma muito diferente da estimulação externa aplicada. Por detrás destas diferenças em reportar a dor pode estar a capacidade em reportar com precisão noutras modalidades sensoriais. Pesquisas anteriores mostraram que, em população normal, a precisão da dor está relacionada com precisão na mesma modalidade sensorial, mas não entre modalidades sensoriais, o que sugere que a precisão não é uma capacidade multimodal. Os bailarinos são estudados pela sua capacidade em suportar e sentir a dor de forma diferente, e ter uma maior capacidade de precisão interoceptiva comparado a não dançarinos. Assim, o objetivo do presente estudo foi investigar se, em bailarinos, havia relações entre a precisão em reportar dor e precisão de reportar estímulos noutras modalidades sensoriais. Trinta e três alunos não licenciados e licenciados em dança foram recrutados numa Escola Superior de Dança. Foi aplicado o procedimento do FAST, o procedimento de deteção do batimento cardíaco, e o procedimento de perceção do paladar. Características psicológicas e uma tarefa neuropsicológica da memória também foram medidos. Os resultados mostraram uma relação significativa entre a precisão em reportar estímulos da mesma modalidade sensorial (paladar), contudo, sem nenhuma relação entre as diferentes modalidades sensoriais. Não houve relações entre a sensibilidade à dor e na capacidade de reportar com precisão a dor, mas houve uma relação significativa entre os anos de prática em dança e a uma capacidade maior de reportar com precisão a dor. Os resultados sugerem que reportar com precisão estímulos é uma característica dentro da mesma modalidade sensorial, mas outros estudos são necessários para perceber como é que uma prática intensa com o corpo pode aumentar a precisão nas modalidades sensoriais.

Palavras-chave: Dor, Interocepção, Precisão, Bailarinos

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> “The task is, not so much to see what no one has yet seen, but to think what nobody has yet thought, about that which everybody sees”
>
> Erwin Schrodinger

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1. Introduction

Pain serve as a function of preserving one's body from potential external life threats, being modulated by sensorial, emotional and cognitive aspects. It is a complex experience highly subjective and difficult to assess both in clinical and experimental settings. The high variability in reporting pain by the individual has been considered one of the reasons for the challenges that clinical trials face in discriminating between an analgesic compound and placebo (Dworkin et al., 2010). High variability in pain may predict a high placebo analgesia response in clinical trials (Treister, Eaton, Trudeau, Elder & Katz, 2017; Wager et al., 2004), but there is still limited knowledge regarding this variability occurs and why subjects differ in their ability to report pain (Quiton & Greenspan, 2008).

To address this issue a procedure named the Focused Analgesia Selection Test (FAST) was recently developed. Its main goal is to assess individuals' pain reporting skills by exposing them to thermal noxious stimuli of known intensities and ask them to rate their respective intensities. Merging these two elements, both the intensity of the stimuli and the subjective pain report to each stimulus, it is possible to measure how reliable and accurate is the subjects pain reporting. The first studies using FAST supported the claim that it measures specifically variability in pain reporting skills (Treister et al., 2017; Treister et al., 2018) yet further studies are needed in order to understand underlying mechanisms.

One of the possible explanations for the differences in pain reporting variability is that individuals more accurate in pain reporting might be more skilled in the ability to report interoception sensations, that is, "the sense of the physiological condition of the entire body" (Craig, 2003) than individuals that have lower pain report accuracy. In a recent study (Agostinho et al., under review) this line of research has been investigated. It was found that in healthy populations pain report accuracy is not related with the ability to report other bodily sensations, specifically interoception (measured by the mental tracking task, Schandry 1981) and taste (measure by a task developed similarly to FAST).

Thus, it is still unclear if in populations known for having higher awareness of their body, such as dancers, a relation between pain reporting accuracy and interoception can be found. Dancers have higher awareness of their bodies and heightened interoception accuracy (Christensen, Gaigg, & Calvo-Merino, 2018). They are also known for experiencing pain differently from non-dancers, developing strategies to overcome pain, and therefore, showing higher pain thresholds and pain tolerance (Tajet-Foxell & Rose, 1997; Tesarz, Schuster, Hartmann, Gerhardt & Eich, 2012).

Accordingly, it is still unclear if this high ability to perceive and detect body signals in dancers due to training can be generalized to different sensory modalities. The purpose of this investigation was to compare the variability in pain reporting skills using FAST and the variability in reporting other sensory modalities tasks. In other words, the main goal was to understand how dancers, known to evidence increased interoception accuracy and exposed by long-term pain, would report pain, and how that relates to accuracy in other sensory modalities such as heartbeat and taste.

2. Literature Review

Life's most fundamental basis is that it needs a constant preservation of ideal parameters, for example levels of oxygen, glucose, ion concentration or temperature to survive, and that is accomplished through the brain and his many neural pathways. It is vital the existence of brain areas that can detect and evaluate the distance of those parameters. This dynamic process is called homeostasis, accomplished through a brain's mechanism that enables a continuous track of the living organism state, integrating numerous signals from the body and thus assessing the ongoing body's state (Damasio & Carvalho, 2013). Three interdependent mechanisms, based on negative feedback, are necessary for each of their own specific parameter: The receptor, the control center and the effector. The receptor detects and sends the information, the main control centers, located in the brainstem and hypothalamus, correct the imbalance, and the effector is the target where it acts on (Cooper, 2008). Homeostasis, as a broader concept, can be found in all levels of the body, from the cellular to the autonomic, neuroendocrine and behavioral responses (Schulkin, 2004). The first theory describing the need for regulating the internal environment (*milieu interieur*) is due to Bernard in 1865 and later developed by Cannon (1926) coining the term homeostasis. Hitherto, both pain and interoception are believed to be homeostatic functions (Craig, 2003; Damásio & Carvalho, 2013).

2.1 Pain

According to Craig (2003) pain, instead of a previous thought exteroceptive sense or cutaneous sub-modality sensation, is a homeostatic emotion consisting both of a sensation and motivation reaction. It results in autonomic and behavioral responses, and generates a negative affective component, which means sensing an environmental change and consequently producing different levels of action programs. Thus, conscious experience of pain emerges from a physiological condition that subconscious homeostatic systems alone were not able to fix. Behavioral drive and cognitive function are yet other mechanisms to repair pain. For example, significant pressure against a sharp object leads, which is painful, also involves a local vasodilation, an autonomic response, and several behavioral responses, as a retraction of the affected limb, facial muscles forming an expression of pain and the attention focused on the affected body part (Damasio & Carvalho, 2013; Johansen, Fields & Manning, 2001).

Although pain is not necessarily tied to a stimulus, it usually starts as nociception which means transduction of noxious stimuli, from de peripheric nervous system to the central nervous system. First, nociceptors, the sensory receptor neurons that are sensitive to noxious or tissue-damaging stimuli trigger a response and mediate further pain processing. They also respond to chemicals released from the traumatized tissue. Nociceptors possess higher thresholds than mechanical receptors from the somatosensitive system and are divided in three main classes: Thermal, mechanical and polymodal. Mechanical nociceptors are activated by tissue-damaging mechanical stimulus; polymodal nociceptors are activated by noxious thermal or mechanical stimuli and thermal nociceptors are activated by temperatures less than about five degrees or greater than forty-five (Dubner & Gold, 1999; Fitzgerald, 2005; Waxman & Zamponi, 2014). Also, nociceptors, in contrast with mechanoreceptors, have small diameter axons, which fall into C-fiber (unmyelinated) and A-δ fibers (thinly myelinated) (Olausson, 2002). Information enters the spinal cord into Lamina I and Lamina V, and then decussates in the ventral commissure, ascending onto the brainstem, namely reticular formation and parabrachial nucleus, to several thalamus nucleus, specifically ventral posterior lateral nucleus onto primary somatic sensory cortex, ventromedial posterior nucleus onto insular cortex, and medial dorsal nucleus which projects to the cingulate cortex. Sensory processing and pain perception involve temporal summation perceived as fast short-latency (sharp pain) and a slow long-latency (burning pain) (Craig & Andrew, 2002; Vierck, Cannon, Fry, Maixner & Whitsel, 1997). Pain originating on the face is mediated through the trigeminal cranial nerve and trigeminal nucleus (Blomqvist, Zhang, & Craig, 2000; Gieslar, Nahin & Madsen, 1984; Olausson et al., 2002; Waxman & Zamponi, 2014).

This is anatomically denominated the anterolateral pathway, a collection of ascending pathways that, through the anterior portion of the lateral column of the spinal cord, travel and synapse in different brain regions. Besides pain, the anterolateral pathway also mediates temperature and itch (McHugh & McHugh, 2000; Peschanski, Kayser & Besson, 1986; Schnitzler & Ploner, 2000). Still, visceral pain is mediated by another pathway, namely, dorsal horn neurons whose axons ascend in the dorsal columns (Cervero & Connel, 1984; Cervero & Laird, 1999; Schnitzler & Ploner, 2000).

From an individual perspective, pain is considered a conscious experience, regulated by (un)conscious responses, and modulated by numerous factors such as sensory, emotional and cognitive experiences, and that eventually will influence action, learning and regulatory behaviors (Craig, 2009; Pollatos, Füstös & Critchley, 2012; Wiech & Tracey, 2013). The experience of pain is highly individual and subjective, depending on neural and behavioral responses to the painful event, i.e. identical noxious stimulus can produce vastly different and unique pain responses across individuals. Pain suppression, as a survival mechanism, relies on descending information from insula, amygdala and anterior cingulate cortex, using serotoninergic, noradrenergic and dopaminergic circuits to inhibit pain transmission through the periaqueductal gray matter and raphe nuclei (Gebhart, 2004; Suzuki, Rygh & Dickenson, 2004; Treister et al., 2009). Endogenous analgesia is, therefore, the outcome of previous circuits promoting release of endogenous opioids such as enkephalins, endorphins and dynorphins acting both in the central and peripheric nervous system (Akil, Watson, Young, Lewis, Khachaturian & Walker, 1984; Fields, 2004).

Hence, through this system, cognition and emotion modulate and bypass the experience of pain increasing tolerance and thresholds, or on the other hand, lowering it (Apkarian, Bushnell, Treede & Zubieta, 2005; Bushnell, Čeko, & Low, 2013; Craig, 2009). Accordingly, for example, negative emotions may impact the affective component of pain negatively (even though this may depend on other factors, as the arousal of this emotion, for a review Wiech & Tracey, 2013), consequently decreasing pain tolerance, and, on the other and, positive emotion can increase pain tolerance (Carter et a., 2002; Zweyer et al., 2004; Wiech, & Tracey, 2013). Likewise, it is known that expectation or anticipation of pain also enhances greatly their response and suffering (Sawamoto et al., 2000).

At pathological level this can end up in hyperalgesia, an exaggerated pain response to noxious stimuli and/or allodynia, feeling pain as a stimulus that is usually innocuous. These processes are due to peripheral sensitization and central sensitization (Sandkühler, 2009; Sommer, & Kress, 2004). Hence, chronic pain, is currently defined as a reoccurring pain, weeks or months after an experienced pain event, with no longer biological value to withstand their complaints. Likewise, pain management can be extremely difficult to deal with, both as physician and patient and, as a consequence, leads to high prevalence and burden of pain in society (Bushnell et al, 2013; Porreca, Ossipov, & Gebhart, 2002). Because pain is a personal and complex experience, mutually influenced by bottom-up and top-down information, it is a huge challenge to measure, study and treat it (Apkarian et al., 2005; Dworkin et al., 2010; Katz, 2005). Throughout the literature, pain measures rely on constructs such pain thresholds and pain tolerance using typically cold, heat or pressure tasks (Williams & Craig, 2016). These tasks depend on verbal numeric responses (Numerical Rating Scale) of the subjects, indicating pain intensity on a 10-cm line, from “no pain” to “ worst pain imaginable” (Visual Analog Scale), or even a list of adjectives to denote increasing pain intensities, such as “no pain”, “mild pain”, “moderate pain” and “severe pain” (Verbal Rating Scale) (Williamson & Hoggart, 2005). Others rely on self-report measures, as questionnaires.

After an increasing number of clinical trials in which the effect of the drugs did not differ significantly from placebo had been described, Dworkin et al., (2010) claimed that the lack of adequate pain treatments and medication may be a consequence, at least in part, of the failure of analgesic clinical trials in discriminating between effective analgesic compound and placebo, leading to low statistical power. One of the reasons for this fail is believed to be the high variability of participants’ pain scores (Harris et al., 2015), which erodes study power. Quinton & Greenspan (2008) suggests that variation in pain reports is understudied and inconsistency in pain reporting tends to be an unchangeable trait in patients with inconsistent pain reports. Although part of this variability may be caused by real pain processing characteristics such as sensory processing called true variance, another part may be due to error variance, related to any reason, including individuals’ inaccuracies in perceiving and measuring pain. In other words, accurate subjects report pain levels reliably to a similar experience, and proportionally to intensity of the stimulation. Individuals who exhibiting high pain variability may compromise the ability of clinical trial to find the true analgesics' effect (Treister et al., 2017).

As an attempt to address this issue, it was recently developed the Focused Analgesia Selection Test (FAST) . The FAST measures pain reporting skills, specifically its variability. It was developed to assess pain reporting accuracy by recording subject's pain reports in response to administration of thermal noxious stimuli of various intensities. Knowing both the intensity of the stimuli and the pain score reported by the subject in response to each stimulus, it allows the assessment of how consistent and reliable each subject is in reporting pain. FAST is not biased by peripheral habituation or sensitization and is well tolerated by individuals (Treister et al., 2017). Recent studies using FAST suggest that, in fact, subjects may differ in their pain reporting skills and that selecting good pain reporters into clinical trials can improve assay sensitivity.

In a two-stage randomized and double-blind trial in patients with painful diabetic neuropathy, Treister et al., (2018) demonstrate that in a first stage directed to training, Accurate-Pain-Report-Training group (APRT), where participants received feedback on their pain report, had lower placebo response and higher accuracy in pain reporting skills opposite to the No-Training group. Hence, it is possible that pain reporting skills might be in fact a trainable skill.

However, reasons explaining these differences on pain reporting skills are still yet to know. Since subjects previous experiences and the need to compare between noxious stimuli in pain tasks has been considered to influence pain report, authors suggest that neuropsychological factors can be related to subjects responses on pain tasks (Koyama, McHaffie, Laurienti, & Coghill, 2005; Shackman et al., 2011). Previous studies suggest a link amongst central sensitization and long-term potentiation, i.e., between pain and memory (Han, Soleiman, Soden, Zweifel, & Palmiter, 2015; Ji, Kohno, Moore, & Woolf, 2003; Price & Inyang, 2015), so it is still an open question if people under pain accuracy assessment could forget noxious stimuli easier than others and so, memory performance could explain some of these differences. Therefore, memory being a complex construct as well, it is measured through a number of test performances. One of them is through memory span, the longest list of items that a subject can reproduce in immediately correct order (Conway et al., 2005). Digit Span Task is neuropsychological measure of short-term memory which consists in reproducing a growing list of numbers previously heard, first in the same order they heard, and then repeating in inverse order. The first task requires immediate memory and the second working memory (Guerreiro, 1998). Other individual characteristics may be involved such as attention to one's body and the tendency to think about themselves (Nakamura & Chapman, 2002) or even stress (Geva & Defrin, 2018), and so, self-report measures such as Multidimensional Assessment Interoceptive Awareness (Mehling et al., 2012), Self-Consciousness Scale (Fenigstein, Scheier, & Buss, 1975), Perceived Stress Scale (Cohen, Kamarck & Mermelstein, 1994) and Hospital Anxiety and Depression Scale (Zigmong & Snaith, 1983) could help explain these differences.

2.2 Interoception

Homeostatic dynamic processes require maintenance of body's physiological parameters in optimal levels. Therefore, central nervous system continuously monitors and represent both interior and exterior environments making internal representations based in their sensorial input. Changes concerning the internal environment, like heart rate or levels of oxygen, are sensed by the interoceptive system, a collection of nerve pathways and central nervous system nuclei keen to detect and map homeostatic signals (Damasio & Carvalho, 2013). Specifically, interoceptive system gathers and integrates multisensorial signals sensed by numerous receptors in the viscera and skin, such as nociceptors, chemosensors and baroreceptors, ultimately, influencing individual's perception of body states. Thus, the brain seems to form a high order percept organization conveying into a cortical interoceptive image located mainly in the insula (Craig, 2009a).

Anatomically, there are two main pathways that carry and gather information from the viscera and internal milieu to the brain. One is Lamina I pathway, which consists of C and A-δ fibers that start from every area of the body and carry information regarding the peripheral blood pressure, muscle contraction in vessel walls, temperature, pH, tissue injury and pain (Craig, 2002; Guyenet, 2006; Sato & Schmidt, 1973; Taylor & Rachman, 1988). This pathway projects to Lamina I (posterior horn of grey matter of the spinal cord and trigeminal nucleus), and then ascends to the brainstem, namely nucleus tractus solitarius, parabrachial nucleus, main integration site for all homeostatic afferent activity, and periaqueductal grey matter. These nuclei are connected or project to cortical and subcortical structures, mainly through thalamic nuclei and to posterior insula (Craig, 1995; Farkas, Jansen, & Loewy, 1997; Herbert, Moga, & Saper, 1990; Zhang & Oppenheimer, 2000). Then, information processing is made posterior-mid-anterior insula which, ultimately, will connect to other cortical structures such as anterior cingulate cortex and orbitofrontal cortex, though some lamina I pathway fibers project directly to the insula, bypassing the brainstem (Craig, Chen, Bandy & Reiman, 2000; Craig, 2009a; Craig 2009b; Saper, 1982).

A second pathway develops through the vagus nerve carrying information from the viscera to the nucleus tractus solitarius. It projects to the parabrachial nucleus, periaqueductal gray matter and hypothalamus and, also, to the insula via thalamus (Critchley & Garfinkel, 2017; Herbert, & Saper, 1990). Still, extensive crosstalk information between vagal pathway and lamina I pathway allows the formation of integrated maps of one's body state. Besides, area postrema, a circumventricular organ, directly senses the internal milieu and projects to the nucleus tractus solitarius and superior colliculus, being a humoral pathway bypassing the blood brain barrier (Critchley & Garfinkel, 2017; Kamermans & Fahrenfort, 2004; Shapiro & Miselis, 1985).

In spite of all physiologically and anatomic studies, neurocognitive construct of interoception has changed across time, lacking a precise definition, having both a restrictive and broader meaning. The initial and more restrictive definition considers interoception as result of sensations only stemming from the viscera (Talland, 1968) and a broader and more recent definition, contemplates interoception as a measure of one's body state as a total, i.e., multimodal integration in the brain, influenced by emotion, health or well-being (Ceunen, Vlaeyen, & Van Diest, 2016; Dworkin, 2007). These two conceptualizations have wielded an extensive range of scientific areas, such as medicine and psychology, studying topics like pain (Duschek, Montoro, & Reyes Del Paso, 2015), anxiety (Paulus, & Stein 2010), emotions (Wiens, 2005; Critchley & Garfinkel, 2017), eating disorders (Pollatos et al., 2008) and decision making (Dunn et al., 2010).

How these different concepts of interoception relate to each other is still under debate, but both are being used in contemporary research (Ceunen, et al., 2016; Dworkin, 2007). Methodological approaches to measure interoception comprise the use questionnaires and behavioral tests that, either exploit natural fluctuations in internal physiological signals (Heartbeat Task) or manipulate organ physiology experimentally

(Water Load Test). Subjects appear to differ substantially on performance regarding interoceptive measures, though reasons for these differences are still yet to be understood (Ceunen, et al., 2016).

Garfinkel, Seth, Barrett, Suzuki & Critchley (2015) dissociate three forms of interoception paradigm, viz. Interoceptive Accuracy, Interoceptive Sensibility and Interoceptive Awareness. Interoceptive Accuracy is assessed via objective tests of interoceptive accuracy where two paradigms were developed: heartbeat discrimination task developed by Katkin, Reed & Deroo, (1983) and heartbeat tracking task established by Schandry, (1981). Heartbeat discrimination task involve the presentation of a periodic external stimuli, like tones or lights. Participants are asked to indicate whether this external stimulus is synchronous or asynchronous with their own heartbeat (Katkin, et al., 1983). Heartbeat tracking task requires participants to feel and count silently their own heartbeats, in rest, without any manual manipulations. This task is repeated several times on specific time windows of 10 to 60 seconds, intertwined with rest periods. At the same time, it is being monitored and recorded participant's own heartbeats. The closer the two, the greater the accuracy (Schandry, 1981). However, methodological variations of both tasks do exist (Ceunen et al., 2016). Interoceptive Sensibility is defined by the self-perceived dispositional tendency to be internally focused and interoceptively cognizant, in other words, to what extent an individual believes that he can focus and detect internal bodily sensations. This is assessed via subjective self-report measures probing perceived aptitude. One example of these measures is the Multidimensional Assessment of Interoceptive Awareness (MAIA). Interoceptive Awareness is a metacognitive awareness of interoceptive accuracy, i.e., how confident is the person on whether he is accurately or inaccurately assessing their heartbeat. (Garfinkel et al., 2015). Despite the widespread use, these methods have limitations and Kleckner, Wormwood, Simmons, Barrett & Quigley (2015) alert that there is an enhanced performance as the number of trails increase. This may suggest it could be a trainable skill as well.

Nonetheless, heartbeat tasks are not the only measures of interoception. Water Load Test is another frequently used measure (Van Dyck et al., 2016). It was first developed to induce gastric distention and to assess gastrointestinal symptoms in patients with functional digestive disorders. Water Load Test stimulate the stomach using a natural distention stimulus, the ingestion of water without the complex hormonal response of a caloric meal. However interesting, an important limitation of current use this measure concerns the lack of standardization in procedures or instructions (Jones, Hoffman, Shah, Patel & Ebert, 2003; Koch, Hong, & Xu, 2000; Van Dyck et al., 2016).

A few studies correlated both measures, heartbeat task and water load test. For example, and, although studies are scarce, Herbert, Muth, Pollatos, & Herbert, (2012) found that accurate cardioreceptive perceivers also had more accurate perception of sensations that correlates with Water Load Test. Ceunen, Van Diest & Vlaeyen (2013) remain cautious stating that for now, it is premature to generalize beyond what has been found and that is still unknown to what extent, performance in heartbeat detection correlates with other forms of interoceptive sensations. If the correlations between these tasks was true, results from the Heartbeat Tasks or Water Load Test could be considered to reflect accuracy and perception of an overall interoceptive sense. On the contrary, Ferentzi, Bogdány, Szabolcs, Csala, Horváth, & Köteles (2018) results showed that interoception cannot be a generalized feature. Authors measured multimodal interoceptive measures, such as gastric perception, heartbeat perception, proprioception, ischemic pain and, at last, taste perception where correlational analysis showed significant associations only between the same sensorial modality, which means that interoceptive information do not crossover and that information regarding one channel only cannot be possibly generalized. Hence, one of the reasons for different results on these studies concerning interoception is thought to be related with methodological differences, consequently leading to extrapolate hazards.

Growing use of taste task perception concerning interoceptive measures have been lately common to assess sensitivity and accuracy (Ceunen et al., 2016). These tasks usually require individuals to taste different flavors, typically sweet and salt, and rate their respective intensity on a scale, whether NRS or VAS. Additionally, same scales can be used to rate how pleasant or unpleasant flavors are to them, which higher levels correspond to higher subjective perceptions (Ferentzi et al., 2018; Hendi & Leshem, 2014). Taste receptor cells are epithelial cells that transduce chemical stimuli. There are four receptors, each receptor parallels to different taste qualities, namely, sweet, sour, bitter and salty, located on the tongue, palate, pharynx, larynx and epiglottis. Information is then carried ipsilaterally through facial, glossopharyngeal and vagus cranial nerves, responsible also for innervation of the gut, cardiovascular system and lugs. Hence, taste's neural system is organized towards identifying nutrients and harmful agents, in relation to particular physiological processes, such as maintaining proper energy stores, electrolyte balance, pH and avoid toxins (Bermudez-Rattoni, 2004; Dulac, 2000; Hernes & Gilbertson, 1999).

Another question that remains to be answered is the relation between these interoceptive tasks and pain perception. It is still open to debate the problem of whether the perception pain stimuli and the perception of interoceptive stimuli are correlated and on what level (neural or behaviorally) (Di Lernia, Serino & Riva, 2016). Werner, Duschek, Mattern & Schandry (2009) showed that experience of pain is not correlated with high or low interoceptive sensitivity and that there were no significant relationships between pain experience and cardiac interoceptive sensitivity. This would suggest that peripheral pain pathway is, at someway, partially independent of interoceptive sensations. Moreover, Pollatos et al., (2012) observed that healthy people, with high interoception sensitivity and accuracy measured through heartbeat detection task, demonstrated enhanced pain perception, through decreased tolerance to pain; Borg, Emond, Colson, Laurent, & Michael, (2015) based in questionnaires, found no changes in fibromyalgia patients on interoceptive sensibility. Although, Duschek, Montoro & Reyes Del Paso (2015) demonstrated that fibromyalgia patients exhibited a significantly reduced interoceptive accuracy as well as inverse correlation between interoceptive accuracy and symptoms severity. Thus, the relation between interoception and pain perception in chronic pain conditions is controversial.

2.3 Dancers

It is known that dance training, in particular long-term training, results in significant changes in body, brain function, and its structures (Calvo-Merino, Glaser, Grèzes, Passingham & Haggard, 2004; Hänggi, Koeneke, Bezzola & Jäncke, 2010). Regardless of the dancing genre, dancers are considered athletes with physical training requiring physical load embodiment, comprising numerous hours of training per week or even per day. Dance training demand both aerobic and anaerobic exercises, and similar to other sports, it involves high metabolic energy which makes nutritional and healthy lifestyle play an important optimization role to endure exercise. In addition, optimizing motor fitness skills entails development of strength, balance and flexibility essential to unnatural physical movements and wider range of movements. Flexibility allows for increased range of motion and accomplishes the aesthetic of dance. Muscular strength creates speed and force, making more powerful movement. Thus, dance requisites physical fitness, movement control and automatization as well as effortlessness, only possible through physical training. It is also worth mentioning other common features of dancers, such as competitiveness, performance anxiety and shorter life time job expectancy. Still, variation of these characteristics does happen depending on the dancing style (Ainsworth et al., 2011; Dowse, McGuigan & Harrison, 2017; Koutedakis & Jamurtas, 2004).

Just like athletes, dancers too withstand both acute and long-standing effects of intense exercise such as pain, i.e., joint displacement or induced muscular high metabolic rates. These populations develop special strategies in bearing pain, whether long or short-term. Hence, reluctance in report injuries or ignoring medical advice for rest is a common behavior of dancers mainly due to fear of losing roles or being considered unreliable. Even though it might be of a dancer's best interest to bear acute lesions, it also may lead to chronic pain and injuries on the long term. Therefore, the more common acute lesions are those by overuse, where intense training needles muscular inflammation, spine and joint displacement, or even lesions on peripheral nerves. If untreated or forced to, it may lead to chronic injuries and chronic pain (Bronner, Ojofeitimi & Spriggs, 2003; Hansen & Reed, 2006; Hincapié, Morton, & Cassidy, 2008; Jacobs et al., 2017).

Following several minutes after exercise, pain thresholds and tolerance seem to increase which suggests endogenous analgesia action (Black, Chesher, Starmer, & Egger, 1979; Koltyn, 2000). It has been described that repeated exposure to high metabolic muscular stress (noxious stimuli through inflammation) enhances muscle pain tolerance (O'Leary, Collett, Howells & Morris, 2017). Moreover, those exhibiting greater endogenous pain modulatory ability, measured by Conditioned Pain Modulation paradigms, a counter-irritation protocol, tolerate better the fatigue exercises (Flood, Waddington & Cathcart, 2017), thus explaining in part the increased tolerance to pain in dancers. Tajet-Foxell and Rose (1995) showed that professional ballet dancers endure high levels of pain, having higher levels of pain thresholds and pain tolerance using Cold Pressure Test, when compared to normal population. The main reasons are thought to be related to highly modulated emotional, motivational and cognitive aspects (Tesarz et al.,2012) granting that most studies describing the pain response of dancers were performed on ballet dancers (Smith et al., 2016).

However, a paradox seems to exist since on the long-term, pain exposure seems to alter physiological parameters differently, in form of peripheral sensitization and central sensitization, which, consequently, alter pain perception (Butha et al., 2001; Victoria & Murphy, 2016) for injuries in the post-dancing career are indeed frequent (Smith et al., 2017). To what extent perception of pain seems to be changed across time or bypassed in dancers, or athletes for that matter, it is still yet to find (Claus & MacDonald, 2017).

Professional dancer's training involves a strong focus on attention to bodily signals with multisensory integration (especially auditory-motor integration) (Koutedakis & Jamurtas, 2004). Regarding interoception, Christensen, Gaigg, & Calvo-Merino (2018) showed, for the first time, higher interoception accuracy, using heartbeat detection task, in professional dancers compared to controls. This effect was independent of difference in heartbeats or time-measure intervals. Also important, is that there was a difference in interoception accuracy between less experienced dancers compared to more experienced in favor of the latter. The reasons that can explain these differences in higher interoception accuracy are unknown, but the authors suggest that this may be related to the emotional characteristics of dancing beside its physical training. Further studies are thus needed to corroborate and better understand these findings (Christensen et al., 2018).

3. The present research

Even though it has been described a higher interoception accuracy in dancers, to the best of our knowledge there is only one study on interoception in this population (Christensen et al., 2018). To our best, there are also no studies on other modalities, such as taste. Accordingly, is yet to know if this higher accuracy is related to a higher accuracy in other bodily sensations, specifically in pain and taste. In a previous study from our lab (Agostinho, under review) it was found that that in healthy population interoception accuracy (measured by heart beat task) is not related with the accuracy in reporting pain and taste, thus supporting the claim that interoception accuracy is specific to each modality. Thus, it becomes important to ascertain whether these results sustain in population showing increased interoception ability. Therefore, the first aim of the current study was to investigate if dancers, known for their increased interoception accuracy, are also more accurate in reporting other bodily sensations, such as pain, measured by FAST procedure and taste, measured by a task analogous to FAST.

Extensive literature exists concerning pain in dancers, particularly on pain thresholds and tolerance (Tesarz et al., 2012). These studies found both higher pain thresholds and tolerance compared to healthy populations (Tajet-Foxell & Rose, 1995; Tesarz et al., 2012). However, to our best, the relationship between pain sensitivity and accuracy in dancers has never been investigated. Therefore, the second aim of this study was to investigate if there were relations between pain reporting accuracy, measured by FAST outcome measures and sensitivity to pain, measured specifically through a pain threshold and tolerance task.

Finally, the third aim of the current study is to further investigate if neuropsychological and psychological characteristics could be related to the accuracy in reporting these three bodily signals (pain, interoception task and taste task) in dancers. Granting rather extensive memory studies related to dancers with positive results, they're related to measure recall of complex non-verbal motor sequences (Stevens, Ginsborg, & Lester, 2011), spatial memory (Cortese & Rossi-Arnaud, 2010) and comparison between motor and verbal memory of specific dance choreographies (Starkes, Deakin, Lindley & Crisp, 1987). To our best no study addressed specifically short-term memory on a cognitive approach using a neuropsychological measure, digit span task. Additionally, were used four self-questionnaires, Multidimensional Assessment Interoceptive Awareness, Perceived Stress Scale, Self-Consciousness Scale and Hospital Anxiety and Depression Scale as a possible explanation for cross-modal accuracy.

4. Methods

4.1 Participants

Undergraduate and graduate dance students were recruited from the Higher School of Dance of Lisbon (Escola Superior de Dança do Instituto Superior Politécnico de Lisboa). Information regarding the study was provided orally to the students during different school activities. Those who voluntarily decided to participate and signed the informed consent were included according to the follow inclusion criteria: age above 18; absence of acute pain at the moment of evaluation or chronic pain condition; absence of psychiatry, cognitive, and /or neurological disorders; no chronic use of medications except for oral contraceptives; completion of pre-selection dance tests, including practical dance evaluations by the dance school; current ongoing attendance of the dance course; a minimal of 3 hour of dance practice per week, professionally or not (Tesarz et al., 2012). Participants were also screened for current medication for pain in the last 48 hours and on daily basis; any uncontrolled chronic medical condition (e.g., uncontrolled diabetes mellitus, unstable ischemic heart disease); persistent or severe infection, drug use with exception of contraceptives.

4.2 Tools and procedures

4.2.1 The Focused Analgesia Selection Test (FAST)

FAST is an instrument designed to assess pain reporting skills when thermal noxious stimuli of varying intensities are applied to ventral surface of the subject's non-dominant forearm (Treister et al., 2017). It uses the Medoc® Thermal Sensory Analyzer II incorporating a Peltier element-based thermode (30 x 30 mm). The subject rates the pain intensity of each stimulus on a 0-100 numerical rating scale (NRS), in which 0 means "no pain" and 100 "the worst pain imaginable". The thermal noxious stimuli were applied to ventral surface of the subject's dominant arm, for the familiarization task, and to the non-dominant forearm for the procedure. The temperature was raised from a baseline of 32°C, peaked for 3 seconds at one out of 7 determined temperatures in random order (44, 45, 46, 47, 48,49, or 50°C). Total stimulus duration was 8 seconds, intertwined with a 15 second interval. Each temperature was presented 7 times in a random block-ordered design (total of 49 stimuli) for each and every subject. The location of the thermode was adjusted every 10 stimuli to every individual to minimize sensitization and/or habituation effects. After each stimulus the subject would rate the pain intensity they perceived through the NRS. Total FAST procedure length was approximately 35 minutes.

The FAST method allows outcome measures such as R2, ICC and Mean CoV. Concerning R2 and based on regression, namely power model regression, it measures agreement (or correspondence) between actual and predicted scores, suggesting that higher scores mean greater accuracy and reliability. The ICC measures the agreement or consistency in responses to the same stimulus over several presentations independent of their order. High value for R2 and ICC denotes a high degree of reliability. Moreover, CoV is the ratio of the standard deviation to the mean, in which average or mean CoV was calculated for every individual based on total mean of every seven mean CoV, i.e., mean of all seven-temperature mean CoV's. High CoV result suggest a larger variability in individuals' reporting.

Familiarization task consisted of three stimuli, presented one time in random order between subjects, amongst three different temperatures (44, 46 and 49°C) that the subject should rate after each temperature.

4.2.2 Taste Perception Task

The Taste Perception Task is a modification of the Hendi & Leshem (2014) procedure aimed to assess the sensitivity to sweet and salty taste. In the current study this task was performed according to Agostinho et al (under review) protocol, aimed to assess the accuracy of tastes. Subjects were asked to grade 5 different concentrations for both sweet and salty taste, administered by oral sprays. Preparation of the sprays was as follows: for the most concentrated salty solution (vial 5), 37.45 g of NaCl was added to 250 cc (quarter-litter) of mineral water. For the second solution (vial 4), the first concentration was diluted by 1.5. For the third concentration (vial 3), the first solution was diluted by ratio of 1:3. The last two concentrations were diluted from the third (vial 2) and the fourth (vial 1) concentrations, by 1:3. Preparation of the sugar solution was as follows: The highest concentration (vial 5) was of 67.5 grams of sugar in 250 cc (quarter-litter) of mineral water. The further sprays were prepared by repeated dilution at a ratio of 1:2, except the second concentration (vial 4), that was prepared from the high concentration and diluted in ratio of 1:1. Mineral water with a maximum of 9mg of NaCl /L was used for both the salty and sugar solutions. Subjects were instructed to rate, for each concentration, its intensity on a NRS ranging from 0 to 100, using the 0 for "not feeling flavor" and 100 "most strong flavor", Between every spray subjects were requested to drink swallow a bit of water, therefore washing their oral cavity. These sprays were applied in pseudo-random order (excluding the subsequent stimulus intensity) and, in each experiment, the order of the test was replaced between the sweet and salty series, making it a total of 25 repetitions for each taste. Subjects also received instructions before the day of the experiment to avoid eating heavy meals drinking any beverages, with the exception of water, one hour before the test session. In accordance with FAST, the taste task outcomes were R2, ICC and CoV.

4.2.3Heartbeat detection task

The heart beat detection task measures accuracy in the perception of one's heartbeat (Schandry, 1981). The participants were asked to sit still and attend to their heartbeats counting silently, and without manually checking, in four intervals (10, 25, 35 and 45 seconds) while the equipment assessed their true heartbeat, i.e., they sat still for 6 minutes and from that point, when they heard the word "now" they counted the heart beats, and when they heard "stop" they said to the experimenter the counted number. Additionally, after each count subjects were asked to give their confidence, between 0 "no confidence" and 10 "total confidence" on their subjective heartbeat count. Scores of each subject was performed according to the following equation:

Score =1/3∑[1 – (recorded heartbeats – counted heartbeats) /recorded heartbeats]

Furthermore, participants screened physiological recording equipment to assess true heartbeat through electrocardiography, using Ag/AgCl electrodes connected to BITalino device hardware (Plux Wireless Biosignals, SA, Lisbon, Portugal) and Open Signal Software (v.2017) (Kleckner et al., 2015).

4.2.4 Heat Pain Thresholds and Tolerance

Pain thresholds and tolerance on the individual's dominant forearm were obtained with the Medoc Thermal Sensory Analyzer II . Temperature raised from 30ºC baseline and subjects were instructed to click on a PC mouse, when they would feel a minimal amount of pain, a change from 0 to 100, which the final NRS corresponded to the mean of three attempts. Likewise, between every stimulus was an interval of 15 seconds. The tolerance task consisted of a similar stimulus, but they were required to click only when they felt that they could not tolerate pain any longer, that is, once they feel that the heat reached an unbearable point. Also, Medoc TSA II has a safety measure that stops at 52ºC.

4.3 Neuropsychological assessment

4.3.1 Digit Span task

Digit Span Attention Task is a subtest of Wechsler Memory Scale, designed to assess short-term memory, which is divided in two tasks, frontward and reverse order. In the forward order, individuals were told a list of random numbers, designed by Guerreiro (1998) with growing levels of difficulty, that they have to listen and then reproduce in the same order they heard. Therefore, the first level is a list of 2 numbers and the last level a list of 9 numbers. This is a measure of immediate verbal memory. The reverse order task required listening to another list of random numbers, with the same growing difficulty, but this time they had to reproduce in the opposite order on what they heard. In each task it would be given to the individual a second chance to complete each level, with a different list, only if they missed the first. The reverse order task is a measure of working memory. Thus, this task took around 4 minutes and ended when completed or when the subjects' failed the two changes of the level. The Portuguese version of this task was validated by Guerreiro (1998).

4.4 Psychological Questionnaires

4.4.1 Sociodemographic questionnaire

Individuals were asked to complete a demographic questionnaire asking questions about their age, sex, height and weight, health condition, medication including contraceptives and consumption habits (alcohol, tobacco, or any other drugs). Subjects specified too the number of years of practice, an estimate of their hours of dancing practice per week and quantify their passion for dance.

4.4.2 Hospital Depression and Anxiety Scale

The Hospital Depression and Anxiety Scale is an instrument of brief application developed for physically ill populations. It determines the levels of depression and anxiety in individuals with no psychiatric medical condition, (Zigmond & Snaith, 1983). This instrument is composed by four-point Likert scale (0-3) with 14 items and two subscales: depression and anxiety, with seven items each. The answers are based on how the subjects felt the last seven days and takes about 2 to 5 minutes to complete. The results will form a range from 0 to 21, for each subscale with the higher score indicating higher levels of depression and anxiety. The Portuguese version of this instrument evidenced good psychometric properties and will be used (McIntyre, Pereira, Soares, Gouveia & Silva, 1999).

4.4.3 Perceived Stress Scale

Perceived Stress Scale is a psychological instrument of brief application for normal population and it measures the degree in which participants' life are considered as stressful and its impact in one's life (Cohen, Kamarck, & Mermelstein, 1983). Its questions are related to how unpredictable, uncontrollable and overloaded events are felt by the individual. This instrument has a total of 14 items, divided by 7 positive and 7 negative items, in a five-point Likert scale, with subjects' answers based on how they have been feeling throughout the last month. Higher scores indicate higher self-perceived stress. The validated Portuguese version is composed by 10 items with good psychometric measures (Trigo, Canudo, Branco & Silva, 2010).

4.4.4 Multidimensional Assessment of Interoceptive Awareness

Multidimensional Assessment of Interoceptive Awareness (MAIA) is an instrument of self-report measure of interoceptive body awareness, aimed to measure between beneficial versus maladaptive interoception attention (Mehling, et al., 2012). MAIA has a total of 33 items and 8 subscales. Each item is answered on a 6-point Likert scale, from 0 – 5, 0 meaning "never" and 5 "always". Higher total and subscale scores indicate higher levels of positive awareness. Portuguese version include 7 subscales viz. (i) Noticing: awareness of uncomfortable, comfortable and neutral bodily sensations; (ii) Not-Distracting: the tendency to not ignore or distract oneself from sensations of pain or discomfort; (iii) Not-Worrying: the tendency to not react with emotional distress or worry to sensations of pain or discomfort; (iv) Attention Regulation: the ability to sustain and control attention to bodily sensation; (v) Emotional Awareness: the awareness of the connection between bodily sensations and emotional states; (vi) Self-Regulation: the ability to regulate psychological distress by attention to bodily sensations; and (vii)

Trusting: experiencing one's body as safe and trustworthy. Moreover, the Portuguese version of this subscales revealed good psychometric properties (Machorrinho, 2017).

4.4.5 Self-Consciousness Scale

Self-Consciousness Scale aims to assess equally private self-consciousness and public self-consciousness in normal population, being private self-consciousness a tendency to introspect and examine one's inner self and feelings and, public self-consciousness, an awareness of the self as it is viewed by others (Scheier, & Carver, 1985). This instrument is composed of 23 items answered in a 5-point Liker Scale ranging from 0-4, 0 being "extremely uncharacteristic" and 4 "extremely characteristic". It has 3 subscales: private self-consciousness (10 items), public self-consciousness (7 items) and social anxiety (6 items). This instrument is validated for the Portuguese population, showing good psychometric characteristics (Neto, 1986).

4.5 Procedure

All instruments and materials were prepared prior to the participants' arrival, as well as an email sent the day before the experiment with instructions to not drink coffee, tea, or alcoholic beverages, not smoking or consume of any substance abuse, and have only a light meal two hours prior the experience . Participants arrived at the study site, specifically an office at local dance college, where explanations regarding the purpose of the study were provided and corresponding inform consent signed. Then participants completed the sociodemographic questionnaire, also designed for inclusion and exclusion criteria. Experimental tasks started with FAST procedure, namely instructions and the familiarization task, followed by FAST procedure *per se,* and then digit span task in the pause until the heat thresholds and tolerance tasks. Next, heartbeat detection task was performed, in which electrodes were placed by the participants according to researcher instructions and consequently verified. Afterward, the taste perception task was performed, first with one of the two flavors, then the remaining questionnaires as a break between the two tastes, finishing with the remaining flavor; salt or sugar first was performed randomly between subjects. Each participant received a code number, which was used along the data analysis. The results and the documents derived from this study were analyzed for the total cohort without any mention to one's identification. For each participant, there was an estimate time of one hour and a half.

4.6 Statistical Analyses

Data was collected and processed via Excel (Microsoft Corp, Redmond, WA, USA), and was analyzed by using the SPSS software version 24 (SPSS, Inc., Chicago, IL, USA). Descriptive statistics were used to present demographic and baseline characteristics. Since data failed normality tests regarding ANOVA repeated measures, it was analyzed with nonparametric tests. Friedman's tests (followed by Wilcoxon post hoc test, when applicable) used to assess differences in pain and taste (sugar and salt) scores. Spearman's correlations were used to assess relations between the accuracy tasks (FAST and taste) and interoception tasks, as well associations with pain-related psychological questionnaires. Statistical significance is defined as $P \leq 0.05$.

5. Results

Participants demographic characterization

Thirty-three undergraduate and graduate students (twenty-six women) from a local dance university, aged between 18 and 24 (*M*=19.67; *SD*=2.03) with 3 to 18 years of dance practice (*M*=11.12; *SD*=3.83). Demographic data from the study population can be found in table 1.

Table 1.

Demographic Characterization of the study population (n=33)

	Mean	Frequency (%)	Minimum	Maximum
Age	19.67±2.03		18	24
Body Mass Index	20.85±1.78		17.48	25.18
Years of Practice	11.12±3.83		3	11
Passion for Dance	90.58±9.08		70	100
Sex				
Female		26 (79%)		
Male		7 (21%)		
Education				
High School		25 (76%)		
Graduate		8 (24%)		

Pain Assessment

Pain Accuracy

FAST Mean pain scores

Descriptive statistics of mean pain intensity of each FAST temperature is shown in graphic 1. Mean pain scores ranged from *M*=7.04 and *SD*=5.84 for 44ºC, the lowest intensity stimulus, to *M*=59.29 and *SD*=25.36 for the 50 ºC, the highest intensity stimulus.

Friedman Test revealed significant statistical differences between participants scores given to different stimuli intensities (Friedman, χ^2= 177.74, P=0.000). Additionally, Post hoc Wilcoxon test showed significant differences amongst scores of each stimuli intensity, specifically between temperature 44 ºC and 45 ºC (Z= -3.622; P=0.00), 45 ºC and 46 ºC (Z= -2.244; P=0.025) 46 ºC and 47 ºC (Z= -3.539; P=0.00), 47 ºC and 48 ºC

(Z= -4.021; P=0.00), 48 ºC and 49 ºC (Z= -4.798; P=0.00) and, at last, between 49 ºC and 50 ºC (Z= -5.013; P=0.00).

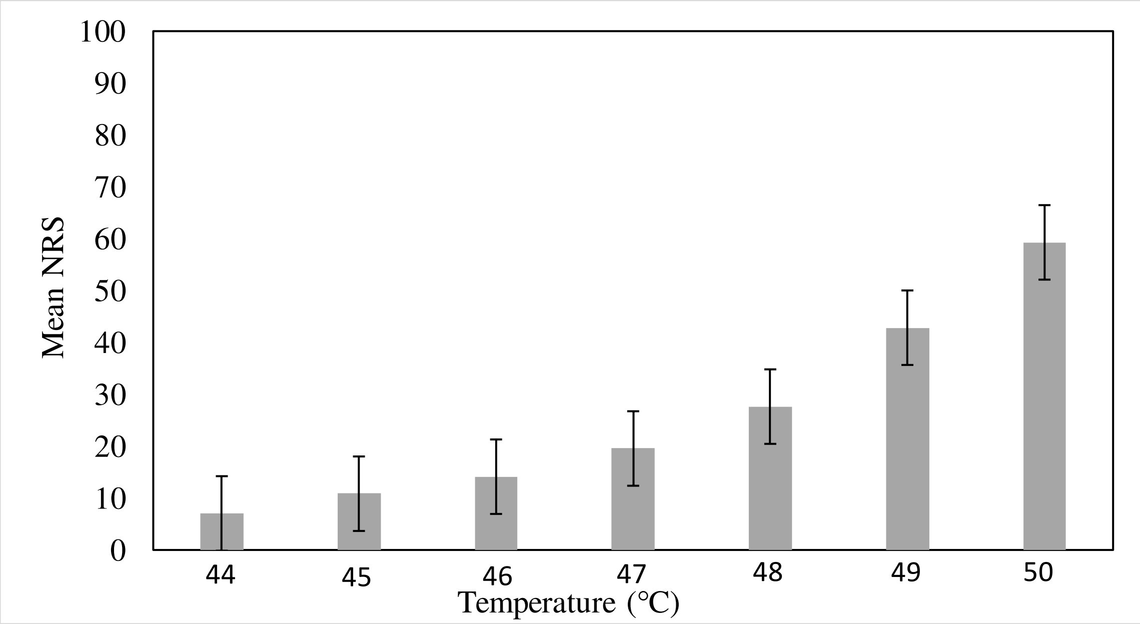

Figure 1: Graphic bars of mean and standard deviation of pain scores (NPR) in response to each FAST stimulus temperature.

FAST Outcome measures

FAST outcome measures can be found in table 2. R2 had an average *M*=0.493 with a *SD*= 0.130, including a minimum of 0.286 and a top of 0.702. Moreover, ICC had an average score of *M*=0.687 and *SD*=0.097 with a minimal score of 0.502 and a maximal of 0.822. Finally, CoV had a mean score of *M*=0.751 with *SD*=0.305, and a lowest score of 0.275 and a highest score of 1.479.

Table 2.

FAST Outcome measures

	R2	ICC	CoV
Mean (SD)	0.493 (0.130)	0.687 (0.097)	0.751 (0.305)
Median	0.494	0.703	0.714
Minimum	0.286	0.502	0.275
Maximum	0.702	0.822	1.479

Pain sensitivity

Descriptive statistics on pain sensitivity measures can be found in table 3. Mean thresholds revealed a minimum of 36ºC temperature and a maximum of 51 with an average threshold temperature of *M*= 45.24ºC and *SD*=3.42 for the least amount of pain. Furthermore, tolerance revealed a mean temperature of *M*= 49.05 and a *SD*=5.34 with a minimal tolerance of 48.8 and a maximal of 52ºC.

Table 3.
Descriptive Statistics of Pain Sensitivity Measures (mean heat pain threshold and mean heat pain tolerance).

	Heat Pain Thresholds (°C)	Heat Pain Tolerance (°C)
Mean (SD)	45.24 (3.42)	50.41 (0.90)
Median	46.33	50
Minimum	36.0	48.8
Maximum	51.0	52.0

Taste Task

Mean taste scores

Descriptive Statistics of mean salt and sugar intensities are depicted in graphic 2. Mean taste intensities ratings for salt ranged from *M*=1.04 and *SD*=2.37 concerning the lowest intensity stimuli to *M*=35.60 with *SD*= 18.32 for the highest intensity stimuli. Friedman Test revealed significant statistical differences between mean intensity ratings for different salt stimuli intensities (Friedman, χ^2= 198.93, P=0.000). Furthermore, post hoc Wilcoxon test showed significant differences amongst all mean intensities scores, specifically between Salt 1 and Salt 2 (Z= -4.93; P=0.00), Salt 2 and Salt 3 (Z= -5.01; P=0.00) Salt 3 and Salt 4 (Z= -4.096; P=0.00), and finally Salt 4 and Salt 5 (Z= -5.013; P=0.00).

Sugar descriptive statistics are presented in graphic 2 . Sugar 1 had a mean intensity score of *M*=1.62 and *SD*= 3.60 and Sugar 5 a mean of *M*=35.88 and *SD*=21.03. Friedman Test showed significant differences between each stimuli intensities (Friedman, χ^2= 120.63, P=0.000), and post hoc Wilcoxon test showed significant differences amid all intensities scores, specifically, between Sugar 1 and Sugar 2 (Z= -3.51; P=0.00), Sugar 2 and Sugar 3 (Z= -4.58; P=0.00) Sugar 3 and 4 (Z= -4.42; P=0.00), and, finally, Sugar 4 and Sugar 5 (Z= -4.87; P=0.00). Thus, higher sugar concentrations lead to higher mean intensities scores and the differences between them are significant.

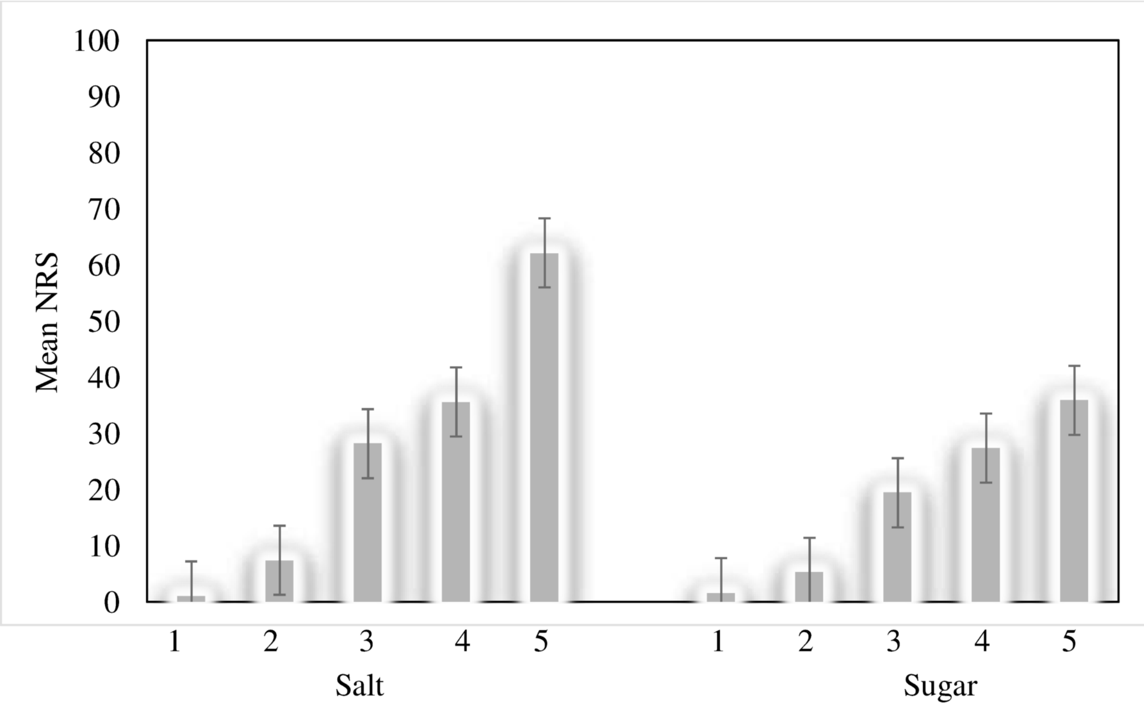

Figure 2: Graphic bars of mean and standard deviation for mean taste scores (NRS) for each salt and sugar intensities.

Taste Outcome measures

The outcome measures of salt and sugar taste task can be found in table 6.

Table 4.

Salt and sugar Outcome measures

Salt	R2	ICC	CoV
Mean (SD)	0.737 (0.174)	0.866 (0.091)	0.484 (0.243)
Median	0.805	0.877	0.418
Minimum	0.132	0.598	0.159
Maximum	0.928	0.984	1.059
Sugar	R2	ICC	CoV
Mean (SD)	0.648 (0.193)	0.740 (0.185)	0.661 (0.238)
Median	737	0.782	0.606

Minimum	0.135	0.338	0.232
Maximum	0.878	0.934	1.250

Interoception

Heart beat detection task

The overall result of Interoception accuracy task are presented in table 4. The mean heartbeat detection score was *M*=0.422 and *SD*=0.316, with a lowest score of 0 and a highest score of 0.993. Thus, these results suggest a high variability of subjects scores in response to this task.

Table 5.
Descriptive statistics of the Heart beat detection task scores

	Mean ±SD	Minimum	Maximum
Interoception Score	0.422±0.316	0.000	0.993

Neuropsychological task

Digit Span

Average scores of Digit Span task can be found in table 7.

Table 6.
Digit Span Task

	Mean ± SD	Minimum	Maximum
Direct Order	5.76± 0.83	4	7
Inverse Order	4.61± 1.01	2	7
Total	10.36± 1.64	7	14

Psychological Questionnaires

Descriptive statistics of the scales and subscales used to assess psychological characteristics can be found in table 8.

Table 7.

Descriptive Statistics of the Questionnaires scores

	Mean ±SD	Minimum	Maximum
HADS			
Anxiety Subscale	10.12 ± 3.97	2	19
Depression Subscale	5.18 ± 2.65	1	11
Total	15.30 ± 5.10	4	24
Perceived Stress Scale	22.33± 3.23	15	29
MAIA			
Noticing subscale	11.97 ± 2.186	5	15
Not Distracting subscale	5.06 ± 4.394	0	17
Not Worrying subscale	11.91 ± 3.565	4	18
Attention Regulation subscale	24.09 ±5.288	15	33
Emotional Awareness subscale	20.30± 3.729	11	25
Self-Regulation subscale	9.12 ±3.130	2	15
Trusting	11.33 ±2.146	6	15
Self-Consciousness Scale			
Private Consciousness	28.70± 2.65	15	40
Public Consciousness	20.39± 4.690	12	27
Social Anxiety	12.70± 5.682	1	23
Total	61.79± 8.302	43	77

Correlations between pain reporting accuracy and accuracy in other modalities

Positive correlations were found between FAST CoV and Sugar CoV (Spearman's r=0.356, P=0.042), meaning that those more accurate in pain reporting were more accurate in the sugar task. Correlations between Interoception, measured by the heartbeat detection task and FAST outcomes were not found, as well as between Interoception and taste task outcomes.

Correlations within the same modality

There were positive correlations between ICC of Salt and Sugar (Spearman's r=0.508, P=0.003), meaning that those more accurate in reporting salty intensities were also more accurate in reporting sugar intensities. No other correlations were found in the other outcome measures.

Correlations between FAST and pain sensitivity

No correlations were found between FAST outcome measures and both pain thresholds and tolerance, i.e., between mean heat pain threshold and R2 (r= -0.212, P=0.253), ICC (r=0.273, P=0.125) and CoV (r= -0.93, P=0.606) nor between heat pain tolerance and correspondingly FAST measures (R2, r= -0.175, P=0.346; ICC, r=0.285, P=0.108; CoV r=0.017, P=0.924).

Correlations between interoception and pain sensitivity

There was an inverse correlation between interoception and mean pain thresholds (Spearman's r= -0.396, P=0.023), which means that subjects with high interoception accuracy had lower heat pain threshold. There were no correlations between between interoception accuracy and pain tolerance (Spearman's r= -0.319, P=0.070).

Correlations between FAST and neuropsychological tasks

There was a positive correlation between inverse digit span and CoV (Spearman's r=0.364, P=0.037). Thus, subjects with higher performance on this memory task had higher pain reporting ability. No other significant correlations were found between this digit span task measures and the other two sensorial modalities (taste and interoception).

Correlations between accuracy and dance experience

Years of dance practice correlated with FAST measure ICC (Spearman's r=0.447, P=0.009). Those with more years of dance experience had higher pain reporting accuracy. Years of dance practice did not correlate with mean thresholds (Spearman's r= -0.073, P=0.685) or pain tolerance (Spearman's r= 0.106, P=0.559). However, positive correlations were found between passion for dance and pain threshold (Spearman's

Spearman's r=0.358, P=0.041). No other correlations were found between dance experience and accuracy and pain sensitivity tasks.

Correlations between outcomes and psychological characteristics

There was a significant correlation between SCC Social Anxiety subscale and salt outcome measures, R2 (Spearman's r=0.351, P= 0.045), ICC (Spearman's r=0.381, P=0.029) and CoV (Spearman's r= -0.492, P=0.04). Thus, the higher the social anxiety the more accurate in perceiving salt intensities. No other correlations were found between SCC and HADS and other task outcome.

Still, MAIA questionnaire correlated in one subscale with FAST Outcome measures, Attention Regulation with FAST CoV, (Spearman's r=0.392, P=0.024). Furthermore, Not Distracting MAIA Subscale correlated with taste task outcome measures, specifically a negative correlation with ICC in salt (Spearman's r= -0.354, P=0.043), which means higher the distraction, lower the accuracy. We also found a positive correlation with CoV (Spearman's r=0.419, P=0.015) from salt, that means higher levels of distraction, higher the variability in subject's accuracy . In terms of sugar, it was found positive correlations, namely R2 (Spearman's r=0.411, P=0.019), meaning higher levels of distraction, higher precision in regression models, and ICC (Spearman's r=0.350, P= 0.046) which means higher levels of distraction, higher values for accuracy. No other correlations were found.

6. Discussion

The present thesis investigated the relation between pain reporting accuracy and the ability to accurately report other bodily sensations in dancers. The main results indicated that similarly to what was found in non-dancers (Agostinho et al, under review), reporting accuracy was correlated within modality but not amongst pain and interoception i.e., there were no correlation amongst pain accuracy and interoception accuracy thus corroborating the evidence previously described. However, differently from the previous study, relations were found between pain reporting accuracy and reporting accuracy in the sweet taste task in dancers.

Relations between pain reporting accuracy and accuracy in reporting other modalities

To our best, this was the second study using FAST procedure, as a measure of pain reporting accuracy, and its relations with reporting accuracy on other sensorial modalities, and the first study on dancers. Confirming previous findings on non-dancers, the current results evidence similar FAST and taste outcome measures . Again, the within modality correlations in taste task were further confirmed, but between modalities, the correlation found between FAST CoV and Sugar CoV in the present thesis is a new finding. This might suggest that eventually due to training in perceiving body signals, there may be a cross modality effect, that is, a tendency to generalize the ability to be accurate in one modality to others sensory modalities. Besides, correlation between pain reporting accuracy (FAST ICC outcome) and years of dance practice may suggest that exposure to long-term dance practice may be indeed a key factor on pain accuracy in dancers. Whether pain or exercise are the most preponderant factor, it remains to be determined in further studies.

Thus, in accordance to Ferentzi et al., (2018) pain reporting accuracy and accuracy in reporting interoception, measured by the heartbeat task, are not related in the current study. Even though Ferentzi used the same heartbeat task as an interoception measure, pain and taste tasks used were different from the tasks used in our study.

Despite of dancers have been previously described has having higher interoception accuracy (Christesen 2018) and increased experience in perceiving their body (ref dos estudos da componente fisica), this study presents accumulating evidence that pain and interoception, although sharing anatomical evidence, do not evidence shared reporting accuracy abilities. Thus, pain and interoception reporting accuracy does not overlap and a cannot be generalized or inferred from each other, thus being process independently. Consequently, we believe that the general use of heartbeat detection task may be more exactly considered a measure of cardiovascular perception and not as an overall measure of interoception accuracy

Different cross-modal accuracy results suggest that different modalities seem to evolve different significance and function from the viewpoint of survival (Ferentzi, et al., 2018). Thus, how a multisensorial integration occurs, how accuracy is processed and perceived by the individuals, and in which tasks could be the best to capture this information is unknown. Although tasks are performed on a conscious level, a possible explanation for the lack of relations between modalities could be in part related to the fact that sensory systems, registering body state changes, are not always accessible to consciousness (Bechara, Damasio, Tranel & Damasio, 1997). It is worth bear in mind that the absence of evidence concerning a general interoceptive ability does not withdrawal the importance of these different interoception tasks individually, for each could be important in particular disease studies, for example, Heartbeat Detection for anxiety (Domschke, Stevens, Pfleiderer & Gerlach, 2010) or Water Load Test for gastric disorders (Jones et al., 2003). Therefore, neural substrate that frames the conscious experience of different sensorial modalities and to what extent pain reporting accuracy and accuracy in reporting other sensorial modalities could be modified by experience or enhanced is still open to discussion.

Relations between pain reporting accuracy and sensitivity to pain

According to the second aim of the study, we aimed to measure the relation between the newly developed pain reporting accuracy measure (FAST) and the well-established pain sensitivity measures, i.e., pain thresholds and tolerance. No correlations were found between pain thresholds and tolerance and any FAST outcome. In spite of pain sensitivity have been well studied in dancers, with studies corroborating higher thresholds and tolerance compared to normal population, no study has yet investigated pain accuracy using FAST. Further studies are therefore required to compare the pain reporting accuracy in dancers with control populations to fully understand specificities of pain accuracy and sensitivity in dancers comparing to non-dancers. Interestingly, passion for dance correlated with heat pain thresholds, suggesting that dancers with higher passion show increase pain thresholds. Akehurst & Oliver (2014) and Rip, Fortin, & Vallerand (2006) found that obsessive, instead of harmonious passion for dance, could be a risk factor for increased acute and chronic injuries. Thus, it seems that higher pain thresholds found on this population in the current studies and others (Tajet-Foxell & Rose, 1995) might be in part related to cognitive-emotional factors that modulate pain perception, but also change in peripheral nociception processes. Nevertheless, to our knowledge no study investigated directly pain sensitivity and passion for dance and the absence of correlations with the current heat pain tolerance task deserves further investigation.

Additionally, it was also investigated the relation between interoception and pain sensitivity. It was found that higher interoception accuracy correlates with lower pain thresholds. The relations between interoception and pain have been preciously studied and Pollatos et al., (2012) reported that on healthy populations the higher the accuracy the lower the pain tolerance. Thus, differences in pain sensitivity measures were found that may be explained through methodologic differences, namely in pain, since Pollatos et al (2012) measured pain using pressure noxious stimuli and not thermal noxious stimuli. Also, instead of one trial of pain tolerance, authors used three trials for both pain thresholds and tolerance. Likewise, Weiss et al., (2014) found using pressure noxious stimuli the same inverse correlations for both pain thresholds and tolerance with interoception accuracy in control group, which did not apply for multisomatoform disorder. Hence, generally speaking, the current study found similar results between interoception accuracy and pain sensitivity in dancers, as previously reported in non-dancers.

Relations between accuracy and neuropsychological and psychological characteristics

The third goal of the present thesis sought to study neuropsychological and psychological factors underlying mechanisms for accuracy across sensorial modalities. The neuropsychological working memory task was related to pain accuracy. This result suggests that in dancers, besides enhanced memory for choreography and spatial memory reported (Stevens, Ginsborg & Lester, 2011; Cortese & Rossi-Arnaud, 2010), memory could be a factor related to pain accuracy. One might speculate that the ability to compare and remember previous pain stimulus while receiving other pain stimulus, may have an influence in the pain rating that the subject will report. Whether just working memory or other types of memory play a role, it is yet to be determined requiring further studies to address it.

Psychological factors that could explain accuracy on different sensorial modalities, were also investigated. Results from the Social Anxiety subscale of the Self-Consciousness Scale were related with accuracy to perceive salt intensities. This particular subscale measures how stressful the individual feels in public or perceives social situations as stressful. Since stress modulates appetite through the autonomic nervous system (Greeno & Wing, 1994), Ileri-Gurel, Pehlivanoglu, & Dogan (2012) found that thresholds for sweet and salty tastes are modulated during stressful conditions, i.e., stress was associated to a lower threshold for taste stimuli. Similarly, Platte, Herbert, Pauli & Breslin (2013) found that sweet and bitter stimuli were rated as more intensive by anxious individuals compared to depressed individuals and non-depressed or non-anxious subjects. These studies are aligned with the current findings. However, the lack of relations between Perceived Stress Scale and taste task, or other modalities, suggest that social stress and not stress in general may be the key factor behind the relations found. In line with previous findings in non-dancers, Depression and Anxiety levels, measured by HADS were also not related to reporting accuracy in dancers.

Furthermore, one MAIA subscale correlated with FAST outcome measures, namely Attention Regulation. Attention Regulation is a subscale that represents one's capacity of control and sustain attention to the body, when facing numerous sensory stimuli competing for attention. Thus, the higher subject thinks they're in control on focusing attention towards their own body, the lower the accuracy in pain reporting. Furthermore, Not Distracting subscale correlated inversely with salt reporting accuracy, which seems to suggest that the higher subjects believed that they are not distracted by noxious stimuli or discomfort, the lower the accuracy in reporting salt intensities. Opposite relations were found between Not Distracting subscale and sugar accuracy measures. Overall there are no consistent pattern of relations that could explain satisfactorily mechanisms in accuracy. Hence, factors that determine the ability to report accurately in different sensorial modalities are still under debate and demands further extensive studies.

Limitations

The current study has also limitations that should be addressed in further studies. The recruited sample, even though having a high number of years of dance practice, is not a professional dancers sample, known to have far more experience and hours of training. A recently published study of interoception in dancers (Christensen et al., 2018) also found that those with increased years of experience had better results in the interoception task than the junior dancers. Studying populations with higher practice could have provided increased support for the relations reporting accuracy between modalities. Moreover, the participants of the current study are younger in age and are only beginning in intensive dance training. Another limitation of the current study is the small sample size and the lack of a control non-dancer group, sought to compare differences between baseline scores and correlations between the study tasks. Another issue that increases the difficulties in comparing accuracy is that the heartbeat detection task is not analogous to FAST procedure and taste task, and accordingly, does not allow the same outcome measures. To overcome this limitation using a similar task for cardiovascular detection could thus add new insights on these relations.

Future research directions

Studying the same relations on professional dancers should be the next step of the current study. Also, the use of a control non-dancer group would allow further comparisons that might elucidate better distinctive features between dancers and normal population. Because certain special features seem to modulate pain perception, it should be also studied and compared the results on dancers and other sports practices. This could allow for further knowledge about which motivational or physical features of the training are related to the changes in pain sensitivity and accuracy. Concerning factors behind reporting accuracy in different sensorial modalities our results indicate the need of a detailed study of cognitive mechanisms, that could help explain these differences. Therefore, studying other cognitive factors such attention and how they interact with sensorial input could help elucidate pain reporting accuracy mechanisms. Likewise, other psychological and emotional factors particularly related to social experiences could also help to understand reporting accuracy.

Conclusions

Taken together, our results show evidence that there are relations between pain reporting accuracy within the same sensory modality and that there is tendency for an increase in the relations between pain reporting accuracy and accuracy to report other bodily sensations in dancers with more years of dance experience. However, these relations are not found between pain and interoception reporting accuracy, measured by the heartbeat detection task. In addition, the current study found that pain reporting accuracy is not related with pain sensitivity. Finally, neuropsychological memory findings highlight the need of further investigation of neuropsychological mechanisms involved in reporting accuracy skills. Relations between reporting accuracy and psychological characteristics do not show a pattern of consistent correlations but provides insights for future studies. Overall, evidence shown in the present study seem to unveil a tendency, compared to healthy population, to a general increase in reporting accuracy in populations with higher experience of their body signals.

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APÊNCIDES

CATÓLICA
CIIS - CENTRO DE INVESTIGAÇÃO INTERDISCIPLINAR EM SAÚDE

CIIS | CENTRO DE INVESTIGAÇÃO INTERDISCIPLINAR EM SAÚDE

CONSENTIMENTO INFORMADO PARA PARTICIPAR NO ESTUDO

Relação entre a precisão de avaliação da dor e precisão na avaliação de estímulos de outras modalidades sensoriais

O presente estudo enquadra-se no projeto de Mestrado em Neuropsicologia pelo Instituto de Ciências da Saúde da Universidade Católica Portuguesa do licenciado Diogo Mendonça, sob a orientação científica da Profª Dra. Rita Canaipa do Centro de Investigação Interdisciplinar em Saúde do Instituto de Ciências da Saúde da Universidade Católica Portuguesa e do Prof. Dr. Roi Treister da Universidade de Haifa.

A sua participação neste estudo é inteiramente voluntária. A seguinte informação deve ser lida com atenção e pode colocar questões sobre aquilo que não entender, antes de decidir se participa ou não neste estudo.

Objetivos do Estudo

Este estudo tem como objetivo compreender os mecanismos de avaliação da dor em bailarinos. É sabido que a avaliação da dor é muito subjetiva e que os estudos para desenvolver novos medicamentos e terapias têm dificuldade em compreender se as pessoas realmente conseguem revelar a dor que sentem. De igual forma, é sabido que bailarinos apresentam registos fisiológicos, como a perceção da dor, de forma diferente das outras pessoas. Este estudo tem, por isso, como objetivo, compreender de que forma esta população específica avalia a dor, e se isso se relaciona com dificuldades na utilização das escalas de medição ou de particularidades na sua sensibilidade à dor noutras tarefas que não envolvem dor, como a frequência cardíaca e avaliação do paladar.

Procedimentos

Numa primeira fase, verificaremos se preenche todos os critérios clínicos necessários para a participação no estudo e pediremos a sua colaboração no preenchimento de alguns questionários que avaliam questões relacionadas com os seus hábitos de saúde e as suas emoções. Serão eles, um questionário sociodemográfico, a Escala Hospitalar de Depressão e Ansiedade, a Escala de Stress Percebido, Escala de Consciência de Si Próprio e Avaliação multidimensional da consciência interoceptiva. Faremos ainda uma rápida tarefa de memória. Depois ser-lhe-á pedido que participe em três tarefas. Uma tarefa envolve a avaliação da dor. Ser-lhe-ão aplicados estímulos térmicos de intensidade variável no seu braço, mas sempre em níveis adaptados à sua sensibilidade e considerados moderados, estímulos esses que deverá avaliar tendo em conta a intensidade que sentiu. A outra tarefa envolve a estimativa do seu batimento cardíaco, enquanto este é medido também por um medidor de cardiofrequência. Por fim, a última tarefa envolverá a avaliação do paladar, pela administração de soluções salinas e doces através de sprays.

Todos os estímulos aplicados durante o estudo terão intensidades variáveis, mas serão no máximo de dor moderada, **nunca atingindo níveis de dor intensa**. Estes estímulos são seguros, não implicando qualquer dano nos tecidos nem quaisquer consequências físicas ou emocionais a longo prazo**. PODERÁ PARAR A ESTIMULAÇÃO ASSIM QUE O ENTENDA**.

Interrupção da sua participação pelo investigador

Os investigadores podem ser forçados a interromper a sua participação neste estudo. Tal poderá acontecer se alguns procedimentos não se realizarem adequadamente, ou devido a inadequações das suas características, por razões de segurança ou por outras razões relevantes para o seu bem-estar ou para o bom desenvolvimento do projeto de investigação. Contudo, será sempre informado se essa situação se colocar.

Benefícios previstos do projeto de investigação

Este estudo pretende ajudar a esclarecer de que forma as pessoas avaliam a sua dor. Nesse sentido, os resultados obtidos poderão trazer informação importantes para estudos futuros que procurem desenvolver e testar novas terapias para o tratamento da dor. Todavia, não são esperados quer benefícios diretos ao seu estado de saúde, quer consequências negativas para bem-estar físico ou psicológico.

Privacidade e Confidencialidade

As únicas pessoas que terão acesso à informação que nos fornecer serão os membros de investigação. Contudo, um código numérico ser-lhe-á atribuído para proteger a sua privacidade. Nenhuma informação sobre si será facultada a qualquer outra pessoa se não assinar consentimento escrito para tal.

Os dados serão analisados em conjunto para todos os participantes do estudo. Quando os resultados deste projeto de investigação forem publicados ou apresentados em conferências, não será fornecida qualquer informação que possa revelar a sua identidade.

Participação e desistência

A sua participação neste estudo em inteiramente **VOLUNTÁRIA**. Escolher participar ou não neste estudo não altera a sua relação com os investigadores nem com as instituições participantes. Se decidir participar poderá, no entanto, retirar o seu consentimento e desistir dessa participação em qualquer fase do estudo sem que tais relações se alterem.

Novos dados

Durante o curso do estudo será informado caso surjam novos dados que alterem os riscos ou benefícios da participação neste estudo e que, por consequência, possam implicar alterações na sua decisão sobre a participação neste projeto. Se tal ocorrer, ser-lhe-á pedido novo consentimento informado.

Identificação dos investigadores

Caso tenha alguma dúvida relacionada com o estudo ou necessite de entrar em contacto com os investigadores poderá fazê-lo para:

Lic. Diogo Manuel Garanito Mendonça diogogaranito@hotmail.com ou pelo telemóvel 964775378

Prof. Dra. Rita Canaipa rita.canaipa@ics.lisboa.ucp.pt ou pelo telemóvel 966538648.

Assinatura do participante da investigação

Declaro que eu,____(nome) com o número de identificação ______________________________________ li e compreendi a informação relativa ao projeto de investigação acima. Foi-me dada a oportunidade de colocar questões, as quais foram devidamente esclarecidas. Foi-me dada uma cópia deste documento.

AO ASSINAR ESTE DOCUMENTO ASSUMO ACEITAR PARTICIPAR VOLUNTARIAMENTE NO ESTUDO NELE DESCRITO.

Assinatura:____

Data: ________________________________

Assinatura do investigador

Expliquei o estudo ao participante e respondi a todas as suas questões. Considero que compreende a informação apresentada neste documento e consente livremente participar neste estudo.

____ (nome do investigador)

Assinatura: ____

Data: ________________________________

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Questionário Sócio Demográfico

ID: __

Sexo

☐ Masculino

☐ Feminino

Idade: ____________________

Altura:____________________

Peso actual:_______________

Estado civil:

☐ Solteiro
☐ Casado
☐ Casado ou viver em união de facto
☐ Separado ou Divorciado
☐ Viúvo

Qual o grau de ensino que completou?
Escolaridade: ☐nenhum ☐4ºano ☐6ºano ☐9ºano ☐12ºano ☐Licenciatura ☐Mestrado

Indique a data da sua última menstruação.____________________________________

Medicação tomada nas últimas 48h. ____

Medicação que toma habitualmente.____

<u>Estilo de vida</u>

Consome bebidas com cafeína (p.e. café, refrigerantes como coca-cola)?

☐ Sim
☐ Não

Se respondeu sim, quantas chávenas/copos toma por dia? ____________________
Quantas chávenas/copos consumiu nas últimas 48h? ________________________

Consome bebidas com teofilina e/ou bebidas energéticas (p.e. chá; red bull)?

☐ Sim
☐ Não

Se respondeu sim, quantas chávenas/copos toma por dia? ________________________
Quantas chávenas/copos consumiu nas últimas 48h? ________________________

Consome bebidas alcoólicas?

☐ Sim
☐ Não

Se respondeu sim, quantos copos toma por dia? ________________________
Quantos copos consumiu nas últimas 48h? ________________________

Fuma?

☐ Sim
☐ Não

Se respondeu sim, quantos cigarros fuma por dia? ________________________
Quantos cigarros fumou nas últimas 48h? ________________________

Consome drogas recreativas?

☐ Sim
☐ Não

Se respondeu sim, quantos consumos faz por semana? ________________________
Quantos consumos fez nas últimas 48h? ________________________

Faz exercício físico com regularidade?

☐ Sim
☐ Não

Se sim, quantas vezes por semana? ________________________
Qual a duraçãode cada sessão/treino? ________________________
Quantas horas de exercício físico fez nas últimas 48h? ________________________

É predominantemente

☐ Dextro
☐ Canhoto

Acontecimentos prévios que tenham resultado em queimaduras severas?

____

Historia de dor crónica?

____

Numa escala de 0 a 100, com que paixão vive a dança? Sendo 0 nenhuma e 100 entrega total.

______

Tester name: Subject name: Date: Subjects no.:

רצף A

Pain Assessment - TSA

Training Phase - TSA:

Familiarization – TSA:

Temperature	46.5°C	44°C	48°C
NPS			

FAST:

°C	NPS	°C	NPS	°C	NPS	°C	NPS	°C	NPS

Placebo Tonic pain I – TSA:

Chosen temperature (°C)	44°C			46.5°C			48°C		
	Pain 20			Pain 40			Pain 80		
Time (sec)	19	12	2	19	12	2	19	12	2
NPS									

Escala de Stress Percebido

As perguntas incluídas nesta escala referem-se aos seus sentimentos e pensamentos durante o último mês. Em cada caso, por favor indique com que frequência se sentiu ou pensou de uma certa maneira.

	Nunca 0	Quase Nunca 1	Às vezes 2	Com alguma frequência 3	Muito frequentemente 4
No último mês, com que frequência se sentiu perturbado por causa de qualquer coisa que aconteceu inesperadamente?					
No último mês, com que frequência se sentiu incapaz de controlar as coisas importantes na sua vida?					
No último mês, com que frequência se sentiu nervoso ou “stressado”?					
No último mês, com que frequência se sentiu confiante na sua capacidade para lidar com os seus problemas pessoais?					
No último mês, com que frequência sentiu que as coisas corriam a seu favor?					
No último mês, com que frequência sentiu que não conseguia lidar com todas as coisas que tinha de fazer?					

	Nunca 0	Quase Nunca 1	Às vezes 2	Com alguma frequência 3	Muito frequentemente 4
No último mês, com que frequência se sentiu capaz de controlar as irritações na sua vida?					
No último mês, com que frequência sentiu que dominava a situação?					
No último mês, com que frequência se sentiu irritado por causa de coisas que estavam fora do seu controlo?					
No último mês, com que frequência sentiu que as dificuldades se acumulavam de tal modo que não conseguia ultrapassá-las?					

Hospital Anxiety and Depression Scale

Os profissionais de saúde sabem que as emoções desempenham um papel importante na maior parte das doenças. Se o seu profissional de saúde souber acerca destes sentimentos poderá ajuda-lo melhor. Este questionário visa ajudar o seu profissional de saúde a saber como se sente. Leia cada frase e indique a resposta que mais se aproxima da forma como se tem sentido na última semana. Não passe muito tempo com cada resposta; a sua reacção imediata a cada uma das frases será provavelmente mais exacta do que uma resposta em que tenha pensado muito tempo. **Faça apenas uma cruz em cada resposta**

1. Sinto-me tenso(a):
A maior parte das vezes ☐
Muitas vezes ☐
De vez em quando, ocasionalmente ☐
Nunca ☐

2. Ainda gosto das coisas de que costumava gostar:
Tanto como gostava ☐
Não tanto como gostava ☐
Só um pouco do que gostava ☐
Quase nada como gostava ☐

3. Tenho uma sensação de medo, como se algo terrível estivesse para acontecer:
Sinto, e muito forte ☐
Sim, mas não muito forte ☐
Um pouco, mas isso não me preocupa ☐
Não, de maneira nenhuma ☐

4. Consigo rir-me e ver o lado divertido das coisas:
Tanto como costumava conseguir ☐
Agora, não tanto como costumava conseguir ☐
Definitivamente, não tanto como costumava conseguir ☐
Não, de maneira nenhuma ☐

5. Tenho preocupações que me passam pela cabeça:
A maior parte do tempo ☐
Muitas vezes ☐
De vez em quando, mas não muitas vezes ☐
Apenas ocasionalmente ☐

6. Sinto-me alegre:
Nunca ☐

Poucas vezes
Às vezes
A maior parte do tempo

7. Posso sentar-me à vontade e sentir-me relaxado:
Sim, definitivamente
Geralmente
Poucas vezes
Nunca

8. Sinto-me mais lento ou vagaroso:
Quase sempre
Muitas vezes
Às vezes
Nunca

9. Sinto uma espécie de medo, como se tivesse um aperto no estômago:
Nunca
Ocasionalmente
Bastantes vezes
Muitas vezes

10. Perdi o interesse pela minha aparência:
Sim, definitivamente
Não me cuido tanto como deveria
Talvez não me cuide tanto como antes
Cuido-me tanto como costumava

11. Sinto-me inquieto(a), como se tivesse que estar sempre a andar de um lado para o outro:
Sim, muito
Sim, bastante
Não muito
Não, de modo nenhum

12. Antecipo as coisas com satisfação:
Tanto como eu costumava fazer anteriormente
Um pouco menos do que anteriormente
Muito menos do que anteriormente
Quase nunca

13. Tenho sentimentos súbitos de pânico:
14. Com muita frequência
Bastantes vezes
Não muitas vezes
Nunca

15. Consigo apreciar um bom livro, um programa e televisão ou de rádio:

Frequentemente ☐
Às vezes ☐
Poucas vezes ☐
Muito raramente ☐