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## Normal or tingly? A story about hands and feet

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## **Normal or Tingly? A Story About Hands and Feet**

Myrto Efstathiou<sup>a\*</sup>, Louise S Delicato<sup>a</sup> and Anna Sedda<sup>a</sup>

*<sup>a</sup>Department of Psychology, School of Social Sciences, Heriot-Watt University,  
Edinburgh Campus, United Kingdom*

Myrto Efstathiou, [me56@hw.ac.uk](mailto:me56@hw.ac.uk)

## Normal or Tingly? A Story About Hands and Feet

**Aims:** Spontaneous sensations (SPS) are sensations which are felt in the body in the absence of external stimulation. The literature on SPS has used explicit measures such as questionnaires to explore SPS, while no studies to date have examined SPS on an implicit level. This study was conducted to collect representative stimuli that can be used to build such a task, for example an Implicit Association Test. **Methods:** An online survey was completed by eighteen participants to identify the most frequent words used to describe our limbs in the presence or absence of SPS. **Results:** Individuals who perceive and those who do not perceive SPS in their limbs describe their limbs as *normal*, while the most frequently described SPS were *itching* and *tingling*. **Conclusions:** Thus, we use the same words/adjectives to describe how we perceive our limbs. However, the way we experience SPS varies as we experience more SPS in hands than feet.

Keywords: spontaneous sensations; hands; feet; body perception; itching, tingling; normal

## 1. Introduction

When you are trying to relax, your attention might shift to various sensations across your limbs, such as tingling or itching to name a few. These spontaneous sensations (SPS) are usually perceived at periods of rest and almost everyone feels them across their body (Michael and Naveteur, 2011; Naveteur et al. 2005). SPS has been of interest to researchers trying to understand how we perceive our body because of their relationship with conscious attention to bodily stimuli which contribute to the formation of our body image (Michael and Naveteur 2011) and with their relationship to disordered bodily awareness (Borg et al. 2015; Michael et al. 2015). While research has measured how the body feels in the presence of those sensations (Beaudoin and Michael 2014; Michael and Naveteur 2011; Michael et al. 2012; 2015; 2017; 2020; Naveteur et al. 2015; Salgues et al. 2021a; 2021b), a baseline measurement of how our body feels in the absence of those sensations is needed in order to develop an accurate understanding of our bodily perception. This is an important step as understanding bodily perception is crucial in our interactions with the environment and in building our sense of self (Harris et al. 2015; Michael et al. 2015).

The most common way to measure SPS is by using subjective methods. For instance, Naveteur and colleagues (2005) first examined SPS by asking participants to focus their attention for 10s to the external side of the first metacarpus of either hand. Then, participants had to indicate whether they perceived any SPS and name the sensations. Half of the participants (51.7%) reported perceiving SPS including shaking, vibration, pricking, pulsations, changes in the temperature, muscular tension, pressure or numbness. Michael and Naveteur (2011) replicated the results by Naveteur and colleagues (2005) for the whole hand, as participants focused their attention for 10s to their hands. Then, the list of SPS presented in the Naveteur and colleagues (2005) study was provided, and participants were asked to indicate which SPS they experienced

during the rest. The SPS most frequently experienced were described by the words *tingling* (30%), *numbness* (20%), *beat/pulse* (19%), *cooling* (16%), *warming* (16%), *muscle stiffness* (15%), *flutter* (14%), and the words least frequently indicated were *tickle* (8%), *vibration* (7%), *skin stretch* (3%) and *itch* (2%). These findings have been replicated in follow-up work (Michael et al. 2012) and in a functional magnetic resonance imaging (fMRI) study (Bauer et al. 2014). These authors used a Likert Scale ranging from weak to strong to measure attention towards SPS in their participants. To create the scale, the authors conducted a pilot study in which participants provided an unrestricted description of SPS from which the most frequent words used to describe SPS were then extracted and adopted in the scale. Similarly, to Naveteur and colleagues (2005), Michael and Naveuter (2011) and Michael and colleagues (2012), the most frequent SPS described in this pilot study were *pulsation*, *vibration*, *enlargement*, *heat*, *cold*, *shrinkage*, *itching*, *stinging* and *numbness*. Thus, there is an agreement in the SPS research on what adjectives are the describing the SPS experience.

These studies show the most common words used to describe SPS. However, these SPS are “violations” of a baseline, as approximately 12% of participants do not experience SPS in more than half of the tested conditions (Michael et al. 2012) and in the study by Naveteur and colleagues (2005) almost half of the participants (48.3%) did not experience SPS. Those participants were excluded from the analyses as the authors were interested in measuring the presence of the SPS experience and not the absence of them. How do we describe our sensations in absence of SPS? To date, measuring SPS on an explicit level, using subjective reports such as questionnaires has been the common practice. However, cognition operates under two separate systems of processing: the automatic, unconscious, quick and implicit system and the controlled, conscious, slow and explicit system (Velkoff and Smith 2020). Therefore, explicit and

conscious measures such as self-reports might not be accurate reflections of an individual's perceptions and attitudes (Carey and Preston 2019). For example, results obtained using explicit measures might be influenced by expectation bias (Gallagher et al. 2021) or response bias, as participants might be unwilling to express their own attitudes or unable to accurately perceive their own cognitions due to poor insight (Velkoff and Smith 2020). Furthermore, measures and tasks in body representation research might differ in terms of the level of awareness required to perform the task such as more *implicit* vs more *explicit* (Brusa et al. 2021; Scarpina et al. 2019), and dissociations have been reported between implicit and explicit measures (Gallagher et al. 2021). No studies to date have examined SPS on an implicit level (unconscious and automatic). Understanding SPS on an implicit level is important as implicit measures are often good predictors of behaviours. They are free of expectation or response biases and, if used in combination with subjective reports, they can provide a more holistic insight into one's cognition (Carey and Preston 2019; Gumble and Carels 2012).

The most commonly used task to explore implicit cognitions is the Implicit Association Test (IAT; Greenwald et al. 1998). The IAT assesses beliefs, attitudes, and cognitions on an unconscious and implicit level. Using a computer-based reaction task, the IAT allows to measurement of the strength of associations between two concepts (*e.g.*, flower vs insects) and an attribute (*e.g.*, pleasant vs unpleasant). Participants are presented with a series of target words in the centre of the screen (*e.g.*, bees) and they are asked to categorise the words based on two categories displayed on the left (*e.g.*, flower & pleasant) and on the right (*e.g.*, insects & unpleasant) of the screen. Participants usually pair target words (*e.g.*, bees) faster with the category that matches their own beliefs (*e.g.*, insects & unpleasant) as the process is automatic.

The IAT is an excellent candidate to explore implicit components of SPS and fill a gap in SPS research. An IAT tailored to SPS has yet to be empirically tested, and it is not straightforward to establish which target words would be appropriate to use. If one follows the IAT classic structure an SPS-IAT would consist of two concepts (presence of SPS versus absence of SPS) and an attribute in relation to the self (self versus other; Carey and Preston 2019; Preston and Ehrsson 2018). The presence of SPS concept is straightforward, as the previous research provides plenty of words to build this category. However, words that perfectly match the category absence of SPS are lacking. These words are essential and must be precise, as randomly established words could lead to reduced construct validity of the IAT and hence unreliable results (Nosek et al. 2005).

The present study aims to provide an initial understanding of how participants perceive and describe their hands and feet, both in the presence of SPS and absence of SPS. This will build the necessary knowledge to tackle implicit components of SPS via tasks such as the IAT. We included feet as well as hands, as our experience of SPS might not be the same across our limbs due to the sensory differences among them. Hands have higher representation in the somatosensory cortex (Penfield and Rasmussen 1950), are twice as thermosensitive than the feet (Ackerley et al. 2014). In addition, touch receptor density is higher in fingertips and tactile sensitivity varies across the body with the most sensitive to be the forehead and the palm, while the thigh and the shin are the least sensitive (Ackerley et al. 2014). Therefore, the experience of SPS might be different across our limbs and this might be reflected in the descriptions of SPS for those limbs.

## **2. Materials and Methods**

A Qualtrics survey was launched from December 2020 until January 2021. Ethical approval was granted by the Ethics Committee at Heriot-Watt University (0924). The study was conducted in concordance with the Declaration of Helsinki (Association 2013).

### ***2.1. Participants***

For exploratory and survey pilot studies, a sample size between 10 to 30 participants is deemed to be sufficient (Hertzog 2008). Participants were recruited using a convenience sampling method. Advertisements were placed on the Student Research Participation System (STREP) at Heriot-Watt University in which psychology students had the opportunity to take part to gain credit which is part of a course requirement. Online advertisements were published in the professional and personal network of the authors and social media (Facebook, Twitter and LinkedIn) were also used.

### ***2.2. Measures***

Participants completed a short online survey titled “How do you feel your hands and feet?” composed by four questionnaires: Screening Questionnaire, General Questionnaire, Limb Laterality Preference Questionnaire, Spontaneous Sensations Questionnaire. See Appendix for the full survey.

#### ***2.2.1. Screening Questionnaire***

Participants were eligible to take part if they did not have a history of a neurological, medical and mental health conditions and use of psychotropic or psychoactive medications as those factors can affect the experience of bodily sensations (Michael et al. 2012). To ensure our eligibility requirements were met, a screening questionnaire was used to determine: presence of a neurological condition (e.g. epilepsy, Parkinson’s disease, stroke), presence of a medical condition (e.g. heart



condition, diabetes, arthritis), presence of a mental health condition (e.g. depression, anxiety, drug/alcohol addiction) diagnosed from a healthcare professional and use of psychotropic or psychoactive medication within the past 3 months. Additionally, we required that participants are English native speakers, as we aimed to collect representative words in English, which describe the experience of spontaneous and normal sensations.

### *2.2.2. General Questionnaire*

A general questionnaire was devised to collect demographic information (e.g. age, biological sex, gender). An open question regarding biological sex and gender was used to be inclusive for all genders and sexes (Cameron and Stinson 2019). Information on factors that might influence the experience of bodily sensations (exercise, caffeine consumption, smoking, and alcohol consumption) was asked (Borg et al. 2015; Michael et al. 2012, 2015; Michael and Naveteur 2011). Additionally, a single question about the presence of restless leg syndrome was asked as spontaneous sensations are often a symptom of this condition (Karroum et al. 2012) as well as the presence of a skin condition such as psoriasis as it might impact the SPS experience. Finally, the education level of the individuals was asked as it might impact how participants describe their bodily sensations using words.

### *2.2.3. Limb Laterality Preference*

Handedness and footedness were measured using eight items from the Lateral Preference Inventory by Coren (1993). Four items measure handedness related to writing, throwing a ball, using a knife, using a hammer and four items measure footedness related to kicking a ball, picking up a pebble, stepping on a beetle and stepping up on a chair. Participants indicated their preference with left (-4), either (0) or

right (4) as options. The average of scores in each item indicates the laterality preference, while scores between -3 to -1 indicate moderate left preference, scores between 3 to 1 indicate a moderate right preference, scores at 0 indicate no preference, 4 scores indicate right sidedness, and -4 scores indicate left sidedness.

#### 2.2.4. *Spontaneous Sensations Questionnaire*

A Spontaneous Sensations (SPS) questionnaire was devised to identify words which we use to describe our hands and feet, in presence and in absence of SPS. We provided participants with a definition of what SPS are (*Spontaneous sensations are sensations that you feel on your body when you are not moving and even when you are not touched*), without providing specific examples, to ensure consistency of understanding but at the same time avoiding a bias in the words used (*1. Definition of SPS*).

Participants were then asked to indicate whether they generally experience SPS in their limbs, and if yes, they were asked to indicate the location of SPS and to describe them using up to five words (*2. Presence of SPS*). Finally, participants described how their limbs feel like in the absence of SPS using up to five words (*3. Absence of SPS*). See Figure 1. The reasoning of structuring our task in terms of asking first about the *Presence of SPS* and then about the *Absence of SPS* is to ensure that participants understand how their limbs feel like when they experience SPS as this reflection will in turn aid them in understanding how their limbs will feel like in absence of those sensations. If it were the opposite order, participants might have confused what SPS are and thus described sensations which belong to the presence of SPS category (e.g. tickling sensations; Michael et al 2012) as absence of SPS.

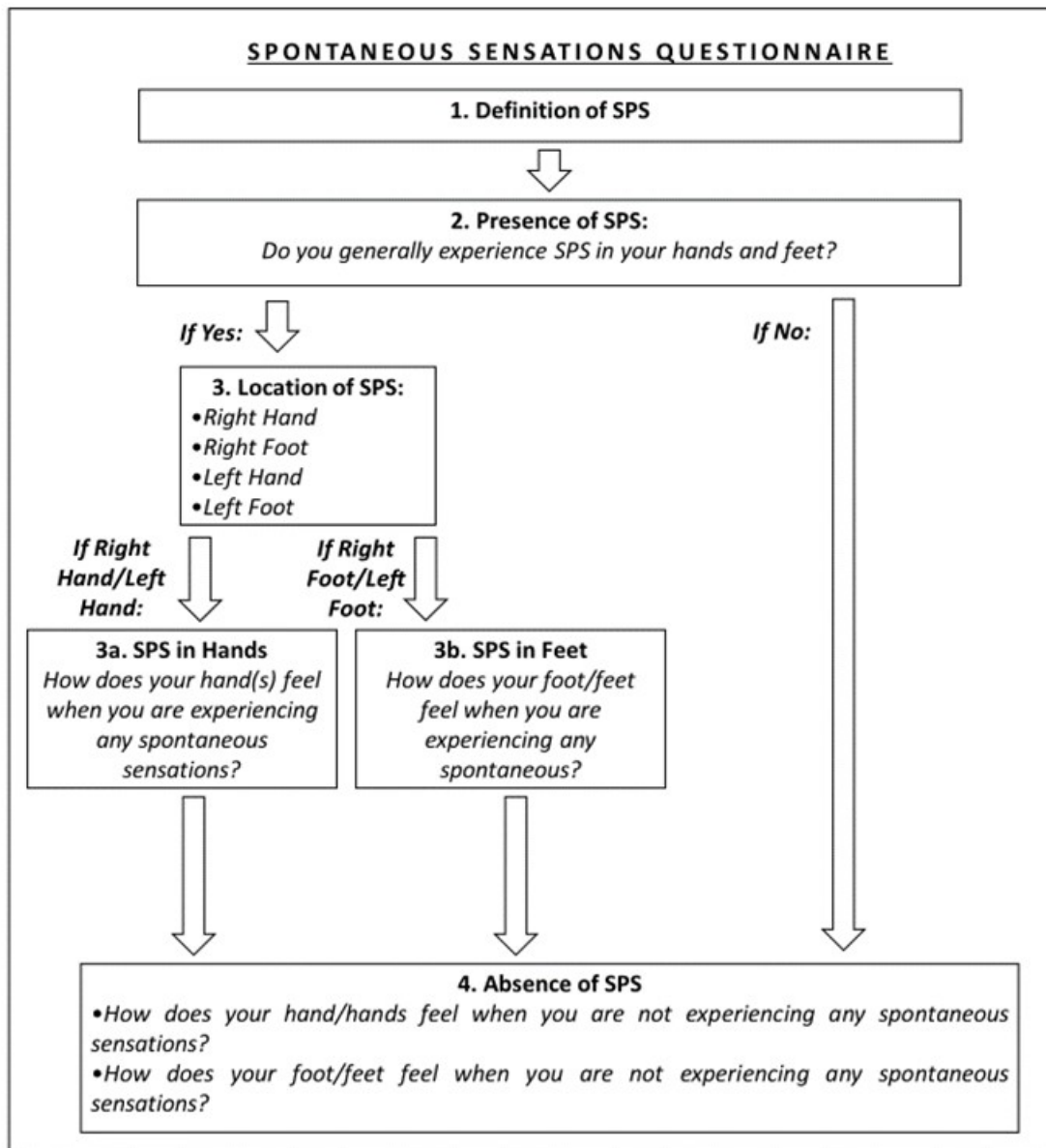


Figure 1. Spontaneous Sensations Questionnaire flow. SPS: Spontaneous Sensations. Arrows indicate the flow of the questionnaire.

### 2.3. Procedure

All measures were administered online using Qualtrics. Informed consent was obtained by all participants, and the debrief procedure was followed upon the completion of the survey. Participants first completed the screening questionnaire to ensure whether our eligibility requirements were met, followed by the general

questionnaire and the lateral preference inventory. Then participants completed the SPS questionnaire for hands and feet. The study took up to 15 minutes to complete.

### **3. Results**

#### ***3.1. Sample Characteristics***

Eighteen healthy individuals completed the survey (age  $M = 32.72$ ,  $SD = 13.64$ ). In terms of sample characteristics, 56% ( $n = 10$ ) indicated a female biological sex, and 44% ( $n = 10$ ) identified as females in terms of gender, 33% ( $n = 7$ ) as males and 6% ( $n = 1$ ) as gender-fluid.

Participants were educated for an average of 17.17 years ( $SD = 3.05$ ). The majority of the participants exercised weekly (78%,  $n = 14$ ) for 5 hours on average ( $SD = 2.88$ ). Moreover, 78% ( $n = 14$ ) of the participants consumed caffeine within the past 24 hours, and 28% ( $n = 5$ ) consumed alcohol within the past 24 hours. All participants were non-smokers (100%,  $n = 18$ ). One participant (6%) reported restless leg syndrome in both legs. Skin conditions were reported by 22% ( $n = 4$ ), with two participants reporting feet as the body parts affected, one participant reported the right hand and both feet and one participant reported only the hands to be affected.

In terms of hand laterality preferences, 78% ( $n = 14$ ) reported right preference, 11% ( $n = 2$ ) reported moderate right preference, 6% ( $n = 1$ ) reported moderate left preference and 6% ( $n = 1$ ) reported left preference. With regards to foot laterality preferences, 83% ( $n = 15$ ) indicated moderate right preference, 11% ( $n = 2$ ) indicated right preference, and 6% ( $n = 1$ ) indicated moderate left preference.

### 3.2. Presence of Spontaneous Sensations Descriptions

The majority of participants (67%,  $n = 12$ ) indicated that they do not generally experience SPS in their limbs, named Group<sub>NO-SPS</sub>. Six participants (33%) indicated that they generally experience SPS, named Group<sub>SPS</sub>.

In the Group<sub>SPS</sub>. ( $n = 6$ ), all participants experienced sensations in one or both hands, while four participants (67%) experienced SPS in their feet too. Specifically, three participants (50%) reported SPS on all limbs, two participants (33%) reported SPS on both hands and one participant (17%) reported SPS on both feet, and on the left hand. Overall, 53% of SPS were present on the left side of the body and 47% of SPS on the right side of the body.

#### 3.2.1. Hands

Of the participants who experienced SPS in hands ( $n = 6$ ), most of them (67%,  $n = 4$ ) used two adjectives to describe their hands in the presence of SPS, while one participant (17%) used three adjectives and one participant (17%) used four adjectives. The most common descriptions for hands with SPS were *tingly/tingling* (33%,  $n = 5$ ), followed by *itchy/itching* (20%,  $n = 3$ ) and temperature-related words such as *cold* (13%,  $n = 2$ ) and *warm* (7%,  $n = 1$ ). *Numb* was also reported by two participants (13%,  $n = 2$ ) while *stiff* and *prodded* were used once (7%).

#### 3.2.2. Feet

Of the participants who experienced SPS in feet ( $n = 4$ ), two participants (50%) used four adjectives to describe their feet in the presence of SPS, one participant (25%) used one adjective and one participant (25%) used three adjectives. The most common descriptions were *itchy/itching* (25%,  $n = 3$ ) and *tingly/tingling* (25%,  $n = 3$ ), followed by *numb* (17%,  $n = 2$ ). *Cold*, *warm*, *tightness*, and *a bit painful* were reported once (8%).

### 3.3. Absence of Spontaneous Sensations Descriptions

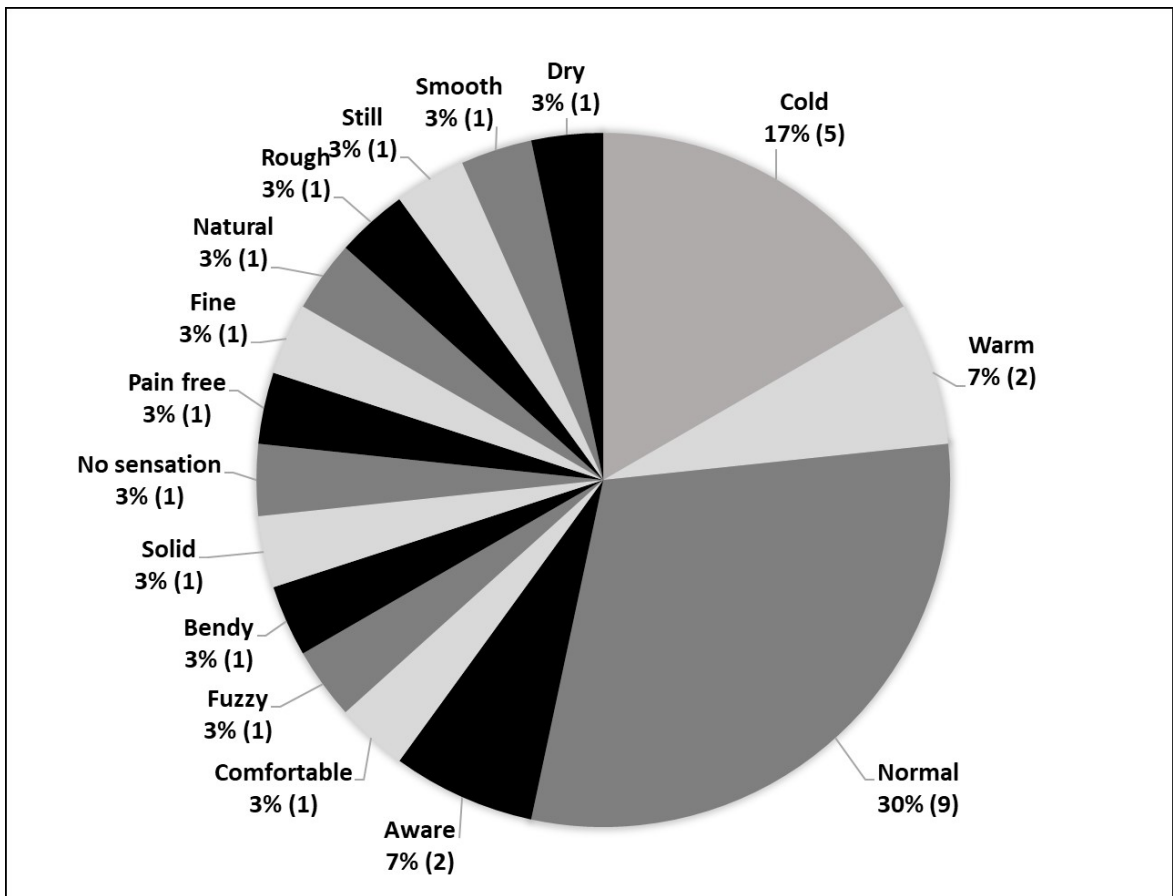


Figure 2. The percentages (frequencies) of adjectives used to describe hands in absence of spontaneous sensations (SPS) in the sample ( $N = 18$ ).

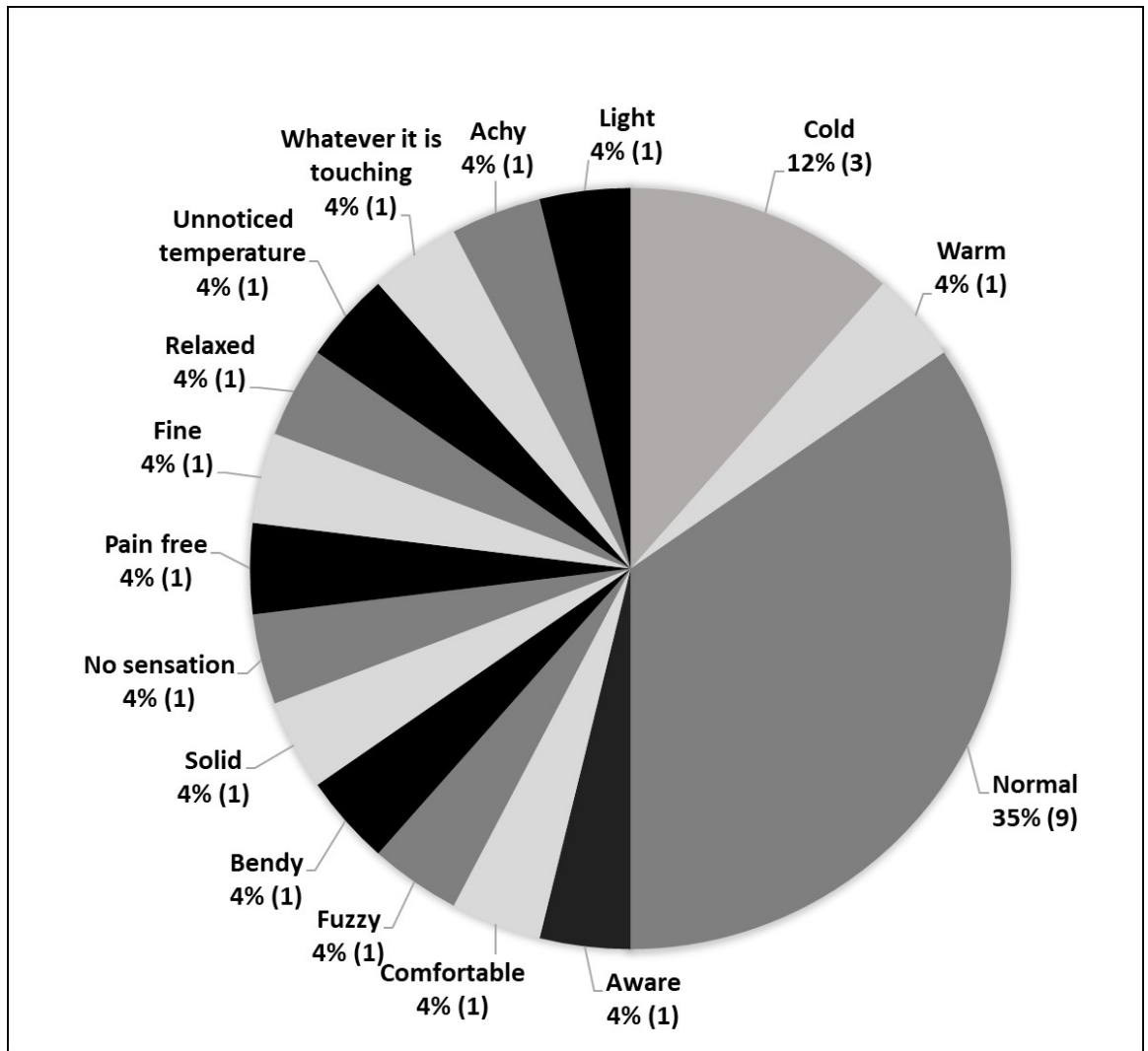


Figure 3. The percentages (frequencies) of adjectives used to describe feet in absence of spontaneous sensations (SPS) in the sample ( $N = 18$ ).

Overall, most participants (67%,  $n = 12$ ) used one adjective to describe their feet in the absence of SPS, while five participants (28%) used two adjectives and one participant (5%) used four adjectives (Figure 3, words used to describe absence of sensations in feet).

To ensure that all participants, regardless of whether they experience SPS (Group<sub>SPS</sub>) or not (Group<sub>NO-SPS</sub>), describe their limbs in a similar way, that is, they use

representative words of the absence of SPS experience, a breakdown of the limb descriptions in absence of SPS per group (Group<sub>SPS</sub>, Group<sub>NO-SPS</sub>) is provided below:

### 3.3.1. *Absence of Spontaneous Sensations Descriptions, Group<sub>SPS</sub>*

The frequency of the adjectives used to describe hands and feet by participants who generally experienced SPS in hands ( $n = 6$ ; Group<sub>SPS</sub>) and in feet ( $n = 4$ ; Group<sub>SPS</sub>) is described below.

#### 3.3.1.1. *Hands*

Of the participants who experienced SPS in their hands ( $n = 6$ ), when asked to describe their hands in absence of SPS, most participants (83%,  $n = 5$ ) used one adjective and one participant (17%) used two adjectives. The most common adjectives used to describe hands in the absence of SPS in this sample, were normal (43%,  $n = 3$ ), followed by being aware (29%,  $n = 2$ ). The adjectives fuzzy and cold, were reported once (14%,  $n = 1$ ).

#### 3.3.1.2. *Feet*

Of the participants who experienced SPS in their feet ( $n = 4$ ), when asked to describe their feet in absence of SPS, most participants (75%,  $n = 3$ ) used one adjective and one participant (25%) used two adjectives. The most common words used to describe feet in the absence of SPS in this sample, were *normal* (50%,  $n = 2$ ), followed by being *aware* (25%,  $n = 1$ ), *fuzzy* (16%,  $n = 1$ ) and *cold* (16%,  $n = 1$ ).

### 3.3.2. *Absence of Spontaneous Sensations Descriptions, Group<sub>NO-SPS</sub>*

The frequency of the adjectives used to describe hands and feet by participants who did not generally experience SPS in hands ( $n = 12$ ; Group<sub>NO-SPS</sub>) and in feet ( $n = 14$ ; Group<sub>NO-SPS</sub>) is described below.



### 3.3.2.1. Hands

Of the participants who did not experience SPS in their hands ( $n = 12$ ), when asked to describe their hand, most participants (59%,  $n = 7$ ) used one adjective, two participants (17%) used two adjectives, one participant (8%) used three adjectives, one participant (8%) used four adjectives, and one participant (8%) used five adjectives. The most common adjectives used to describe hands in the absence of SPS in this sample, were *normal* (26%,  $n = 6$ ), followed by *cold* (18%,  $n = 4$ ) and *warm* (9%,  $n = 2$ ). The following adjectives were reported once (4%): *comfortable*, *bendy*, *solid*, *no sensation*, *pain free*, *fine*, *natural*, *rough*, *still*, *smooth*, *dry*.

### 3.3.2.2. Feet

Of the participants who did not experience SPS in their feet ( $n = 14$ ), when asked to describe their feet, most participants (64%,  $n = 9$ ) used one adjective, four participants (29%) used two adjectives and one participant (7%) used four adjectives. The most common adjectives used to describe feet in the absence of SPS in this sample, were *normal* (33%,  $n = 7$ ), followed by *cold* (9%,  $n = 2$ ). The following adjectives were reported once (5%): *warm*, *comfortable*, *bendy*, *solid*, *no sensation*, *pain free*, *fine*, *relaxed*, *unnoticed temperature*, *whatever it is touching*, *achy*, *light*.

## 4. Discussion

This study aimed to understand how participants perceive their hands and feet, in the absence and the presence of spontaneous sensations (SPS). The most frequent adjectives to describe how limbs feel like in the presence of SPS were *tingly*, *itchy*, temperature-related SPS (*cold* and *warm*) and *numb*; most participants used more than two adjectives to describe their limbs and hands reported more SPS than feet. The most frequent adjectives to describe how limbs feel like in the absence of SPS were *normal*

and temperature-related SPS (*cold* and *warm*), while most participants used one adjective to describe their limbs.

#### ***4.1. Presence of Spontaneous Sensations Descriptions***

The descriptions of SPS provided by participants in this study supports the SPS results of the research on hands and extend this to include feet. The most frequent descriptions of SPS were *tingly*, temperature-related (*cold*, *warm*) and *numb* (Michael et al. 2012; Michael and Naveteur 2011); *itchy* was also frequently reported (Bauer et al. 2014). Therefore, participants still report experiencing the most frequent descriptions of SPS even when they are not provided with a list of words to choose from. This was true for both hands and feet. Hence, our study's methodology reduces the possibility of bias by not providing the list of possible SPS, and it also replicates previous studies of SPS in hands and extends those findings in feet.

All participants in the Group<sub>SPS</sub> experienced sensations in one or both hands, while four participants experienced SPS in their feet. This might suggest differences in how we perceive bodily sensations across our limbs. For instance, hands are more sensitive to temperature changes than feet, the fingers have higher touch receptor density than the feet and the palm is one of the most tactile sensitive areas of the body (Ackerley et al. 2014). Hence, there might be differences in the location and intensity of SPS presented in hands and feet. To further support this suggestion, temperature-related SPS (*cold*, *warm*) were more frequent in hands than feet. Therefore, how the way we experience SPS in our hands and feet might differ.

The SPS were represented equally to both sides of the body. This is different to research showing that SPS were more frequent in the left side of the body (Michael et al. 2012; Michael and Naveteur 2011; Naveteur et al. 2015). However, that research focused on right-handed participants and on hands only, while our research

complements and enhances the SPS literature by exploring both hands and feet and by including hand and foot preferences for right, left and mixed laterality.

#### ***4.2. Absence of Spontaneous Sensations Descriptions***

In terms of limb descriptions in the absence of SPS, the words normal and temperature-related words such as cold and warm were the most frequent. By dividing the sample in two groups, those who do not generally experience SPS (Group<sub>NO-SPS</sub>) and those who do (Group<sub>SPS</sub>), a slightly different pattern appears. The most frequently used words to describe limbs in the absence of SPS in the Group<sub>NO-SPS</sub> were normal and temperature-related words (cold, warm). Whereas, the most frequently used words to describe limbs in absence of SPS in the Group<sub>SPS</sub> were normal and aware. This might be related to the fact that no examples of SPS were provided to the participants to reduce the bias of reporting, and as such, participants might not have had expectations on what SPS might appear. Therefore, sensations such as cold and warm, which are SPS and they have been repeatedly reported by SPS research (Michael et al. 2012; Michael and Naveteur 2011), might have been categorised to the absence of SPS adjectives by the Group<sub>NO-SPS</sub> due to the lack of examples that we did not provide. Furthermore, the adjective aware was used to describe limbs in the absence of SPS by the Group<sub>SPS</sub>. This adjective was not used by the Group<sub>NO-SPS</sub>. It might be that conscious attention of somatic stimuli allows us to construct our body image by providing us with information about the spatial frontiers of our body and by becoming more aware of them (Michael and Naveteur 2011). Hence, individuals with a reduced bodily awareness to bodily sensations might then perceive SPS in a different way. In other words, those who pay more attention to their body might be more aware of it and thus they are more likely to experience SPS (Michael et al. 2015).

The adjective normal was the most frequently used word to describe hands and feet in the absence of SPS in both groups. It should be noted that words provided least frequently such as natural, comfortable, and fine might also be categorised under the normal term. Three out of six participants of the Group<sub>SPS</sub> also used the adjective normal, to describe their limbs without SPS experience. Hence, the adjective normal describes how limbs feel, irrespective of whether an individual experiences SPS or not. Most participants indicated that they do not experience SPS generally in their limbs. This is not surprising, and it is partly in line with Naveteur and colleagues (2005) who showed that approximately 48% of their sample did not experience SPS. However, our study included a short question which aimed to capture the general experience of SPS, without providing examples of SPS and this is different from other studies in the SPS literature (Michael and Naveteur 2011; Michael et al. 2012; 2015; 2017; Naveteur et al. 2005; 2015). In addition, experimental studies in the literature asked participants to pay attention to their hands for any SPS at that moment. Therefore, participants in this study might have underreported their SPS experience due to the lack of SPS examples or not remembering any of their past SPS experiences.

### ***4.3. Conclusions***

This study showed that the most frequently used words to describe limbs in the absence of SPS is normal, irrespective of whether the individual generally experiences SPS or not. For people who generally experience SPS, descriptions of itchy, and tingly were the most frequent in both hands and feet. This study also shows that more participants perceived SPS in their hands than their feet. Hence the way we experience SPS varies across our limbs. However, we use the same words to describe how our limbs feel like, irrespective if we are talking about hands or feet. The words identified in this study can be used to explore SPS on an implicit and automatic level using an

Implicit Association Test (IAT; Greenwald et al. 1998). The most frequent words used to describe experience in the presence / absence of SPS can be included in the IAT as validly representative stimuli for those categories (Nosek et al. 2005). In this way, the research community can further understand what SPS are using explicit and implicit methods, and how we pay attention to them.

### **Disclosure statement**

No potential conflict of interest was reported by the author(s).

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### **Data availability statement**

The dataset is fully available here: Efstathiou M. Delicato L. Sedda A. 2021. Normal or Tingly? A story about Hands & Feet. Open Science Framework.

<https://doi.org/10.17605/OSF.IO/2QZFD>,

### **References**

- Ackerley R. Carlsson I. Wester H. Olausson H. Backlund Wasling H. 2014. Touch perceptions across skin sites: Differences between sensitivity, direction discrimination and pleasantness. *Front. Behav. Neurosci.* 8: 1–10.
- Association WM. 2013. 10.1001@Jama.2013.281053. 2013–2016.
- Bauer CCC. Barrios FA. Díaz JL. 2014. Subjective somatosensory experiences disclosed by focused attention: Cortical-hippocampal-insular and amygdala contributions. *PLoS ONE.* 9(8).
- Beaudoin R. Michael GA. 2014. Gating of spontaneous somatic sensations by movement. *Somatosens Mot Res.* 31(3): 111–121.

Borg C. Emond FC. Colson D. Laurent B. Michael GA. 2015. Attentional focus on subjective interoceptive experience in patients with fibromyalgia. *Brain Cogn.* 101: 35–43.

Brusa F. Kretzschmar L. Magnani FG. Turner G. Garraffa M. Sedda A. 2021. Talking with hands: body representation in British Sign Language users. *Exp Brain Res.* 239(3): 731–744.

Cameron JJ. Stinson DA. 2019. Gender (mis)measurement: Guidelines for respecting gender diversity in psychological research. *Soc Personal Psychol Compass.* 13(11): 1–14.

Carey M. Preston C. 2019. Investigating the Components of Body Image Disturbance Within Eating Disorders. *Front Psychiatry.* 10: 1–15.

Coren S. 1993. The lateral preference inventory for measurement of handedness, footedness, eyedness, and earedness: Norms for young adults. *Psychon Bull Rev.* 31(1): 1–3

Gallagher M. Colzi C. Sedda, A. 2021. Dissociation of proprioceptive drift and feelings of ownership in the somatic rubber hand illusion. *Acta Psychol.* 212: 103192.

Greenwald AG. McGhee DE. Schwartz JLK. 1998. Measuring individual differences in implicit cognition: The implicit association test. *J Pers Soc Psychol.* 74(6): 1464–1480.

Gumble A. Carels R. 2012. The harmful and beneficial impacts of weight bias on well-being: The moderating influence of weight status. *Body Image.* 9(1): 101–107.

Harris LR. Carnevale MJ. D'Amour S. Fraser LE. Harrar V. Hoover AE. Mander C. Pritchett LM. 2015. How our body influences our perception of the world. *Front psychol.* 6: 819.

Hertzog MA. 2008. Considerations in determining sample size for pilot studies. *Res Nurs Health*. 31(2): 180–191.

Karroum EG. Golmard JL. Leu-Semenescu S. Arnulf I. 2021. Sensations in restless legs syndrome. *Sleep Med*. 13(4): 402–408.

Michael GA. Naveteur J. 2011. The tickly homunculus and the origins of spontaneous sensations arising on the hands. *Conscious Cogn*. 20(3): 603–617.

Michael GA. Dupuy MA. Deleuze A. Humblot M. Simon B., Naveteur J. 2012. Interacting effects of vision and attention in perceiving spontaneous sensations arising on the hands. *Exo Brain Res*. 216(1): 21–34.

Michael GA. Guyot D. Tarroux E. Comte M. Salgues S. 2020. Feeling Oneself Requires Embodiment: Insights From the Relationship Between Own-Body Transformations, Schizotypal Personality Traits, and Spontaneous Bodily Sensations. *Front psychol*, 11.

Michael GA. Naveteur J. Dupuy MA Jacquot L. 2015. My heart is in my hands: The interoceptive nature of the spontaneous sensations felt on the hands. *Physiol Behav*. 143: 113–120.

Michael GA Tapiero I. Gálvez-García G. Jacquot L. 2017. Thoughts and sensations, twin galaxies of the inner space: The propensity to mind-wander relates to spontaneous sensations arising on the hands. *Conscious and cogn*. 55: 223–231.

Naveteur J. Dupuy MA. Gabrielli F. Michael GA. 2015. How we perceive our own hands: Effects of attention, aging, and sex. *Somatosens Mot Res*. 32(4): 227–235.

Naveteur J. Honoré J. Michael GA. 2005. How to detect an electrocutaneous shock which is not delivered? Overt spatial attention influences decision. *Behav. Brain Res*. 165(2): 254–261.

Nosek BA. Greenwald AG. Banaji MR. 2005. Understanding and using the implicit association test: II. Method variables and construct validity. *Pers Soc Psychol Bull.* 31(2): 166–180.

Penfield W. Rasmussen, T. 1950. *The cerebral cortex of man; a clinical study of localization of function.* Macmillan

Preston C. Ehrsson H. 2018. Implicit and explicit changes in body satisfaction evoked by body size illusions: Implications for eating disorder vulnerability in women. *PLoS ONE.* 13.

Salgues S. Plancher G. Michael GA. 2021a. Visuospatial working memory abilities and spontaneous sensations perception. *Somatosens Mot Res.* 38(3): 164–177.

Salgues, S., Plancher, G., Jacquot, L., Naveteur, J., Fanuel, L., Gálvez-García, Michael G. A. 2021b. To the self and beyond: Arousal and functional connectivity of the temporo-parietal junction contributes to spontaneous sensations perception. *Behav. Brain Res.* 396.

Scarpina F. Magnani FG. Tagini S. Priano L. Mauro A. Sedda A. 2019. Mental representation of the body in action in Parkinson's disease. *Exp. Brain Res.* 237(10): 2505–2521.

Velkoff EA. Smith, AR. 2020. Preliminary development of an implicit association test to measure body dissatisfaction and predict disordered eating behaviors. *Body Image.* 34: 51–58.

## **Appendix**

***Survey: How do you feel your hands and feet?***

**Screening Questionnaire:**



Before you start the experiment, we ask all prospective participants to read the following statements for the following reasons: (1) the way we designed this specific research and (2) the tasks that you will be asked to carry out.

The following statements are aimed at understanding if you are eligible to take part in our study. If any of the following statement apply to you, unfortunately you are not eligible to take part at the present time. If you are in doubt, please contact us at [me56@hw.ac.uk](mailto:me56@hw.ac.uk)

We thank you for your time and of your interest in our study.

Do any of the following statements apply to you?

- Are you a non-native English speaker?
- Do you have a diagnosed neurological condition such as epilepsy, Parkinson's disease, multiple sclerosis or others?
- Have you ever had a stroke or a traumatic brain injury?
- Do you have a heart condition (e.g. angina, history of heart attack)?
- Do you have diabetes?
- Do you suffer from arthritis?
- Do you have problems with moving your hands and/or feet?
- Do you have a diagnosis of a mental health condition (e.g. depression, anxiety, drug or alcohol addiction) from a healthcare professional (e.g. psychiatrist or psychologist)?
- Within the past 3 months, have you taken any medication for mood (e.g. antidepressants, antipsychotics, anxiolytics, mood stabilizers)?

- Within the past 3 months, have you taken any substance that can affect your thoughts, moods and behaviour (e.g. cannabis, hashish, ecstasy, cocaine, heroin, amphetamines)?

Yes/No

### **General Questionnaire:**

Now we will ask you a series of questions about your profile, your habits and health. Some questions might seem strange: please bear with us, we will explain their aim at the end of the study.

- What is your age? Open question
- I identify my biological sex as: Open question
- I identify my gender as: Open question
- How many years of education do you have?
- Do you exercise (e.g. meditation, yoga, weightlifting, running)? Yes/No If yes, how many hours per week do you spend exercising?
- Did you have a caffeinated drink (e.g. redbull, coffee, tea, soft drinks) within the last 24 hours? Yes/No
- Did you have an alcoholic drink (e.g. wine, whiskey, beer) within the last 24 hours? Yes/No
- Do you smoke (e.g. cigarettes, cigar)? Yes/No
- Do you suffer from restless leg syndrome? For more information about restless leg syndrome can be found here: <https://www.nhs.uk/conditions/restless-legs-syndrome/> ? Yes/No If yes, which body parts are affected?
- Do you suffer from a skin condition (e.g. eczema, psoriasis) in your hands and/or feet? Yes/No If yes, which body parts are affected?

- Do you use a QWERTY keyboard? Yes/No If no, please describe the type of keyboard that you use Open question

### **Lateral Preference Inventory by Coren (1993):**

The following questions are aimed to measure your hand and foot preference. Please read each question below. Decide which hand or foot you use for each activity and check one box (left, either, right) that best describes your behaviour in each case.

Which hand...

- Do you use to draw? (1) Left Either Right
- Do you use to throw a ball to hit a target? (2) Left Either Right
- Do you use to hold an eraser on paper? (3) Left Either Right
- Do you use to remove the top card when dealing from a deck? (4) Left Either Right

Which foot...

- Do you use to kick a ball to hit a target? (1) Left Either Right
- Would you use to pick up a pebble with your toes? (2) Left Either Right
- Would you use to step on a bug? (3) Left Either Right
- Do you place on a chair first to step on it? (4) Left Either Right

### **Spontaneous Sensations Questionnaire:**

Spontaneous sensations are sensations that you feel on your body when you are not moving and even when you are not touched.

**Now we ask you to think about your own experience of spontaneous sensations in your hands and feet.**

- Do you generally feel spontaneous sensations in your hands and feet? *Yes/No*

If *Yes*: Please select the areas that you generally feel spontaneous sensations:

*Right Hand Right Foot Left Hand Left Foot*

If they select *Right Hand/Left Hand*: How does your hand(s) feel when you are experiencing any spontaneous sensations? Please use up to 5 words to describe the feelings.

If they select *Right Foot/Left Foot*: How does your foot/feet feel when you are experiencing any spontaneous sensations? Please use up to 5 words to describe the feelings.

**Now we ask to think about your hands and feet, without the spontaneous sensations.**

- How does your hand/hands feel when you are not experiencing any spontaneous sensations? Please use up to 5 words to describe the feelings.
- How does your foot/feet feel when you are not experiencing any spontaneous sensations? Please use up to 5 words to describe the feelings.