THE EFFECTS OF IMPLICIT MOTOR IMAGERY IN AGING USING THE HAND LATERALITY JUDGMENT TASK

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ABSTRACT

Cognitive states like motor imagery (MI; simulating actions without overtly executing them) share a close correspondence with action execution, and hence, activate the motor system in a similar way. However, as people age, reduction in specific cognitive abilities like motor action simulation and action planning/prediction are commonly experienced. Previous research has shown that with age, the ability to implicitly simulate upper-limb movements declines. At present, most research on implicit motor imagery has focused largely on young healthy adults. Using the hand laterality judgement task, the present study examined sex differences, which have not previously been reported for older adults. In addition, this study examined the influence of aging on implicit simulation processes for both simple and difficult upper-limb movements. Forty right-handed young adults (20 male, 20 female; *M* = 22, *SD* = 5.05) and forty right-handed old adults (16 male, 24 female; *M* = 76.5, *SD* = 7.33) with normal or corrected-to-normal were recruited. Response times and accuracy were recorded as participants indicated the laterality of right-and-left hand images from two different views and four different orientations. We expected older adults to be less accurate and have slower reaction times than younger adults in their left-right hand judgments when presented with hand stimuli in both simple and difficult orientations from different viewpoints. Several main findings emerged: (1) Older adults were slower to respond to both canonical (0° and 90°M) and difficult (90°L and 180°) orientations from different viewpoints than younger adults, suggesting an age-related decline in implicit simulation processes; (2) For older adults, a medial-over-lateral advantage was found for both back and palm views, whereas for younger adults, this effect was only evident for palm views; (3) Older adults had higher proportion of errors at both viewpoints compared to younger adults, but performed equally well on both canonical and difficult orientations suggesting that although older adults take longer to respond to simple and difficult orientations they are just as accurate as younger adults; (4) Males of all ages made more errors for palms than back views, but for females, this difference was only apparent in older females, suggesting a decline in implicit motor imagery among certain sexes and age groups. This study reports new findings about sex differences in individuals' use of strategies (visual vs. motor imagery) to solve the hand laterality judgement task. Furthermore, these findings complement the literature showing age-related declines in motor simulation processes.

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CHAPTER I

GENERAL INTRODUCTION

Think back to a time you learned a new motor skill, such as shooting a free-throw or tying a shoelace. In both scenarios, to acquire and maintain the motor skill, you capitalize on the ability to internally simulate actions without overtly executing them. These internal action simulations help interact with the environment, and consequently allow us to steer our actions toward goal-states. They are performed so quickly and effortlessly that we generally do not realize how often we use them to prepare for everyday actions. As we watch somebody's action with the goal to model it, we recall past events, anticipate potential actions, and seek additional information about the feasibility of those actions (Annett, 1995). Each time such an action is simulated, it relies on the complex interplay between various information processing systems, including the motor and sensory system.

Consider the example of athletes mentally preparing themselves to shoot free-throws before a game. Prior to any overt movement, internal representations of the body in action are initiated, which, aided by top-down processing, allow for the anticipation of actions (Decety & Grezes, 1999). In this case, players must first simulate motor representations that correspond to the unfolding action being imagined. This enables the player to internally reproduce the action by shifting their body to an optimal position, aligning the shooting hand, and finally shooting the basketball. In spite of not performing the action, simulating movements involves a series of complex and interacting processes that occur during motor planning and preparation. Simulating free-throw actions, for instance, require athletes to obey the same motor rules and biomechanical constraints of the represented movement (Decety et al.,1989; Gentili et al., 2004; Jeannerod & Decety, 1995). It would be quite ineffective to simulate motor actions without considering the properties pertaining to the action, for example, in which a player may orient their shooting hand in an awkward position. This brief description emphasizes the importance of simulation processes that help anticipate the effects of possible actions in relation to the environment.

Motor Simulation

One way to look at motor actions that extend beyond the observable overt stage is to examine the role of motor imagery. Motor imagery is a cognitive process that allows for the rehearsal of movements without any motor output (Decety, 1996; Jeannerod & Decety, 1995; Jeannerod, 1994, 1997, 2001). We can, for example, re-enact actions off-line in order to predict future states of movements. In computation terms, internal models transform intended actions into motor commands, generating sensory consequences of the movement (Wolpert & Miall, 1996). These internal motor representations have important implications in predicting actions that enhance motor planning and execution. Moreover, internal models tend to be carried out with respect to the egocentric frame of reference that simulate dynamic behavior of the human body (Jeannerod, 1997). Motor imagery can be divided into two categories: visual and kinesthetic. Visual imagery is the visual representation of an action (e.g., running on a treadmill) whereas kinesthetic imagery is the sensory experience of the motor act (e.g., feeling the glutes, hamstrings, and quads while running on a treadmill; Mizuguchi et al., 2015). According to the *Motor Simulation Theory* (Jeannerod, 2001), there appears to be an important relationship between executed and simulated actions. Cognitive states such as kinesthetic motor imagery share the same representations as their overt counterparts (Decety et al., 1989; Decety & Jeannerod,1995; Jeannerod, 1994, 1997). In particular, this theory postulates that motor imagery activates the motor system in a similar way that is observed during action execution. Despite the similar mechanisms involved in motor simulation and execution, imagery involves the complete inhibition of overt output. The descending pathways and spinal circuits that normally carry voluntary commands appear to be blocked, preventing motoneuron activation. Examining the representations for executing and simulating actions provides insight into the cognitive mechanisms underlying motor imagery.

A number of studies involving mental chronometry paradigms (i.e., investigating cognitive processing speed via response times) have reported similar time durations when comparing actual and simulated movements (Jeannerod, 1994; Saimpont et al., 2012). Decety et al. (1989) investigated actual and simulated walking times to different pre-specified distances (5, 10 or 15m). A close correlation was found between mental walking times and actual walking times and their corresponding distances. This mental isochrony has also been confirmed in studies involving graphic tasks (Decety & Michel, 1989; Papaxanthis et al., 2002). When physically writing a signature or drawing a Necker’s cube, it was found that mental durations of an action operate similarly to actual movements. In addition to temporal correspondence, it has been suggested that simulated and real actions adhere to the same speed-accuracy trade-offs characterized by Fitt's law (i.e., an inverse relationship between increasing task difficulty and decreasing movement speed; Cerritelli et al., 2000; Decety et al., 1995; Maruff et al., 1999). For instance, Decety et al. (1995) setup a virtual reality environment and instructed participants to imagine walking through gates of different widths at varying distances. Mental walking times increased with decreasing gate width and increasing gate distance.

When we engage in motor tasks like lifting weights or biking, we can almost instantly feel an increase in energy. While motor imagery inhibits overt output, the autonomic nervous system (ANS) involved in central operations like motor planning and prediction escapes voluntarily control (Collet et al., 1999; for review see Guillot & Collet, 2005). The fact that motor simulation shares a close correspondence with motor execution, we should also expect to find similar physiological correlates. Decety and others (1991) measured cardiac and respiratory activity in subjects during mental simulation of actions like walking or running on a treadmill at various speeds. When the speed of imagined walking changed from 3 mins at 5 km/h to 3mins at 8 km/h and finally to 3 min at 12 km/h, autonomic activation increased proportionally to the imagined effort. Likewise, physiological changes induced during motor simulation have also been replicated in studies involving weightlifting performance (Decety et al.,1993). When simulating leg exercises with a 15 and 19 kg load, Decety et al. (1993) demonstrated that both heart and respiratory rates increased. Furthermore, similar autonomic responses between motor execution and simulation have also been reported when participants observe effortful actions generated by others (Paccalin & Jeannerod, 2000). In general, muscular strength increases when we repeatedly carry out a motor act. Yue and Cole (1992) found that through the simple process of rehearsing actions offline, we can also enhance motor performance. For example, one group physically flexed and relaxed their little finger (i.e., hypothenar muscles), whereas the other group mentally simulated the same action for the same amount of time. It was found that the group who physically executed the motor act exhibited a 30 percent increase of strength in that muscle, whereas the group who mentally simulated the motor act demonstrated a 22 percent increase. Both physically and mentally simulating the act enhanced muscular forces, supporting the *Motor Simulation Theory*. Overall, these findings suggest that autonomic activation associated with muscular force is encoded at the representational level i.e., during planning and preparation of actions.

After this consideration, it is important to examine the changes occurring in the brain where motor commands are generated. Brain imaging studies further support the notion that there is a parallel between motor imagery and actual movement (Jeanneord, 2001; Grezes, Decety, 2001). For instance, when imagining or executing hand movements similar cerebral structures are activated including: the posterior parietal cortex, premotor cortex, supplementary motor area, basal ganglia, cerebellum (Gerardin et al., 2000; Hanakawa et al., 2003). Volumes of activation tend to be weaker during motor imagery than during motor execution (Jeannerod, 2001). According to some studies using functional resonance imaging, the primary motor cortex is also active during motor imagery tasks, indicating that action simulation involves virtually all phases of motor control (Gerardin et al., 2000; Porro et al., 1996; Roth et al.,1996; Porro et al., 2000). However, the primary motor cortex has not been consistently found to be active during motor imagery suggesting action simulation only involves the early stages of action generation (Parsons et al., 1995; Hanakawa et al., 2003, Meister et al., 2004). The basis of what we know about similar neural mechanisms has been realized from patients with motor impairments. Patients with lesions restricted to the parietal cortex show deficits in using imagery in the first-person (i.e., motor imagery). In particular, they show difficulties in predicting the duration of simulated and executed movement, whereas patients with primary motor impairments and patients with inferotemporal lobe damage are just as accurate as healthy controls on motor imagery tasks (Sirigu et al., 2001). This suggests that the parietal cortex, which is involved in action planning and programming, is critical to motor imagery, whereas the primary motor and inferotemporal cortex activity may not be necessary at the representational stages of action. Moreover, it has been shown that patients with hemiplegia (Decety & Boisson, 1990) and patients with Parkinson’s disease (Dominey et al., 1994; Helmich et al., 2007) simulate actions as slow as executed movements. These effects are in line with the notion that motor simulation shares similar time durations, physiological correlates, and neural structures found operating during motor execution.

Implicit Motor Imagery in Mental Rotation of Hands

Action simulation involved in motor imagery can be implicitly triggered when individuals unconsciously simulate an action. As is the case in *Hand laterality judgement task*, where individuals are asked to identify the laterality of left-and right-hand images presented at different angles (Cooper & Shepard, 1975; Parsons, 1987a, 1987b, 1994; Sekiyama, 1982; Figure 1). It's thought that participants solve this task by mentally rotating their own hand into the orientation of the visually presented hand (Dalecki et al., 2012; Jeannerod & Decety, 1995; Parsons, 1994). Parsons (1994) conducted a series of experiments in which he asked participants to make hand judgements and found that the time taken to mentally rotate one's hand is similar to the time taken to execute the corresponding movement. Unlike external objects (i.e., 3-D objects), the mental rotations of one's own hand are strongly influenced by the same motor rules and anatomical constraints that shape real movements (Petit et al., 2003; Sekiyama, 1982). Consider the example of simulating a push up, in which one places their palms in an awkward orientation. It would be quite impractical and effortful to execute this motor act. Relative to motor execution, mental spatial transformation of hands presented at lateral orientations (i.e., facing away from mid-sagittal plane of the body) require an increased angle of rotation resulting in longer recognition times and greater errors. Whereas medial orientations of hands (i.e., facing towards the mid-sagittal plane of the body) generate the fastest and most accurate responses (Parsons, 1994). This notion of a medial-over-lateral advantage (MOLA) proposes close correspondence between certain kinematic and temporal characteristics of actual movements and their mental simulations (Bläsing et al.,2013; Dalecki et al., 2012; Parsons, 1994). Further, this conjecture is also supported by patients with congenital limb defects, such as Aplasia (Vannuscorps et al., 2012) and Amelia (Funk & Brugger, 2008) who demonstrate a biomechanical effect for their preserved and absent limbs. Similarly, chronic health conditions such as Parkinson's disease (Helmich et al., 2007; Scarpina et al., 2019; Bek et al., 2022), chronic arm/shoulder pain (Coslett et al., 2010), and focal hand dystonia (Fiorio et al., 2006) also show a biomechanical effect, but with reduced performance.

The anatomical constraints of the body appear to be more pronounced for palm than back views (Bläsing et al., 2013; Cooper & Shepard, 1975; Ionta et al., 2007; Parsons, 1987b, 1995; Sekiyama, 1982). Namely, response times for palm views are longer for lateral orientations compared to medial orientations, suggesting stronger biomechanical effects for this view (Bläsing et al., 2013; Zapparoli et al., 2014; Conson et al., 2017). Functional Magnetic Resonance Imaging (fMRI) data suggests that palm-view stimuli are processed by similar brain regions involved in motor simulation and execution, including the left supplementary motor area, left premotor and parietal cortices, while back-view stimuli are thought to include visual areas of the brain, including the bilateral lingual gyri and the right precuneus (Zapparoli et al., 2014). This supposed shift in strategy offers that when viewing back hand stimuli, participants employ visual strategies, whereas palm-hand stimuli employ motoric strategies (Bläsing et al., 2013; Gentilucci et al., 1998; Nagashima et al., 2021). Some patient's studies have proposed implicit motor imagery has a motoric nature (Rumiati et al., 2001; Sekiyama, 1982). For example, patients with parietal cortex damage who show intact mental simulation of 3-D objects, show impaired mental simulation of hands presented from first-person imagery (Rumiati et al., 2001; Sirigu & Duhamel, 2001). This strong dissociation makes intuitive sense, as mentally rotating objects relative to the environment (object-centered reference) do not adhere to same anatomical constraints of real movements (Howard, 1982). Differentiating between visual and motor strategies requires factoring in visual and sensorimotor familiarity. For example, when we use our hands to type, we are accustomed to looking at the backs of our hands, whereas writing with our palms is motoric in nature. Further evidence is provided by those with unilateral amelia (Funk & Brugger, 2008). For example, unilaterally amelic patients show an advantage in identifying their preserved hand compared to their absent hand. In particular, they respond faster to hands from the back view than from the palm view, demonstrating that visual and sensorimotor are fundamental to solving the laterality task. View is not the only variable influencing imagined spatial transformations of limbs; laterality is also significant (Cheng et al., 2020; Ionta et al., 2007; Ionta & Blanke, 2009; Parsons, 1987b). Right-handed participants recognize right hands faster, whereas left-handed participants do not show a left-hand preference (Gentilucci et al., 1998). When framed in relation to hand preference, right-handed participants show a left-hemispheric dominance for motor control (Tomasino et al., 2003).

The configuration of one's body in space is important during motor imagery tasks, as proprioceptive information influences aspects of simulated movements (Conson et al., 2015; Ionta et al., 2007; Ionta et al., 2012; Shenton et al., 2004; Sirigu & Duhamel, 2001; Saimpont et al., 2021). When mentally rotating hands, actual limb posture has been shown to disrupt response times. Ionta et al., (2007) required participants to place their hands either on their knees or behind their backs with the fingers intertwined and verbally judge the laterality of hand images. It was found that mental rotation times were slower for the back compared to the front postural position, verifying actual biomechanical constraints influence mental rotation tasks. In contrast, when asked to perform the same task using a third-person perspective (i.e., rotating someone else's hand), mental rotation times were faster in the back than frontal postural position suggesting the use of non-motor mechanisms (Sirigu & Duhamel, 2001). These studies support the hypothesis that mental rotation of hands recruit specific motor planning and preparation processes subjected to the same motor rules of real actions.

Age-Related Differences in Motor Imagery

As people age, reductions in specific cognitive abilities like motor action simulation (Saimpont et al., 2009; Skoura et al., 2005) and action planning/prediction (Gabbard et al., 2011; Personnier et al., 2008; Skoura et al., 2008) are commonly experienced. There are now several examples of mental imagery tasks involving mental rotation of 3-D objects (Puglisi & Morell, 1986), alphabetical letters (Cerella et al., 1981; Dror & Kosslyn, 1994; Iachini et al., 2019), and human faces (Adduri & Marotta, 2009; Habak et al., 2008) that have shown older adults to be slower and/or less accurate than younger adults. For instance, Dror and Kosslyn (1994) found that older adults require more time to mentally rotate figures as the angle of rotation increases. This outcome may relate to the idea that specific components of imagery such as image generation (i.e., ability to form a mental image) and image manipulation (i.e., the ability to spatially transform a mental image) are deteriorated in older adults (Briggs et al., 1999; Craik & Dirkx, 1992; Dror & Kosslyn, 1994; Schott, 2012).

A similar age-related slowing and decline in accuracy has also been well-documented in motor imagery tasks (Beauchet et al., 2010; Gabbard & Cordova, 2013; Mulder et al., 2007; Personnier et al., 2010; Skoura et al., 2005; Saimpont et al., 2015; Zapparoli et al., 2014). When imagining whole-body movements, older adults show a greater decline in performance accuracy compared to younger adults (Saimpont et al., 2010; Devlin & Wilson, 2010). In locomotion tasks involving executing and simulating walking movements over varying distances, older adults generally underestimate their mental walking times. However, when older adults perform and simulate walking movements along paths of different widths (15 cm, 25 cm, and 50 cm), chronometric data shows that they overestimate mental walking times (Personnier et al., 2010). The same pattern of age-related temporal discrepancies was also observed in pointing arm movements, where older adults' covert movements did not adhere to the same motor rules and biomechanical constraints as overt movements (Paizis et al., 2014). Despite following the same speed-accuracy trade-offs for executing motor actions, their ability to simulate internal actions decreases when the spatiotemporal constraints (speed-accuracy trade-offs) of a task increase (Schott & Munzert, 2007). When imagining parts of the body (i.e., hands), the ability to implicitly simulate complex upper-limb movements declines with aging (De Simone et al., 2013; Iachini et al., 2019; Saimpont et al., 2009; Saimpont et al., 2013; Sapsford et al., 2016). Saimpont et al., (2009) demonstrated that older adults were less accurate than their younger counterparts for hand rotations requiring greater amplitude of displacement, like the palm of the hand at 90° lateral (90°L) or the back of the hand at 180° orientation that require greater motion of the limb joints. In a related study, De Simone et al., (2013) also showed that older adults had lower accuracy and longer response times for biomechanically awkward hand orientations. Consistent with the motor simulation hypothesis, biomechanical constraints normally applied during real movements affect mental simulations of hands in aging populations, particularly for non-dominant hands (Personnier et al., 2008; Saimpont et al., 2009). In comparison to younger adults, right-hand dominant older adults have a more pronounced difference for their left hand when executing and simulating motor actions (Skoura et al., 2008). Overall, implicit motor imagery is well preserved in older adults, although it may be altered for complex upper-limb movements (for review see Saimpont et al., 2013).

Sex Differences in Mental Rotation of the Hand

While sex differences in the mental rotation of objects have been widely acknowledged (Campos, 2014; Parsons et al., 2004; Linn & Pertersen, 1985), studies of implicit motor imagery have not yielded conclusive results. Using a simple paper-and-pencil version of the Hand Mental Rotation Test (Bonda et al., 1995), Karádi and others (1999) found a male advantage for hands presented at 180° orientations. Other studies, however, report no differences in accuracy performance between males and females (Teng & Lee, 1982; Seurinck et al., 2004; Mochizuki et al., 2019). When solving the classical version of hand laterality judgment task, response time differences between men and women are evident. Men judge the laterality of left-handed stimuli faster than women (Mochizuki et al., 2019). Moreover, sex differences have been found when judging hand laterality of right and left images from different views (Conson et al., 2020). For instance, males exhibit faster response times when viewing palm hand stimuli at 0°, 90°, and 180° orientations, while women display faster response times when viewing right back hands at 0° orientation and left back hands at 0° and 90° orientations (Conson et al., 2020). Consequently, males and females use different motor simulation strategies depending on which side of the hand is being shown, with males mainly using motor strategies for palm-view stimuli and females using visual strategies for processing back-hand stimuli. The above-cited literature on this topic reveals sex differences in implicit motor imagery use between males and females.

The Current Study

Hypotheses

Participants in this study will judge the laterality of left-and-right hand images from two different views and four different orientations. Overall, hand stimuli presented at difficult orientations, such as 90°L and 180°, are expected to produce the greatest alterations to performance. As these orientations impose greater anatomical constraints, longer response times and decreased accuracy were expected. In addition, the supposed shift in strategy when judging hand laterality of right and left images from different views is expected to show a medial-over-lateral-advantage (MOLA), particularly for palm-views. Increased response times and error rates for stimuli presented at canonical orientations (0° and 90°M) were not expected. In view of well-documented declines in sensorimotor and cognitive functions in aging populations, it was hypothesized that older adults will be less accurate and have slower reaction times than young adults in their left-right hand judgments when presented with hand stimuli in both simple and difficult orientations. As both males and females exploit motor simulation processes differently, it was anticipated that older women will perform better on stimuli presented from the back, while older men will perform better on palm-view stimuli. Overall, simulated hand movements were expected to obey the same motor rules and biomechanical constraints that govern real-world hand movements.

CHAPTER II

GENERAL METHODOLOGY

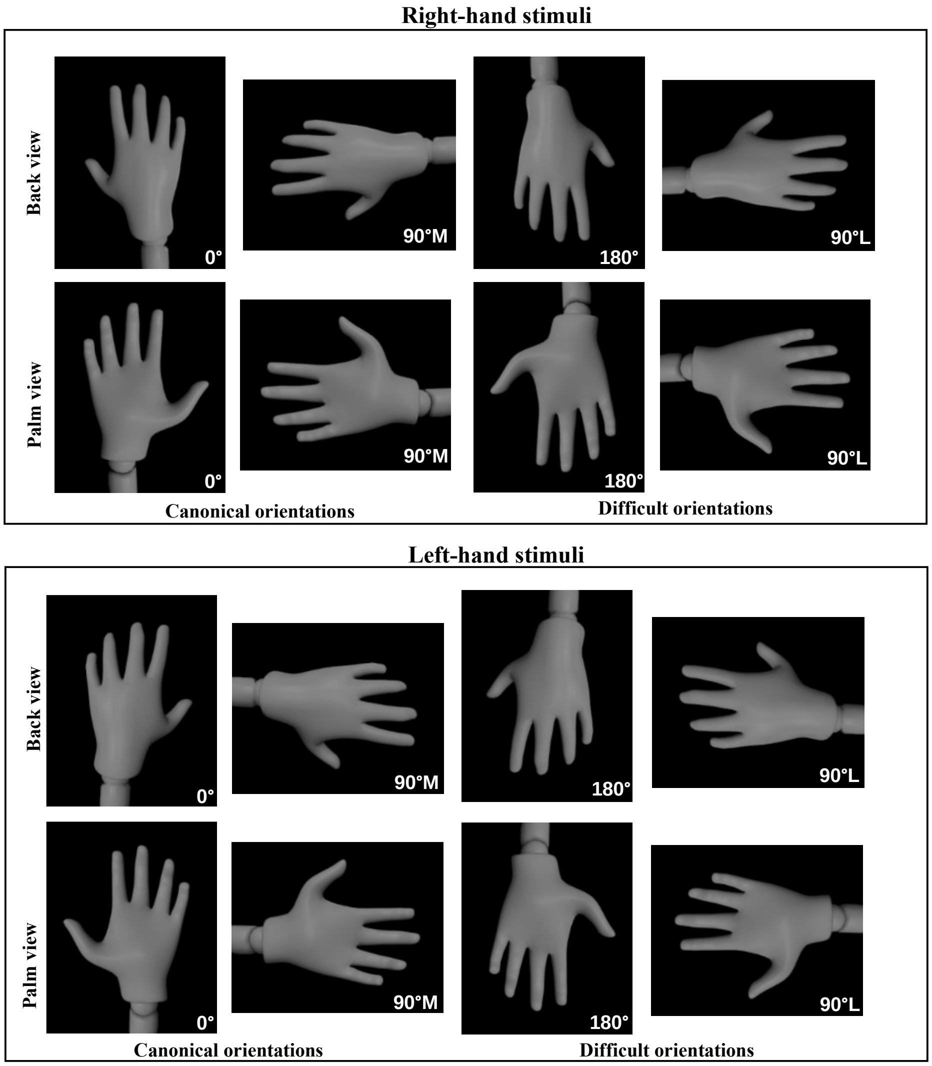
Forty right-handed young adults (20 male, 20 female; age range 17- 37 years old; *M* = 22, *SD* = 5.05) with normal or corrected-to-normal vision were recruited from the University of Manitoba's psychology participant research pool and received course credit for their participation. Forty-two right-handed old adults (17 male, 25 female; age range 65- 94 years old; *M* = 76.2, *SD* = 7.38) with normal or corrected-to-normal vision were recruited through local newsletters, word of mouth, talks presented at independent living facilities, and finally through the Centre on Aging's database (see Appendix A for recruitment material). Two older adults were excluded from the study due to motor impairments. A total of forty right-handed old adults (16 male, 24 female; age range 65- 94 years old; *M* = 76.5, *SD* = 7.33) were included in the study. Informed consent was provided electronically by younger adults (see Appendix B), whereas written consent was obtained from older adults before beginning the experiment (see Appendix C). After consent was obtained, participants were instructed to complete several demographic questions regarding sex, age, visual acuity, and handedness (using a modified version of the Edinburgh Handedness Inventory; Oldfield, 1971; see Appendix D). All participants engaged in regular physical exercise, cognitive activities, (e.g., reading books, doing puzzles, etc.) and had no known neurological problems. Participants over the age of 65 completed a modified version of the Mini Mental State Examination (MMSE; Folstein et al., 1975; see Appendix E) and received a mean score of 28.7 (*SD*= 1.8). The simple reaction time (SRT), in which participants responded to stimuli with both hands was also measured (young: right= 288 ms [*SD*=62.2], left= 291 ms [*SD*=63.4]; old: right= 404ms [*SD*= 67.5], left=398 ms [*SD*=68]). After the testing session, all participants underwent debriefing (see Appendix F). All participants were naive to the purpose of the experiment. The research complies with the American Psychological Association ethical standards in the treatment of participants and has been approved by University of Manitoba Research Ethics Board, Fort Garry, our Faculty, the COVID Recovery Response Team, the COVID Recovery Steering Committee, and the University Provost.

Stimuli and Materials

The task was created using lab.js, an open-source online experimental platform for behavioral and cognitive sciences (Henninger et al., 2019). Participants were shown grey-coloured depictions of left or right mannequin hands measuring 578 x 447 pixels, created with Poser 4.0 software (Curious Labs, Santa Cruz, CA, USA). Target hand images were presented one at a time on a black background, measuring 800 x 600 pixels. Participants were shown right or left hands, displayed from two different viewpoints (palm and back) and in four different orientations: 0°=upright position, 90°medial= facing toward the midsagittal plane of the body, 90° lateral=facing away from the midsagittal plane of the body, and 180°= downright position (Figure 1). To indicate the laterality of left-and-right hand images, participants pressed the right-sided ‘K’ key for right-hand stimuli and the left-sided ‘A’ key for left-hand stimuli. The experiment was divided into 3 series, each consisting of 32 stimuli presented in random order. A total of 96 trials (2 [left- and right-hand images] x 2 [palm and back views] x 4 [0, 90°medial, 90° lateral, and 180°orientation] x 6 trials [in each)]) were administered to each participant. The stimuli presented in the virtual and in-person condition were exactly the same. The task programmed in lab.js was hosted on an online platform called Github.

Figure 1

Right- and left-hand stimuli



Note. This figure shows right- and left-hand stimuli displayed from two different viewpoints (back and palm) and in four different orientations: 0°, 90°medial (canonical orientations), 90° lateral, and180° (difficult orientations), used in the *Hand Laterality Judgment Task*.

Procedure

Virtual condition

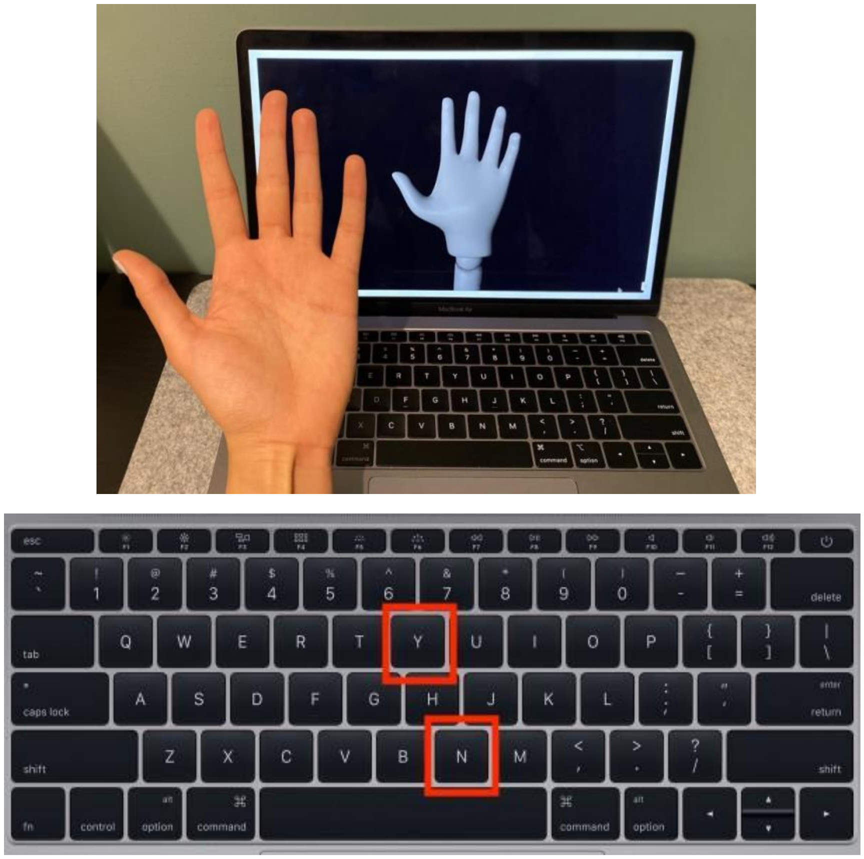
In accordance with COVID-19 restrictions, data collection was conducted remotely with younger adults. Prior to beginning the experiment, participants were instructed to sit in front of their computer device with their hands resting palm-down on the keyboard. Participants completed two training phases to familiarize themselves with the experimental protocol. Similar training phases were used in a previous normal aging study reported in Saimpont et al. (2009). In training phase one, 16 unique hand stimuli were presented on the screen to ensure all participants could physically move and match their hands to the stimuli (Figure 2). The instructions provided real hand images that matched the experimental hand stimuli to clarify the task. Participants pressed the ‘Y’ key to indicate their ability to physically move and match their hand to the image displayed on the screen, and the ‘N’ key if they were unable to do so. Participants unable to physically move and match their hand to the screen image were excluded from the analysis. Each trial began with a white fixation cross appearing on the computer screen for 1500 ms, followed by a target hand image that remained on the screen until the participants physically attempted to move and match their hand to the orientation and view of the hand-stimuli.

The second training phase was designed to familiarize participants with left-and-right hand images presented in different orientations and views. Participant completed 32 practice trials in this training phase to ensure they were performing the trials according to the instructions. Participants did not physically move and match their hands to the image displayed on the screen. Instead, participants selected the ‘K’ key for right hand-stimuli and the ‘A’ key for a left hand-stimuli (Figure 3). The trials were interspersed with a white fixation cross (displayed for 1500 ms), and a target image remained on the screen until the participants indicated the laterality by either pressing either the left or right button on the keyboard.

Once the trial ended, participants were shown a screen to prepare them for the next trial (Figure 4). Once both training phases were complete, participants began the experimental phase. The experimental phase included the same instructions provided in phase two, except participants were instructed to respond as quickly and accurately as possible. Upon finishing the experiment, participants were directed to the debriefing form.

Figure 2

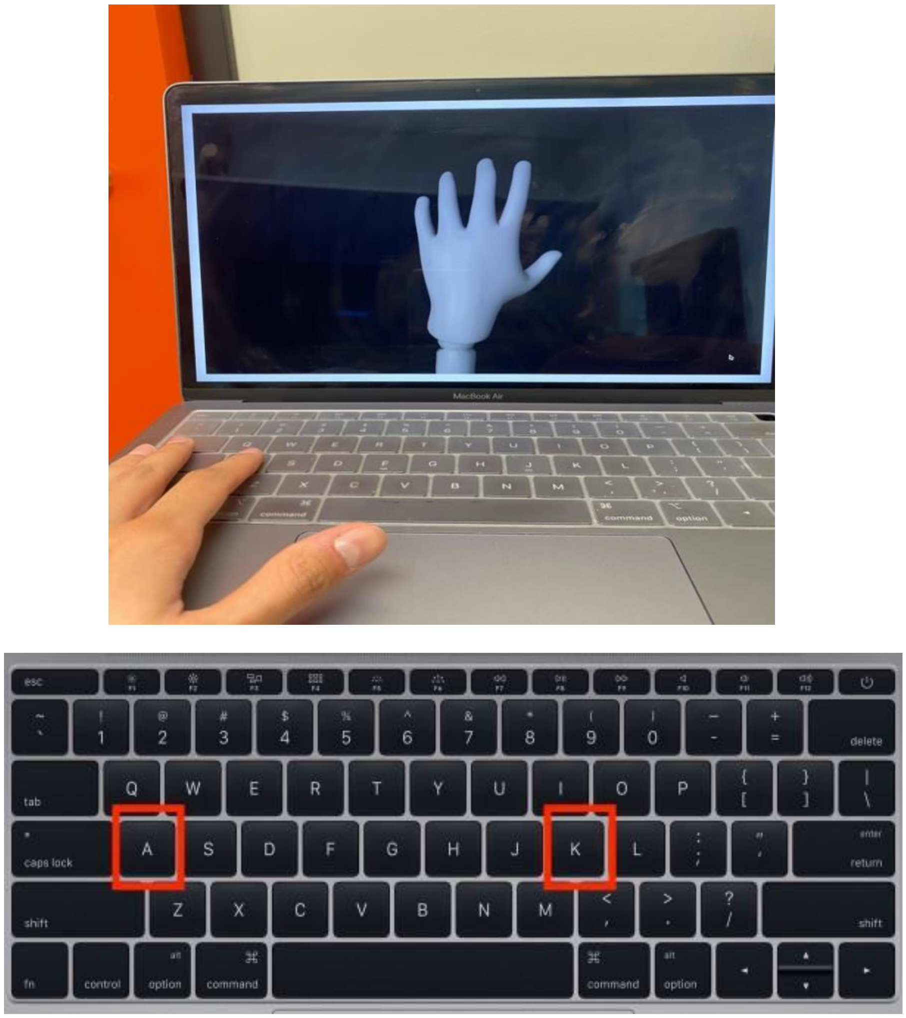
Training phase one



Note. Participants physically moved and matched their hands to the stimuli. If they could match their hand to the image displayed on the screen, they pressed the 'Y' key, whereas if they could not do so they pressed the 'N' key.

Figure 3

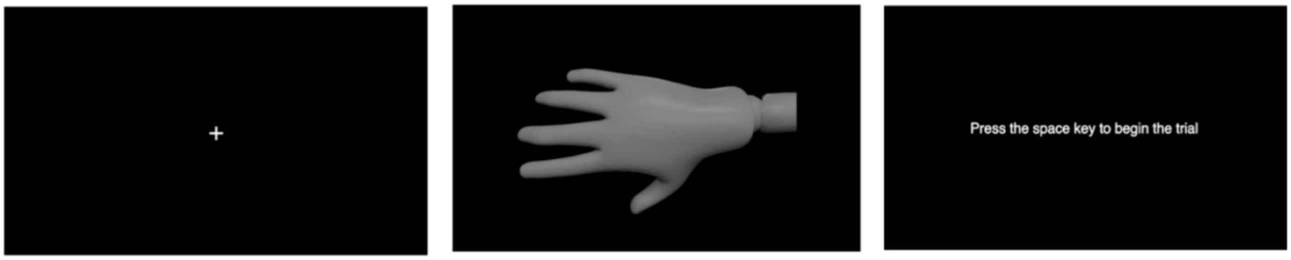
Training phase two



Note. Participants used their mental abilities to determine the laterality of left- and right-handed images presented in different orientations and views by placing their hands on the keyboard. In this phase, participants did not physically move and match their hands to the image displayed on the screen. Participants selected 'K' for the right-hand stimulus and 'A' for the left-hand stimulus.

Figure 4

An example of a typical trial



Note. Each trial will start with a white fixation cross (1500ms) followed by the target picture (Back view, right-hand at 90° M) and end with a "Press the space key to begin next trial" screen to ensure participants are ready for the next trial.

In-person condition

As COVID-19 restrictions eased slightly, permission was sought to test older adults in-person to ensure minimal loss of data. Detailed information regarding the study was provided through phone calls and emails to participants. Data collection appointments for in-person data collection were sent to interested participants. As a preventative measure against COVID-19, the researcher and participant were required to be fully vaccinated and wore reusable or disposable masks during the experiment. On the day of the visit, both the researcher and participant were screened for COVID-19 related symptoms (see Appendix G). COVID-19 screening requirements were met by all participants. A disinfected laptop was set up in the participants home while maintaining a distance of 2 meters. Following the setup, participants began the experiment. A link to the experiment was emailed to participants who chose to use their personal computer device. The researcher monitored participants' motor movements during training phase one, which required them to move and match their hands to stimuli. For training phase two, researchers made sure that participants utilized motor strategies by pressing either the A key (left-hand stimuli) or the K key (right-hand stimuli) instead of physically moving their hands. After the training phases, the experimental phase began, which was similar to the virtual condition. During this phase, the researcher reminded participants not to physically move and match their hands to the hand-stimuli presented and respond as quickly and accurately as possible. All equipment was thoroughly disinfected following the in-person visit.

To account for possible confounding variables, eight younger adults (2 male, 6 female; average age 19) with normal or corrected-to-normal vision were recruited from the psychology participant pool at the University of Manitoba. Similar measures were used for COVID-19, apart from the task taking place in *Neuropsychology of Vision: Perception and Action Lab*. The in-person and virtual conditions did not significantly differ on either dependent measure.

Data processing and analysis

The goal of the present study was to examine the effects of implicit motor imagery on aging using the *hand laterality judgment task*. Participants judged the laterality of right-and-left hand images displayed from two different viewpoints and in four different orientations. Analyses were mainly concerned with response times and accuracy.

Excluded data

In the RT analysis, experimental trials were excluded if they were two standard deviations above or below the mean (total loss, 4.7% of trials) or if they involved incorrect responses for trials (total loss, 12.2% of trials). In total, 16.9% of the response time experimental trials were excluded from the analysis (total loss, 12.8% of older adult trials and 4.5% of younger adult trials).

Dependent measures

As response times (RT) in the hand laterality judgement task closely correspond to task execution (Parsons, 1987;1994), I examined RTs, defined as the interval between the onset of a hand stimulus to the push of either an 'A' or 'K' response button. Accuracy was analyzed as the number of correct responses out of the total number of trials. With accuracy treated as count data, the proportion of errors was calculated for each unique condition based on 6 trials. Scores of 6 indicated 0% proportion of errors (i.e, 100% accuracy), scores of 5 indicated 16.6% proportion of errors (i.e., 83.3% accuracy), scores of 4 indicated 33.3 % proportion of errors (i.e., 66.7% accuracy), scores of 3 indicated 50 % proportion of errors (i.e., 50% accuracy), scores of 2 indicated 66.7% proportion of errors (i.e., 33% accuracy), scores of 1 indicated 83.3% proportion of errors (i.e, 16.7% accuracy), and scores of 0 indicated 100% proportion of errors (i.e., 0% accuracy).

In order to evaluate the above hypotheses, trial data within each condition was averaged to create mean condition values for each participant. Response times for correct trials were analysed with a 2 (sex; between-subjects) x 2 (age; between-subjects) x 2 (laterality; within-subjects) x 2 (view; within-subjects) x 4 (orientation; within-subjects) repeated measures Analysis of Variances using jamovi (Version 1.6). Any violations of sphericity were tested for using Mauchly's test and were addressed using a Greenhouse-Geisser correction. When interactions were present, post-hoc pair-wise comparisons were carried out using a Bonferroni correction. Response time analyses were limited to three-way interactions. Results of all pairwise comparisons can be found in Appendix H. Accuracy was analyzed using a Generalized Linear Mixed Model (GLMM) in jamovi (Version 1.6), assuming a Poisson distribution for count data with a log link function. Different models were fitted and tested using different combinations of fixed effects, followed by the removal of non-significant predictor variables (i.e., laterality). The final model included sex, age, orientation, and view as fixed effects, while participant ID was treated as a random effect to control for the influence of between-participants variation. The following GLMM was used to fit the data: Accuracy~1+ Sex + Age + Orientation+ View + (1|Participant ID). When interactions were present, post-hoc pair-wise comparisons were carried out using a Bonferroni correction. Results of all pairwise comparisons can be found in Appendix H.

CHAPTER III

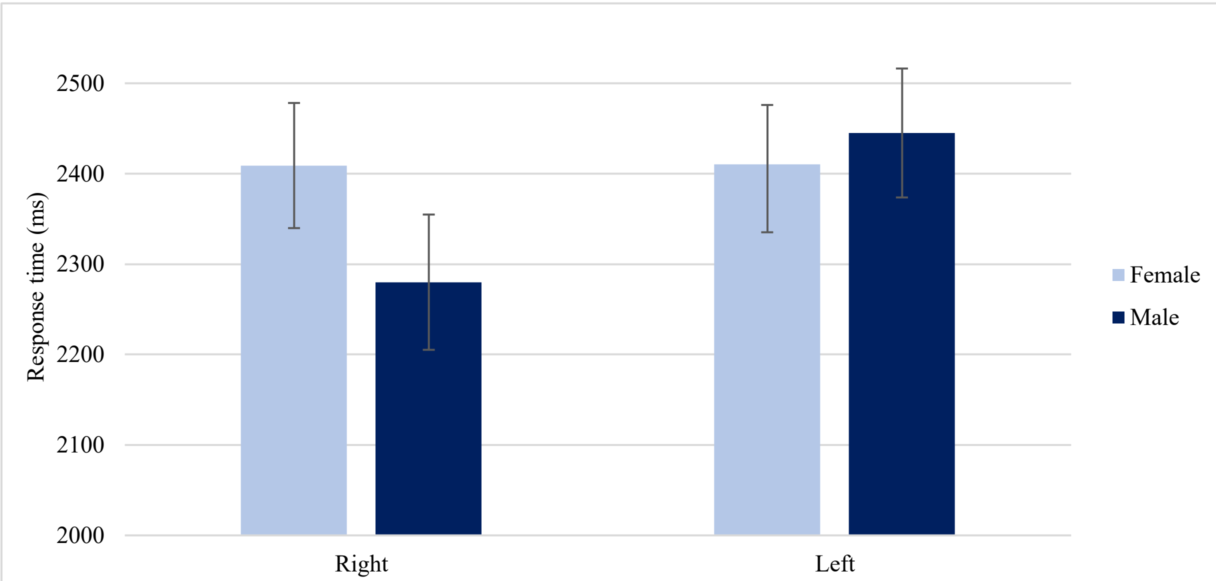
RESULTS

Response Time

The ANOVA revealed a significant interaction of Laterality x Sex, $F(1, 76) = 9.785$, $p < .05$, $\eta_p^2 = .114$ (Figure 5), with males responding faster to right than left hands ($p < .05$). A three-way Laterality x Orientation x Age interaction was found to be significant, $F(2.55, 193.77) = 2.869$, $p < .05$, $\eta_p^2 = .036$ (Figure 6). Post Hoc comparisons revealed that younger adults had faster response times for right-and-left hands than their older counterparts at both canonical (0° and 90°M; $p < .001$) and awkward orientations (90°L and 180°; $p < .001$). When presented with either right or left hands, both older and younger adults responded faster to canonical orientations (0° and 90°M; $p < .001$) than difficult orientations (90°L and 180; $p < .001$). Particularly, older adults were faster to respond to right hands placed at 90°M than 0° and the same orientation presented from the left hand ($p < .05$). Furthermore, left hands presented at 180° showed slower spatial transformations than right hands presented at 90° L ($p < .05$). A View x Orientation x Age was found to be significant, $F(2.36, 179.23) = 2.942$, $p < .05$, $\eta_p^2 = .037$ (Figure 7). Planned comparisons revealed that younger adults had faster response times for both back and palm views than their older counterparts at both canonical (0° and 90°M; $p < .001$) and awkward orientations (90°L and 180°; $p < .001$). With increasing angles of rotation for both back and palm views, average response times increased for younger and older adults. Differences between canonical orientations for back-views for younger and older adults were found, with the fastest response times occurring at 0° ($p < .001$). While this difference was absent for younger adults when viewing palm-view stimuli from 0°, older adults were faster when viewing palm-view stimuli presented at 90°M ($p < .001$). Furthermore, back views showed faster response times than palm views presented at 0° and 90°L ($p < .001$), with the exception of 180°, which had the slowest response times ($p < .001$). For older adults, the MOLA effect was revealed for both back and palm views, whereas for younger adults, this effect was only evident for palm views. In addition, lateral orientations presented from palm-views showed greater alterations to performance for younger and older adults ($p < 0.05$).

Figure 5

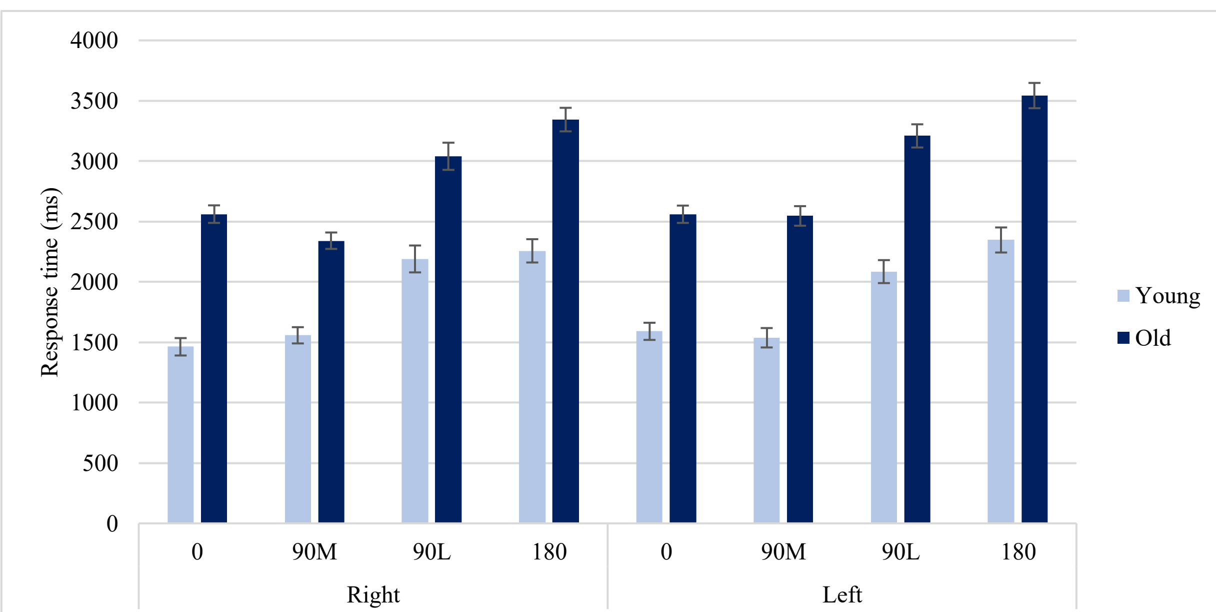
Laterality x Sex



Note. Average response time to right and left hands for females and males. Error bars represent standard error of mean.

Figure 6

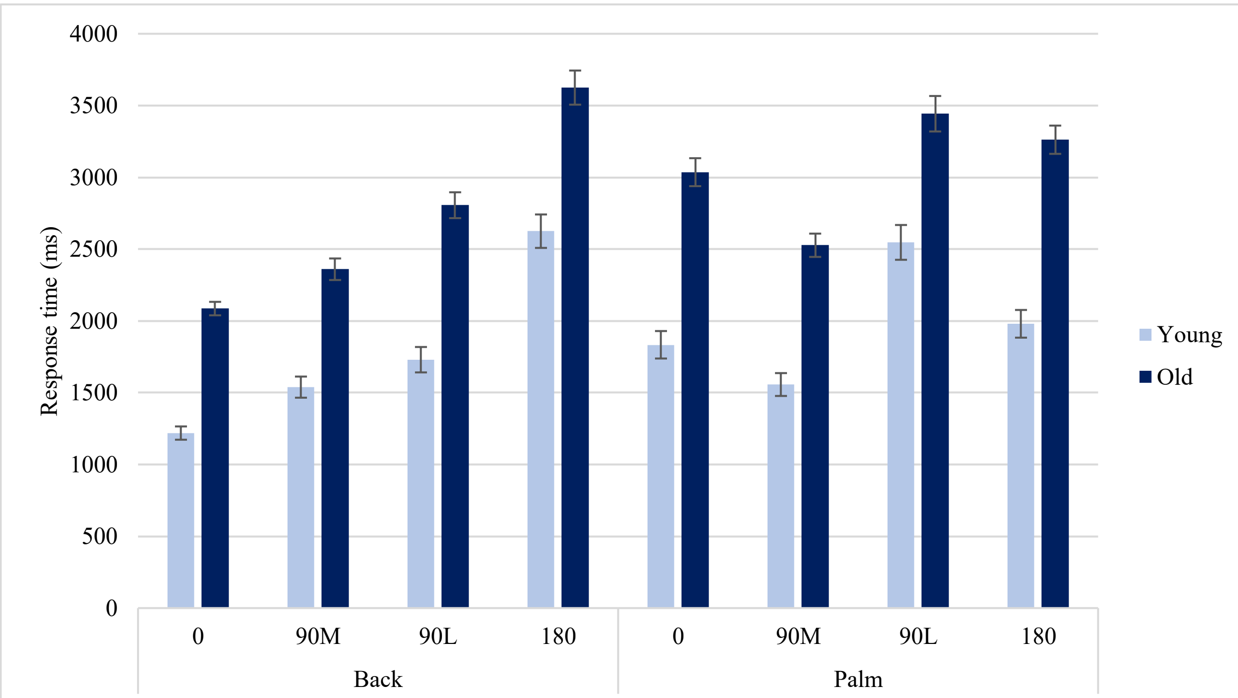
Laterality x Orientation x Age



Note. Average response time to right and left hands at the four different orientations for younger and older adults. Error bars represent standard error of mean

Figure 7

View x Orientation x Age



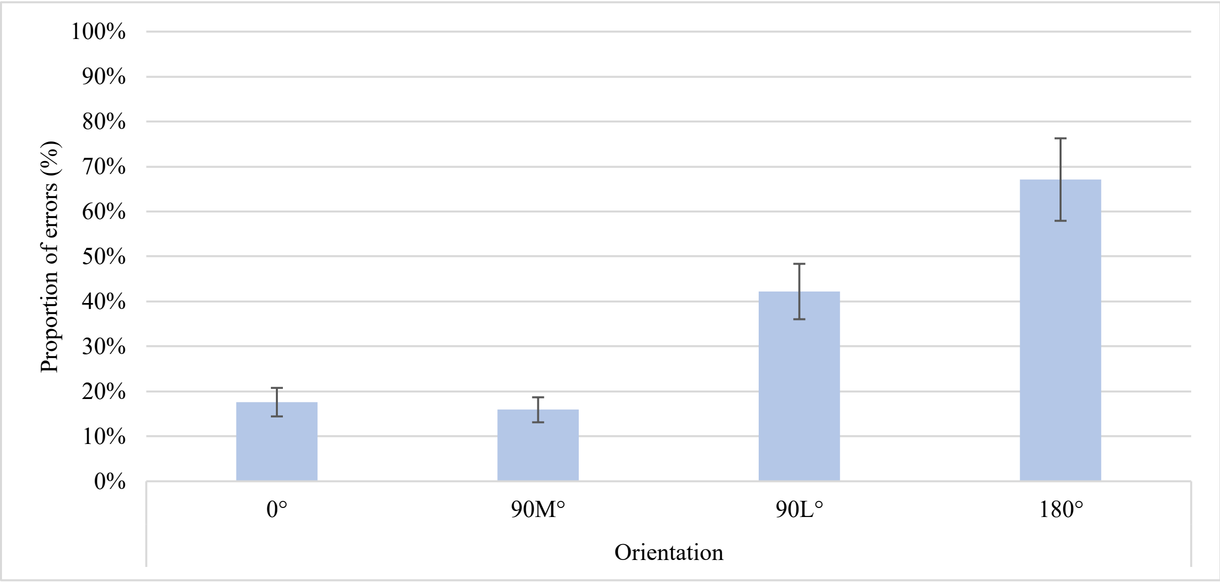
Note. Average response time to back and palm views at the four different orientations for younger and older adults. Error bars represent standard error of mean.

Accuracy

In examining the frequencies of errors participants made when indicating the laterality of right-and left-hand images, a significant main effect of orientation was found, χ^2 (3) = 167.07, *p* < .001 (Figure 8). Higher proportion of errors occurred at 90L° and 180° (i.e., difficult orientations) compared to 0° and 90°M (i.e., canonical orientations), without differences between the canonical orientations (all *ps* < .001). A View x Orientation interaction was found to be significant, χ2 (3) = 95.02, *p* < .001 (Figure 9). For back views, errors increased as the angle of rotation increased, with no differences between canonical orientations, and the highest errors occurring at 180° ($p < .05$). The proportion of errors was also higher for palm views presented at biomechanically awkward orientations (90°L and 180°; $p < .001$) than for canonical orientations (90°M; $p < .05$). Furthermore, differences for canonical orientations were found for palm-view hands, with higher errors occurring at 90°M compared to 0° ($p < .001$). A comparison of palm views presented at 0° and 90°L orientations with the same orientations presented from the back view revealed greater proportion of errors ($p < .05$). An Age x View x Sex interaction was found to be significant, $\chi 2$ (3) = 5.98, $p < .05$ (Figure 10). Age was found to be associated with a greater proportion of errors at both viewpoints in older adults compared to younger adults ($p < .001$). Furthermore, younger males made more errors when viewing hands from the palm view compared to back view ($p < .05$). While both young and older males made more errors for palms than back views, this difference was only apparent in older females and not younger females ($p < .001$).

Figure 8

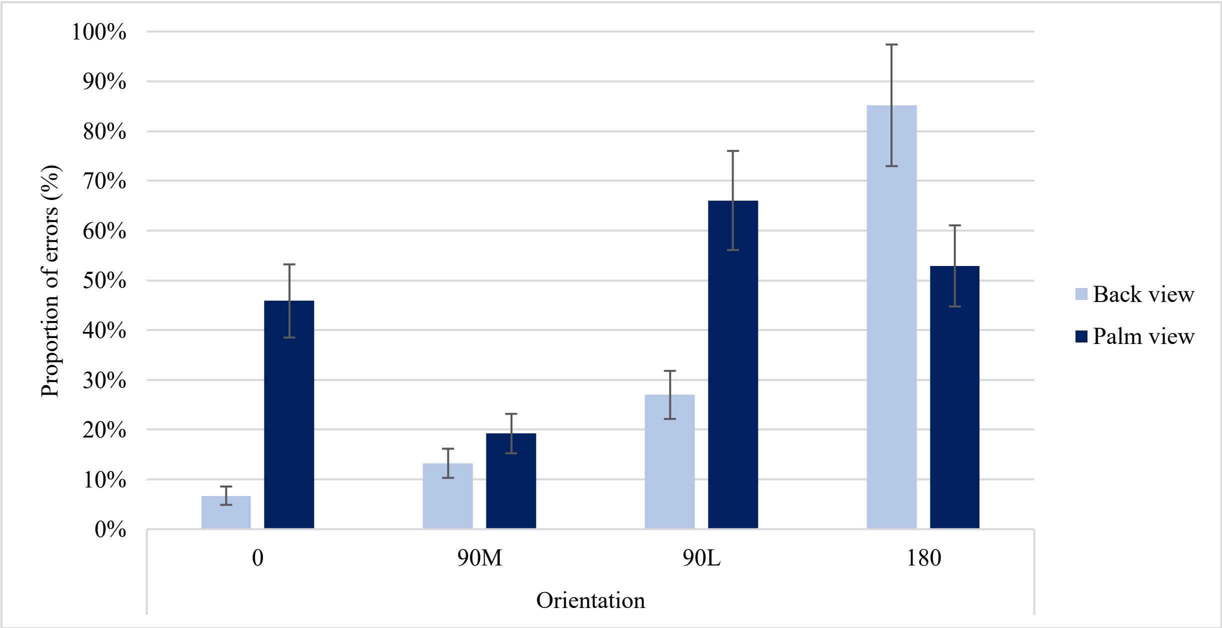
Orientation



Note. Average proportion of errors at the four different orientations. Error bars represent standard error of mean.

Figure 9

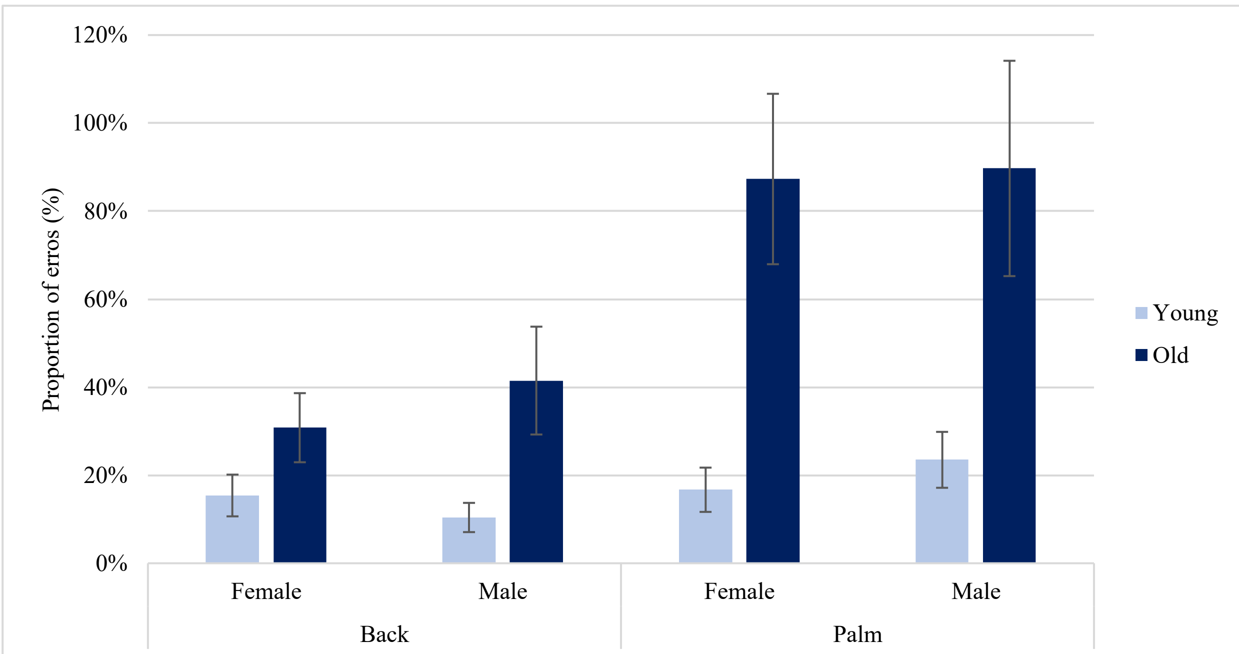
View x Orientation



Note. Average proportion of errors at the four different orientations for back and palm views. Error bars represent standard error of mean.

Figure 10

Age x View x Sex



Note. Average proportion of errors to back and palm views for younger and older adults, separately in females and males. Error bars represent standard error of mean.

CHAPTER IV

GENERAL DISCUSSION

The aim of this study was to explore age-related differences in implicit simulation processes using the *Hand laterality judgement task* (HLJT), in which individuals had to identify the laterality of right- and left-hand images displayed from two different viewpoints and in four different orientations. We sought to determine if biomechanical effects emerge for different views and orientations; if similar strategies are used during implicit motor processes between younger and older adults; if aging on its own impairs the ability to mentally simulate both simple and complex hand movements; if sex differences play a role in implicit motor processes and if they become more pronounced with age. If one considers the motor rules and anatomical constraints that define real movements, it shouldn't be surprising to find similar patterns when mentally simulating those movements. Considering the difference in response times and errors between difficult (i.e., 90°L and 180°) and canonical orientations (i.e., 0° and 90 °M), one can infer that the participants mentally rotated the experimental hand stimuli in a manner consistent with previous research (Parsons, 1994). Although a supposed shift in strategy when viewing back hand stimuli (i.e., visual strategies) and palm-hand stimuli (i.e., motoric strategies) was observed, response times and proportion of errors made when indicating the laterality of right-and-left hand images occurred in a manner consistent with the *Motor Simulation Theory* (Jeannerod, 2001). Overall, simulated hand movements obeyed the same motor rules and biomechanical constraints that govern real-world hand movements.

Orientation-by-view effects

With the less familiar palm view, there was a greater emphasis on motor imagery, as evidenced by an overall increase in response times and errors. Based on these findings, motor representations of the hand are more closely associated with first-person perspective than with third-person perspective. Using imagery in the first-person, the configuration of one's hand in space is used as a reference point to align the hand with the visually presented stimuli. In other words, internal representations of the hand in action are initiated, which, aided by top-down processing, allow individuals to solve the task without executing the action itself. As a result, rotating hands from simple to upright positions is easier than rotating hands from difficult to upright positions, where more rotational axes are involved (Shepard & Metzler, 1971; Parsons, 1994). Consequently, participants appeared to mentally rotate hand stimuli into the upright position of their own hands placed on the keyboard. When presented with orientations that required fewer rotations, they were able to simulate upper-limb movements more easily by aligning their own hands with the experimental stimuli. However, as the rotation angle increased, the mental effort required to complete the task also increased, as indicated by slower response times and higher error rates.

The biomechanical constraints of motor imagery resulted in a medial-over-lateral advantage (MOLA) when imagining spatial transformations of upper-limb movements. In accordance with the previously reported MOLA (Cooper & Shepard, 1975; Parsons, 1994; Zapparoli et al., 2016), rotations made away from the body's midline when compared with rotations made towards the body's midline produced the greatest alterations to performance. Given the findings discussed in the introduction, this notion of a MOLA is likely to occur because one's hand configuration affects imagined spatial transformations made during the task. Consistent with this, the effort required to carry out lateral rotations is greater than that of medial rotations, verifying motor imagery mirrors hand mechanics of real movements. The presence of a stronger MOLA was observed for palm views, which supports the idea that palm-hand stimuli employ motor strategies (ter Hortst et al., 2010; Bläsing et al., 2013). In particular, viewing palms in lateral orientations resulted in a 1000 ms longer response time and 50% more errors than viewing palms in medial orientations. Consider, for example, how difficult it is to orient the palm in a lateral direction (i.e., starting at 0° and rotating counter clockwise by 90°) despite the smaller angle of rotation. As one moves along a longer path (i.e., starting at 0° and rotating clockwise by 270°), the hands undergo less biomechanical strain despite increased rotational angle. Compared to 180° views, palm views at 90°L showed a greater increase in response time and error. In keeping with previous studies, the increased processing time for lateral orientations might be explained by the fact that participants followed a longer pathway when the shortest one was not biomechanically feasible (Shiffrar and Freyd, 1990, 1993). Moreover, this increase in rotational axes to achieve a desired position supports the facilitation of motor imagery (ter Hortst et al., 2010). By this account, proprioceptive input (i.e., the on-line position of the participant's hand) is critical to action simulation, especially when viewing hands from the palm (Ionta et al. 2007; Shenton et al., 2004). This is commonly understood to reflect motor simulation processes, as the biomechanical constraints encoded at the representational level (i.e., during planning and preparation of actions) closely correspond to overt actions (Parsons, 1987, 1994; Jeannerod & Frak, 1999). Unlike object-based mental rotations that follow a linear pattern with increasing rotation, mental simulations of upper-limbs are not linearly modulated by angular rotations of the hands (Devlin & Wilson, 2010; Sekiyama 1982). A nonlinear pattern of response time and accuracy was also observed for palm-view stimuli at canonical orientations, with better performance at 90°M than 0°. Similarly, previous literature has also reported faster response times for medial compared to upright positions (Conson et al., 2020; Saimpont et al., 2009), although similar results were not observed for accuracy. Considering participants' familiarity with the upright position and its lack of rotation, it may have been difficult to distinguish between back 0° and palm 0° views, resulting in longer response times and greater errors. It is further possible that the grey-coloured depictions of right and left mannequin hands disturbed the ability to discern differences between the two views.

When attempting to judge the laterality of right-and-left hands from the back view, response times and errors increased proportionally to the angle of rotation as previously observed for 3-D objects (Cooper & Shepard, 1975). Given the linear relationship between response time and errors with rotation of the hand, it seems visual strategies are employed to simulate hands viewed from the back (ter Horst et al., 2010; Bläsing et al., 2013). The reliance on a visual strategy for back-view stimuli, suggests that participants used third-person imagery (i.e., rotating someone else's hand) rather than the on-line position of their hands to solve the task. This claim is further supported by the absence of a MOLA for this view, as demonstrated by no difference between medial and lateral orientations. While one can argue that back 180° orientations are subject to greater anatomical constraints than palm 180° orientations, the MOLA that has long been used to indicate the use of motor imagery is absent for back-views. As with external objects (Kolers & Pomerantz, 1971), participants followed the shortest rotational pathway when presented with back-view hand stimuli, as shown by their reduced response times and higher error rates for lateral than downright positions. In view of the imagined path chosen for back-view stimuli, hand properties for lateral movements were not accounted for, suggesting that visual strategies were employed in this instance. An explanation for the lack of difference between medial and lateral orientations can also be attributed to visual familiarity with the hand. In this study, participants indicated right- and left-hand laterality via keypress responses. While solving the task, participants may have been accustomed to looking at the back of their hands to simulate actions, suggesting a greater reliance on visual imagery. Accordingly, the fastest spatial transformations of upper-limb movements occurred at back views presented at 0° orientations. Visual familiarity with this given hand position in everyday settings would explain these results (Parsons, 1994). In view of large overlap of the systems involved when viewing the back of the hand, one should interpret the difference between visual and motor strategies as a partial dissociation (Zapparoli et al., 2016).

Age-related Declines in Implicit Motor Imagery

In terms of solving the HLJT, participants utilized both motor and visual strategies depending on the view and orientation of the experimental hand stimuli. As expected, the relative importance of each view and orientation varied with age, with older adults performing significantly worse in terms of response times and accuracy – with increasing hand trajectory and biomechanical constraints older adults' response times increased. Interestingly, the current study, however, found a more prominent increase in response times for older adults when compared to previous studies (De Simone et al., 2013; Saimpont et al., 2009). The results are in support of previous research (Saimpont et al., 2009) in that older adults show more pronounced declines for anatomically restricted orientations (De Simone et al., 2013; Saimpont et al., 2009). In contrast to Saimpont et al. (2009), this study measured differences in viewpoints and found that both back and palm views showed greater age-related biomechanical effects in older adults. Response times increased roughly by 1000 ms for canonical and difficult orientations, respectively. When considering viewpoint differences, a MOLA was seen for back and palm views in older adults, but only for palm views in younger adults. As discussed earlier, mental rotations of hands may rely on two imagery strategies depending on the view of the hand: motor strategies (i.e., using a first-person perspective) and visual strategies (i.e., using a third-person perspective). Generally, one utilizes motor strategies when observing palm-hand stimuli, and visual strategies when observing back-hand stimuli. Using the Kinesthetic and Visual Imagery Questionnaire (KVIQ), previous studies have reported a decline in visual dominance in older adults (Malouin et al., 2010; Mulder et al., 2007). This outcome may relate to the idea that specific components of imagery such as image generation and image manipulation are deteriorated for mental-visual images in older adult (Dror & Kosslyn, 1994). This suggests that older adults have difficulty manipulating back-views in a lateral direction, and thus may have a greater reduction in visual motor imagery than kinesthetic motor imagery.

However, other studies (Heremans et al., 2011) using the KVIQ did not report such a loss of visual dominance. Accordingly, a linear increase in response times was observed with the rotation of the hands for back views, suggesting an overall use of visual imagery. Furthermore, the difficulty regarding lateral direction for back views was exacerbated for palm views, which presented a more pronounced increase in anatomical constraints. Age-related changes in implicit motor imagery may further be explained by alterations in neural activity during the HLJT in older adults (Zapparoli et al., 2016). Particularly, visual areas of the brain have been shown to compensate for reduced motor imagery ability in older adults. Similar findings have been reported in patients with Parkinson's disease who rely on visual information to solve the HLJT in order to compensate for the decline in motor imagery (Helmich et al., 2007). As a result, the ability to simulate motor representations of upper-limb movement declines with age, especially with regard to canonical and difficult orientations of the palm.

When compared to younger adults, older adults generally had slower response times to right- and left-hands, particularly for their non-dominant hand. A similar age-related decline for the non-dominant hand has been observed in previous studies (Saimpont et al., 2009). The results from this study also showed a slower response to canonical and difficult hand orientation for right- and left-hands. Cognitive functions, such as speed of processing (i.e., the speed at which a cognitive task is completed), tend to decline with age (Salthouse, 1980, 1996). Age differences between older and younger adults may be explained by hand movement speed differences, as inferred from the simple reaction time (SRT) test. While this was not reported by Saimpont et al. (2009), it is important to note the current study included forty older adults, as opposed to previous studies that only had twenty, which may have increased the power to detect a difference. For canonical and difficult orientations, it was predicted that older adults would demonstrate a decline in accuracy; this was not observed. Older adults performed equally well on canonical and difficult orientations, suggesting that despite being slower to respond, the older adults were just as accurate as younger adults (Devlin & Wilson, 2010). This result extends that of prior studies showing older adults prioritize movement accuracy over movement speed (Seidler- Dobrin & Stelmach, 1998). When examining the effects of laterality, the differences are also explained by the fact that right-handed participants recognize right hands faster than left hands, whereas no such effect has been found for left-handed participants. (Gentilucci et al., 1998; Takeda et al., 2010). Similarly, older adults showed quicker responses for their right hand when viewing hands from canonical and difficult orientations. Particularly, faster response times were observed for right hands presented at 90°M when compared to left hands at 90°M and for right hands presented at 90°L when compared to left 180°. The results indicate that implicit motor imagery tends to decline with age, particularly when viewing the non-dominant hand in simple and difficult orientations.

In contrast to the orientation of the stimuli, age-related accuracy differences were observed for the view of the hand. When compared to younger adults, older adults had a higher proportion of errors at both viewpoints, but this difference was more apparent when considering palm-view stimuli. According to the results discussed above, as people age, reductions in specific cognitive abilities like motor action simulation (Saimpont et al., 2009; Skoura et al., 2005) are commonly experienced. Accordingly, a stronger emphasis on motor imagery was apparent with the palm view, as evidenced by an overall increase in errors. Considering palm-view stimuli employ more motoric strategies, it can be inferred that older adults' ability to implicitly simulate motor representations decreases with age. However, these differences should not be considered without taking sex into account.

Sex Differences in Motor Simulation Processes

When viewing the palm side of the hand, older males and females made significantly more errors than their younger counterparts. As the accuracy patterns between older males and females were similar, it appears that they employed similar strategies when simulating upper-limb movements. Considering that palm-view stimuli employ motoric strategies, it seems that older adults utilized motoric strategies to solve the HLJT, as evidenced by the 40% increase in errors when compared to back-view stimuli. This further supports the notion that older adults' ability to implicitly simulate motor representations declines. Contrary to palm-view stimuli, older males and females performed better on back-view stimuli, which do not adhere to the same anatomical constraints as real movements. This suggests that the decline in kinesthetic motor imagery is more pronounced than that in visual motor imagery for both older males and females. The results of this study agree with previous studies showing a decline in implicit motor imagery with age (Saimpont et al., 2009). To the best of our knowledge, this is the first study to demonstrate a decline in implicit motor imagery for older males and females when solving the hand laterality judgement task.

Younger males, but not younger females, showed a decline in accuracy when presented with palm-view stimuli compared with back-view stimuli. While previous studies have not found sex differences in accuracy when viewing hands in different views (Mochizuki et al., 2019; Conson et al., 2020), they have found that males responded faster to palm-view judgments (Conson et al., 2020). In contrast to previous literature that supported a male advantage for palm-views, our study found that males exhibited an advantage for back views when compared to palm views. Several studies have shown a male advantage in the mental rotation of external objects that rely on visual strategies (Campos, 2014; Parsons et al., 2004; Linn & Pertersen, 1985). Similarly, rotating hands from the back also elicits visual strategies, indicating that males show an advantage for visual motor imagery. In other words, young males approach the experimental hand stimuli like an external object in order to solve the HLJT. According to Vouyer and others (2017), males demonstrate an advantage for object-based transformations and not egocentric transformations, with greater accuracy but no differences in response times. In line with this, males exhibited greater accuracy when rotating their hand like an external object, while no differences in response times were observed. Similar age-related advantages of back-views are seen in males, suggesting that visual-motor imagery remains intact while implicit motor imagery declines. In previous studies, it has been reported that females perform better when viewing hands from the back than from the palm. However, our findings differed from those of Conson et al. (2020), showing no differences when comparing back and palm views among younger females. In light of this, it is likely that younger females may use a combination of motor and visual strategies to complete the HLJT. However, as women age, they show a greater decline in implicit motor imagery, as reflected by the increase in errors for palm-view stimuli.

It was found that males responded faster to right hands than left hands, whereas the same was not observed for females. In particular, males' response times to right hand stimuli were approximately 100 ms faster than left hand stimuli. These results may be explained by the faster reaction times observed for males when using their dominant hands compared with their non-dominant hands. When solving the HLJT, males may show a preference for their visual and sensorimotor familiar dominant hand. Similarly, it has also been shown that males respond faster when viewing right hands from the back of the hand (Conson et al., 2020). However, other studies have reported no differences between men's responses to left- and right-hands (Mochizuki et al., 2019). Generally, right-handed participants are faster at recognizing right hands, but further research is still needed to examine sex differences when determining the laterality of the hands.

Future directions

Several studies have demonstrated that the back of the hand employs visual strategies (i.e., a third-person perspective), while the palm of the hand employs motor strategies (i.e., a first-person perspective; Bläsing et al., 2013; Gentilucci et al., 1998; Nagashima et al., 2021). When viewed from the back, the anatomical constraints of the body seem to be less pronounced than the palm view of the hand. As a result, faster response times were observed for this view, regardless of one's age and sex. Moreover, accuracy for this view was higher in younger and older males and females. There is still a need to explore what role vision plays in judging hand laterality when viewing back and palm views, since several aspects of behavior patterns that occur during simulation have not been examined. Future work in this area will examine eye-movement dynamics during the *Hand Laterality Judgment Task* to determine whether participants use any visual cues (e.g., thumb or little finger of the hand) when simulating upper-limb movements.

The results of this study suggest that proprioceptive input (i.e., the on-line position of the participant's hand) is critical to action simulation, especially when viewing hands from the palm. While there is evidence to suggest that motor action simulation declines with age, no study has examined the effects of peripheral factors, such as body position, on motor imagery performance in aging populations. Future research is required to assess whether the adopted hand posture influences response times and accuracy when implicitly rotating hands in varying orientations and views. The *Neuropsychology of Vision: Perception and Action Lab* plans on further exploring the effects of motor imagery in healthy aging.

CHAPTER V

GENERAL CONCLUSIONS

In conclusion, this study provides novel evidence for a decline in implicit motor imagery among older males and females when solving the hand laterality judgement task. In particular, our study suggests that when simulating simple or difficult upper limb movements from the back or palm of the hands, different strategies (e.g., motoric or visual strategies) may be used depending on one's age and sex. Males are particularly adept at visual motor imagery, whereas females use both visual and kinesthetic motor imagery to solve the HLJT. However, as one age, a greater decline in kinesthetic motor imagery over visual motor imagery is seen for both older males and females. Based on the similarities between implicit motor imagery and actual movements, this study will offer insights into its application as a tool for enhancing motor performance in aging populations. Motor imagery has been shown to be an effective tool for a wide range of clinical populations and may be a useful addition to physiotherapy and occupational therapy as it allows older adults to safely simulate movements while reducing the physical demands of actual movement. Considering that cognitive mechanisms underlying motor imagery vary by age and sex, implicit motor imagery should be used on an individual treatment basis rather than as a one-size-fits-all approach.

References

Adduri, C. A., & Marotta, J. J. (2009). Mental rotation of faces in healthy aging and Alzheimer's disease. *PlOS One*, *4*(7), e6120-e6120. https://doi.org/10.1371/journal.pone.0006120

Annett, J. (1995). Motor Imagery: Perception or Action? *Neuropsychologia*, *33*(11), 1395-1417. https://doi.org/10.1016/0028-3932(95)00072-B

Beauchet, O., Annweiler, C., Assal, F., Bridenbaugh, S., Herrmann, F. R., Kressig, R. W., & Allali, G. (2010). Imagined Timed Up & Go test: a new tool to assess higher-level gait and balance disorders in older adults? *Journal of the Neurological Sciences*, *294*(1-2), 102–106. https://doi.org/10.1016/j.jns.2010.03.021

Bek, J., Humphries, S., Poliakoff, E., & Brady, N. (2022, January 8). Mental rotation of hands and objects in ageing and Parkinson's disease: Differentiating motor imagery and visuospatial ability. https://doi.org/10.31234/osf.io/3t9kv

Bläsing, B., Brugger, P., Weigelt, M., & Schack, T. (2013). Does thumb posture influence the mental rotation of hands? *Neuroscience Letters*, *534*(1), 139–144. https://doi.org/10.1016/j.neulet.2012.11.034

Bonda, E., Petrides, M., Frey, S., & Evans, A. Neural correlates of mental transformations of the body-in-space. *Proceedings of the National Academy of Sciences*, *92*(24), 11180-11184. https://doi.org/10.1073/pnas.92.24.11180

Campos, A. (2014). Gender differences in imagery. *Personality and Individual Differences, 59*, 107-111. https://doi.org/10.1016/j.paid.2013.12.010

Cerella, J., Poon, L. W., & Fozard, J. L. (1981). Mental rotation and age reconsidered. *Journal of Gerontology*, *36*(5), 620–624. https://doi.org/10.1093/geronj/36.5.620

Cerritelli, B., Maruff, P., Wilson, P., & Currie, J. (2000). The effect of an external load on the force and timing components of mentally represented actions. *Behavioural Brain Research*, *108*(1), 91–96. https://doi.org/10.1016/S0166-4328(99)00138-2

Cheng, Y., Hegarty, M., & Chrastil, E. R. (2020). Telling right from right: The influence of handedness in the mental rotation of hands. *Cognitive Research: Principles and Implications*, *5*(1), 25-25. https://doi.org/10.1186/s41235-020-00230-9

Collet, C., Dittmar, A., & Vernet-Maury, E. (1999). Programming or inhibiting action: evidence for differential autonomic nervous system response patterns. *International journal of psychophysiology : official journal of the International Organization of Psychophysiology*, *32*(3), 261–276. https://doi.org/10.1016/s0167-8760(99)00022-7

Conson, M., De Bellis, F., Baiano, C., Zappullo, I., Raimo, G., Finelli, C., Ruggiero, I., Positano, M., UNICAMPSY18 group, & Trojano, L. (2020). Sex differences in implicit motor imagery: Evidence from the hand laterality task. *Acta Psychologica*, *203*, 103010. https://doi.org/10.1016/j.actpsy.2020.103010

Conson, M., Errico, D., Mazzarella, E., De Bellis, F., Grossi, D., & Trojano, L. (2015). Impact of body posture on laterality judgement and explicit recognition tasks performed on self and others' hands. *Experimental Brain Research*, *23*3(4), 1331–1338. https://doi.org/10.1007/s00221-015-4210-3

Conson, M., Volpicella, F., De Bellis, F., Orefice, A., & Trojano, L. (2017). "Like the palm of my hands": Motor imagery enhances implicit and explicit visual recognition of one's own hands. *Acta Psychologica*, *180*, 98–104. https://doi.org/10.1016/j.actpsy.2017.09.006

Cooper, L. A., & Shepard, R. N. (1975). Mental transformation in the identification of left and right hands. *Journal of Experimental Psychology: Human Perception and Performance*, *1*(1), 48–56. https://doi.org/10.1037/0096-1523.1.1.48

Coslett, H. B., Medina, J., Kliot, D., & Burkey, A. (2010). Mental motor imagery and chronic pain: the foot laterality task. *Journal of the International Neuropsychological Society : JINS*, *16*(4), 603–612. https://doi.org/10.1017/S1355617710000299

Craik, F. I. M., & Dirkx, E. (1992). Age-related differences in three tests of visual imagery. *Psychology and Aging*, *7*(4), 661–665. https://doi.org/10.1037/0882-7974.7.4.661

Dalecki, M., Hoffmann, U., & Bock, O. (2012). Mental rotation of letters, body parts and complex scenes: Separate or common mechanisms? *Human Movement Science*, *31*(5), 1151–1160. https://doi.org/10.1016/j.humov.2011.12.001

De Simone, L., Tomasino, B., Marusic, N., Eleopra, R., & Rumiati, R. I. (2013). The effects of healthy aging on mental imagery as revealed by egocentric and allocentric mental spatial transformations. *Acta Psychologica*, *143*(1), 146–156. https://doi.org/10.1016/j.actpsy.2013.02.014

Decety, J. (1996). The neurophysiological basis of motor imagery. *Behavioural Brain Research*, *77*(1-2), 45–52. https://doi.org/10.1016/0166-4328(95)00225-1

Decety, J., & Boisson, D. (1990). Effect of brain and spinal cord injuries on motor imagery. *European Archives of Psychiatry and Clinical Neuroscience*, *240*(1), 39-43. https://doi-org.uml.idm.oclc.org/10.1007/BF02190091

Decety, J., & Grèzes, J., (1999). Neural mechanisms subserving the perception of human actions. *Trends in Cognitive Sciences*, *3*(5), 172-178. https://doi.org/10.1016/S1364-6613(99)01312-1

Decety, J., & Michel, F. (1989). Comparative analysis of actual and mental movement times in two graphic tasks. *Brain and Cognition*, *11*(1), 87–97. https://doi.org/10.1016/0278-2626(89)90007-9

Decety, J., Jeannerod, M., & Prablanc, C. (1989). The timing of mentally represented actions. *Behavioural Brain Research*, *34*(1-2), 35-42. https://doi.org/10.1016/S0166-4328(89)80088-9

Decety, J., Jeannerod, M., Durozard, D., & Baverel, G. (1993). Central activation of autonomic effectors during mental simulation of motor actions in man. *The Journal of Physiology*, *461*(1), 549-563. https://doi.org/10.1113/jphysiol.1993.sp019528

Decety, J., Jeannerod, M., Germain, M., & Pastene, J. (1991). Vegetative response during imagined movement is proportional to mental effort. *Behavioural Brain Research*, *42*(1), 1–5. https://doi.org/10.1016/S0166-4328(05)80033-6

Devlin, A. L., & Wilson, P. H. (2010). Adult age differences in the ability to mentally transform object and body stimuli. Neuropsychology, development, and cognition. Section B, *Aging, Neuropsychology and Cognition*, *17(*6), 709–729. https://doi.org/10.1080/13825585.2010.510554

Dominey, P., Decety, J., Broussolle, E., Chazot, G., & Jeannerod, M. (1995). Motor imagery of a lateralized sequential task is asymmetrically slowed in hemi-Parkinson's patients. *Neuropsychologia*, *33*(6), 727–741. https://doi.org/10.1016/0028-3932(95)00008-Q

Dror, I. E., & Kosslyn, S. M. (1994). Mental imagery and aging. *Psychology and Aging*, *9*(1), 90–102. https://doi.org/10.1037/0882-7974.9.1.90

Fiorio, M., Tinazzi, M., & Aglioti, S. M. (2006). Selective impairment of hand mental rotation in patients with focal hand dystonia. *Brain : a journal of neurology*, *129*(Pt 1), 47–54. https://doi.org/10.1093/brain/awh630

Funk, M., & Brugger, P. (2008). Mental rotation of congenitally absent hands. *Journal of the International Neuropsychological Society : JINS*, *14*(1), 81–89. https://doi.org/10.1017/S1355617708080041

Gabbard, C., & Cordova, A. (2013). Association between imagined and actual functional reach (FR): a comparison of young and older adults. *Archives of Gerontology and Geriatrics*, *56*(3), 487–491. https://doi.org/10.1016/j.archger.2012.12.008

Gabbard, C., Caçola, P., & Cordova, A. (2011). Is there an advanced aging effect on the ability to mentally represent action? *Archives of Gerontology and Geriatrics*, *53*(2), 206–209. https://doi.org/10.1016/j.archger.2010.10.006

Gentili, R., Cahouet, V., Ballay, Y., & Papaxanthis, C. (2004). Inertial properties of the arm are accurately predicted during motor imagery. *Behavioural Brain Research*, *155*(2), 231–239. https://doi.org/10.1016/j.bbr.2004.04.027

Gentilucci, M., Daprati, E., & Gangitano, M. (1998). Right-handers and left-handers have different representations of their own hand. *Cognitive Brain Research, 6*(3), 185–192. https://doi.org/10.1016/S0926-6410(97)00034-7

Gerardin, E., Sirigu, A., Lehéricy, S., Poline, J. B., Gaymard, B., Marsault, C., Agid, Y., & Le Bihan, D. (2000). Partially overlapping neural networks for real and imagined hand movements. *Cerebral Cortex*, *10*(11), 1093–1104. https://doi.org/10.1093/cercor/10.11.1093

Grèzes, J., & Decety, J. (2001). Functional anatomy of execution, mental simulation, observation, and verb generation of actions: a meta-analysis. *Human brain mapping*, *12*(1), 1–19. https://doi.org/10.1002/1097-0193(200101)12:1<1::aid-hbm10>3.0.co;2-v

Guillot, A., & Collet, C. (2005). Duration of mentally simulated movement: a review. *Journal of motor behavior*, *37*(1), 10–20. https://doi.org/10.3200/JMBR.37.1.10-20

Habak, C., Wilkinson, F., & Wilson, H. R. (2008). Aging disrupts the neural transformations that link facial identity across views. *Vision Research*, *48*(1), 9–15. https://doi.org/10.1016/j.visres.2007.10.007

Hanakawa, T., Immisch, I., Toma, K., Dimyan, M. A., Van Gelderen, P., & Hallett, M. (2003). Functional properties of brain areas associated with motor execution and imagery. *Journal of neurophysiology*, *89*(2), 989–1002. https://doi.org/10.1152/jn.00132.2002

Helmich, R. C., de Lange, F. P., Bloem, B. R., & Toni, I. (2007). Cerebral compensation during motor imagery in Parkinson's disease. *Neuropsychologia*, *45*(10), 2201–2215. https://doi.org/10.1016/j.neuropsychologia.2007.02.024

Henninger, F., Shevchenko, Y., Mertens, U. K., Kieslich, P. J., & Hilbig, B. E. (2019, January 16). lab.js: A free, open, online study builder. https://doi.org/10.31234/osf.io/fqr49

Heremans, E., Feys, P., Nieuwboer, A., Vercruysse, S., Vandenberghe, W., Sharma, N., & Helsen, W. (2011). Motor imagery ability in patients with early- and mid-stage Parkinson disease. *Neurorehabilitation and neural repair*, *25*(2), 168–177. https://doi.org/10.1177/1545968310370750

Howard, I. P. (1982). Human visual orientation. New York: John Wiley and Sons.

Iachini, T., Ruggiero, G., Bartolo, A., Rapuano, M., & Ruotolo, F. (2019). The Effect of Body-Related Stimuli on Mental Rotation in Children, Young and Elderly Adults. *Scientific Reports, 9*(1), 1169. https://doi.org/10.1038/s41598-018-37729-7

Ionta, S., & Blanke, O. (2009). Differential influence of hands posture on mental rotation of hands and feet in left and right handers. *Experimental Brain Research*, 195(2), 207–217. https://doi.org/10.1007/s00221-009-1770-0

Ionta, S., Fourkas, A. D., Fiorio, M., & Aglioti S. M. (2007). The influence of hands posture on mental rotation of hands and feet. *Experimental Brain Research*, *183*(1), 1-7. https://doi-org.uml.idm.oclc.org/10.1007/s00221-007-1020-2

Ionta, S., Perruchoud, D., Draganski, B., & Blanke, O. (2012). Body context and posture affect mental imagery of hands. *PLOS One*, *7*(3), e34382. https://doi.org/10.1371/journal.pone.0034382

Jeannerod, M. (1994). The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences*, *17*(2), 187-202. doi:10.1017/S0140525X00034026

Jeannerod, M. (1997). The Cognitive Neuroscience of Action. Blackwell Publishers Ltd.

Jeannerod, M. (2001). Neural simulation of action: a unifying mechanism for motor cognition. NeuroImage, 14(1), 103-109. https://doi.org/10.1006/nimg.2001.0832

Jeannerod, M. (2006). Motor cognition: What actions tell the self. Oxford University Press. https://doi.org/10.1093/acprof:oso/9780198569657.001.0001

Jeannerod, M., & Decety, J. (1995). Mental motor imagery: a window into the representational stages of action. *Current Opinion in Neurobiology*, *5*(6), 727-732. https://doi.org/10.1016/0959-4388(95)80099-9

Karádi, K., Szabó, I., Szepesi, T., Kállai, J., & Kovács, B. (1999). Sex differences on the hand mental rotation task for 9-yr.-old children and young adults. *Perceptual and Motor Skills*, *89*(3 Pt 1), 969–972. https://doi.org/10.2466/pms.1999.89.3.969

Kolers, P. A., & Pomerantz, J. R. (1971). Figural change in apparent motion. *Journal of Experimental Psychology, 87*(1), 99–108. https://doi.org/10.1037/h0030156

Linn, M. C., & Petersen, A. C. (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. *Child Development, 56*(6), 1479–1498. https://doi.org/10.2307/1130467

Linn, M. C., & Petersen, A. C. (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. *Child Development, 56*(6), 1479–1498. https://doi.org/10.2307/1130467

Malouin, F., Richards, C. L., & Durand, A. (2010). Normal aging and motor imagery vividness: implications for mental practice training in rehabilitation. *Archives of Physical Medicine and Rehabilitation*, *91*(7), 1122–1127. https://doi.org/10.1016/j.apmr.2010.03.007

Malouin, F., Richards, C. L., & Durand, A. (2010). Normal aging and motor imagery vividness: implications for mental practice training in rehabilitation. *Archives of physical medicine and rehabilitation*, *91*(7), 1122–1127. https://doi.org/10.1016/j.apmr.2010.03.007

Maruff, P., Wilson, P. H., De Fazio, J., Cerritelli, B., Hedt, A., & Currie, J. (1999). Asymmetries between dominant and non-dominant hands in real and imagined motor task performance. *Neuropsychologia*, *37*(3), 379–384. https://doi.org/10.1016/S0028-3932(98)00064-5

Meister, I. G., Krings, T., Foltys, H., Boroojerdi, B., Müller, M., Töpper, R., & Thron, A. (2004). Playing piano in the mind--An fMRI study on music imagery and performance in pianists. *Cognitive Brain Research, 19*(3), 219–228. https://doi.org/10.1016/j.cogbrainres.2003.12.005

Miall, R. C. (2003). Connecting mirror neurons and forward models. *NeuroReport*, *14(*17), 2135-2137. https://doi.org/10.1097/00001756-200312020-00001

Mizuguchi, N., Yamagishi, T., Nakata, H., & Kanosue, K. (2015). The effect of somatosensory input on motor imagery depends upon motor imagery capability. *Frontiers in psychology*, *6*, 104. https://doi.org/10.3389/fpsyg.2015.00104

Mochizuki, H., Takeda, K., Sato, Y., Nagashima, I., Harada, Y., & Shimoda, N. (2019). Response time differences between men and women during hand mental rotation. *PLOS One*, *14*(7), Article e0220414. https://doi.org/10.1371/journal.pone.0220414

Mulder, T., Hochstenbach, J. B., van Heuvelen, M. J., & den Otter, A. R. (2007). Motor imagery: the relation between age and imagery capacity. *Human Movement Science*, *26*(2), 203–211. https://doi.org/10.1016/j.humov.2007.01.001

Nagashima, I., Takeda, K., Harada, Y., Mochizuki, H., & Shimoda, N. (2021). Age-Related Differences in Strategy in the Hand Mental Rotation Task. *Frontiers in Human Neuroscience*, *15,* 615584. https://doi.org/10.3389/fnhum.2021.615584

Nagashima, I., Takeda, K., Harada, Y., Mochizuki, H., & Shimoda, N. (2021). Age-Related Differences in Strategy in the Hand Mental Rotation Task. *Frontiers in human neuroscience*, *15*, 615584. https://doi.org/10.3389/fnhum.2021.615584

Paccalin, C., & Jeannerod, M. (2000). Changes in breathing during observation of effortful actions. *Brain Research*, *862*(1-2), 194–200. https://doi.org/10.1016/S0006-8993(00)02145-4

Paizis, C., Skoura, X., Personnier, P., & Papaxanthis, C. (2014). Motor asymmetry attenuation in older adults during imagined arm movements. *Frontiers in Aging Neuroscience, 6,* Article 49. https://doi.org/10.3389/fnagi.2014.00049

Papaxanthis, C., Schieppati, M., Gentili, R., & Pozzo, T. (2002). Imagined and actual arm movements have similar durations when performed under different conditions of direction and mass. *Experimental Brain Research*, *143*, 447-452. https://doi-org.uml.idm.oclc.org/10.1007/s00221-002-1012-1

Parsons L. M. (1987). Imagined spatial transformations of one's hands and feet. *Cognitive Psychology*, *19*(2), 178–241. https://doi.org/10.1016/0010-0285(87)90011-9

Parsons, L. M. (1987). Imagined spatial transformation of one's body. *Journal of Experimental Psychology: General, 116*(2), 172–191. https://doi.org/10.1037/0096-3445.116.2.172

Parsons, L. M. (1994). Temporal and kinematic properties of motor behavior reflected in mentally simulated action. *Journal of Experimental Psychology: Human Perception and Performance, 20*(4), 709–730. https://doi.org/10.1037/0096-1523.20.4.709

Parsons, L. M., Fox, P. T., Downs, J. H., Glass, T., Hirsch, T. B., Martin, C. C., Jerabek, P. A., & Lancaster, J. L. (1995). Use of implicit motor imagery for visual shape discrimination as revealed by PET. *Nature*, *375*(6526), 54–58. https://doi.org/10.1038/375054a0

Parsons, T. D., Larson, P., Kratz, K., Thiebaux, M., Bluestein, B., Buckwalter, J. G., & Rizzo, A. A. (2004). Sex differences in mental rotation and spatial rotation in a virtual environment. *Neuropsychologia*, *42*(4), 555–562. https://doi.org/10.1016/j.neuropsychologia.2003.08.014

Personnier, P., Kubicki, A., Laroche, D., & Papaxanthis, C. (2010). Temporal features of imagined locomotion in normal aging. *Neuroscience Letters*, *476*(3), 146–149. https://doi.org/10.1016/j.neulet.2010.04.017

Personnier, P., Paizis, C., Ballay, Y., & Papaxanthis, C. (2008). Mentally represented motor actions in normal aging II. The influence of the gravito-inertial context on the duration of overt and covert arm movements. *Behavioural Brain Research*, *186*(2), 273–283. https://doi.org/10.1016/j.bbr.2007.08.018

Petit, L. S., Pegna, A. J., Mayer, E., & Hauert, C. -A. (2003). Representation of anatomical constraints in motor imagery: Mental rotation of a body segment. *Brain and Cognition*, *51*(1), 95–101. https://doi.org/10.1016/S0278-2626(02)00526-2

Petit, L. S., Pegna, A. J., Mayer, E., & Hauert, C. -A. (2003). Representation of anatomical constraints in motor imagery: Mental rotation of a body segment. *Brain and Cognition,* *51*(1), 95–101. https://doi.org/10.1016/S0278-2626(02)00526-2

Porro, C. A., Cettolo, V., Francescato, M. P., & Baraldi, P. (2000). Ipsilateral involvement of primary motor cortex during motor imagery. *The European journal of neuroscience*, *12*(8), 3059–3063. https://doi.org/10.1046/j.1460-9568.2000.00182.x

Porro, C. A., Francescato, M. P., Cettolo, V., Diamond, M. E., Baraldi, P., Zuiani, C., Bazzocchi, M., & di Prampero, P. E. (1996). Primary motor and sensory cortex activation during motor performance and motor imagery: a functional magnetic resonance imaging study. *The Journal of neuroscience : the official journal of the Society for*

Neuroscience, *16*(23), 7688–7698. https://doi.org/10.1523/JNEUROSCI.16-23-07688.1996

Puglisi, J. T., & Morrell, R. W. (1986). Age-related slowing in mental rotation of three-dimensional objects. *Experimental aging research*, *12*(4), 217–220. https://doi.org/10.1080/03610738608258571

Raz, N., Briggs, S. D., Marks, W., & Acker, J. D. (1999). Age-related deficits in generation and manipulation of mental images: II. The role of dorsolateral prefrontal cortex. *Psychology and Aging, 14*(3), 436–444. https://doi.org/10.1037/0882-7974.14.3.436

Roth, M., Decety, J., Raybaudi, M., Massarelli, R., Delon-Martin, C., Segebarth, C., Morand, S., Gemignani, A., Décorps, M., & Jeannerod, M. (1996). Possible involvement of primary motor cortex in mentally simulated movement: a functional magnetic resonance imaging study. *Neuroreport*, *7*(7), 1280–1284. https://doi.org/10.1097/00001756-199605170-00012

Rumiati, R. I., Tomasino, B., Vorano, L., Umiltà, C., & De Luca, G. (2001). Selective deficit of imagining finger configurations. *Cortex; a journal devoted to the study of the nervous system and behavior*, *37*(5), 730–733. https://doi.org/10.1016/s0010-9452(08)70626-9

Saimpont, A., Malouin, F., Durand, A., Mercier, C., di Rienzo, F., Saruco, E., Collet, C., Guillot, A., & Jackson, P. L. (2021). The effects of body position and actual execution on motor imagery of locomotor tasks in people with a lower-limb amputation. *Scientific Reports*, *11*(1), 13788-13788. https://doi.org/10.1038/s41598-021-93240-6

Saimpont, A., Malouin, F., Tousignant, B., & Jackson, P. L. (2012) The influence of body configuration on motor imagery of walking in younger and older adults. *Neuroscience*, *222*(11), 49-57. https://doi.org/10.1016/j.neuroscience.2012.06.066

Saimpont, A., Malouin, F., Tousignant, B., & Jackson, P. L. (2013). Motor imagery and aging. *Journal of Motor Behavior, 45*(1), 21–28. https://doi.org/10.1080/00222895.2012.740098

Saimpont, A., Malouin, F., Tousignant, B., & Jackson, P. L. (2015). Assessing motor imagery ability in younger and older adults by combining measures of vividness, controllability and timing of motor imagery. *Brain Research*, *1597*, 196–209. https://doi.org/10.1016/j.brainres.2014.11.050

Saimpont, A., Mourey, F., Manckoundia, P., Pfitzenmeyer, P., & Pozzo, T. (2010). Aging affects the mental simulation/planning of the "rising from the floor" sequence. *Archives of Gerontology and Geriatrics, 51*(3), e41–e45. https://doi.org/10.1016/j.archger.2009.11.010

Saimpont, A., Pozzo, T., & Papaxanthis, C. (2009). Aging affects the mental rotation of left and right hands. *PLOS One*, *4*(8), e6714-e6714. https://doi.org/10.1371/journal.pone.0006714

Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological Review, 103*(3), 403–428. https://doi.org/10.1037/0033-295X.103.3.403

Salthouse, T. N. (1980). Biologic Response to Sutures. *Otolaryngology–Head and Neck Surgery*, *88*(6), 658–664. https://doi.org/10.1177/019459988008800606

Sapsford, F., Dewhurst, S., & Donovan, T. (2016). Ageing affects accuracy in hand laterality judgement. Physiotherapy, *102,* e30-e30. https://doi.org/10.1016/j.physio.2016.10.042

Scarpina, F., Magnani, F. G., Tagini, S., Priano, L., Mauro, A., & Sedda, A. (2019). Mental representation of the body in action in Parkinson's disease. *Experimental brain research*, *237*(10), 2505–2521. https://doi.org/10.1007/s00221-019-05608-w

Schott N. (2012). Age-related differences in motor imagery: working memory as a mediator. *Experimental Aging Research*, *38*(5), 559–583. https://doi.org/10.1080/0361073X.2012.726045

Schott, N., & Munzert, J. (2007). Temporal accuracy of motor imagery in older women. *International Journal of Sport Psychology*, *38*(3), 304–320.

Seidler-Dobrin, R. D., He, J., & Stelmach, G. E. (1998). Coactivation to reduce variability in the elderly. *Motor control*, *2*(4), 314–330. https://doi.org/10.1123/mcj.2.4.314

Sekiyama, K. (1982). Kinesthetic aspects of mental representations in the identification of left and right hands. *Perception & Psychophysics*, *32*(2), 89–95. https://doi.org/10.3758/BF03204268

Seurinck, R., Vingerhoets, G., de Lange, F. P., & Achten, E. (2004). Does egocentric mental rotation elicit sex differences? *NeuroImage*, *23*(4), 1440–1449. https://doi.org/10.1016/j.neuroimage.2004.08.010

Shenton, J. T., Schwoebel, J., & Coslett, H. B. (2004). Mental motor imagery and the body schema: evidence for proprioceptive dominance. *Neuroscience Letters*, *370*(1), 19–24. https://doi.org/10.1016/j.neulet.2004.07.053

Sirigu, A., & Duhamel, J. R. (2001). Motor and visual imagery as two complementary but neurally dissociable mental processes. *Journal of Cognitive Neuroscience*, *13*(7), 910–919. https://doi.org/10.1162/089892901753165827

Sirigu, A., Duhamel, J.-R., Cohen, L., Pillon, B, & Agid, Y. (1996). The mental representation of hand movements after parietal cortex damage. *Science*, *273*(5281), 1564–1568. https://doi.org/10.1126/science.273.5281.1564

Skoura, X., Papaxanthis, C., Vinter, A., & Pozzo, T. (2005). Mentally represented motor actions in normal aging. I. Age effects on the temporal features of overt and covert execution of actions. *Behavioural Brain Research*, *165*(2), 229–239. https://doi.org/10.1016/j.bbr.2005.07.023

Skoura, X., Personnier, P., Vinter, A., Pozzo, T., & Papaxanthis, C. (2008). Decline in motor prediction in elderly subjects: right versus left arm differences in mentally simulated motor actions. *Cortex; a journal devoted to the study of the nervous system and behavior*, *44*(9), 1271–1278. https://doi.org/10.1016/j.cortex.2007.07.008

Teng, E. L., & Lee, A. L. (1982). Right-left discrimination: no sex difference among normals on the Hand Test and the Route Test. *Perceptual and Motor Skills*, *55*(1), 299–302. https://doi.org/10.2466/pms.1982.55.1.299

ter Horst, A. C., van Lier, R., & Steenbergen, B. (2010). Mental rotation task of hands: differential influence number of rotational axes. *Experimental brain research*, *203*(2), 347–354. https://doi.org/10.1007/s00221-010-2235-1

Tomasino, B., Toraldo, A., & Rumiati, R. I. (2003). Dissociation between the mental rotation of visual images and motor images in unilateral brain-damaged patients. *Brain and Cognition*, *51*(3), 368–371. https://doi.org/10.1016/s0278-2626(02)00570-5

Vannuscorps, G., Pillon, A., & Andres, M. (2012). Effect of biomechanical constraints in the hand laterality judgment task: where does it come from?. *Frontiers in human neuroscience*, *6*, 299. https://doi.org/10.3389/fnhum.2012.00299

Voyer, D., Jansen, P., & Kaltner, S. (2017). Mental rotation with egocentric and object-based transformations. *The Quarterly Journal of Experimental Psychology, 70*(11), 2319–2330. https://doi.org/10.1080/17470218.2016.1233571

Wolpert, D. M., & Miall, R. C. (1996) Forward Models for Physiological Motor Control. *Neural Networks*, *9*(8), 1265-1279. https://doi.org/10.1016/S0893-6080(96)00035-4

Yue, G., & Cole, K. J. (1992). Strength increases from the motor program: comparison of training with maximal voluntary and imagined muscle contractions. *Journal of neurophysiology*, *67*(5), 1114–1123. https://doi.org/10.1152/jn.1992.67.5.1114

Zapparoli, L., Invernizzi, P., Gandola, M., Berlingeri, M., De Santis, A., Zerbi, A., Banfi, G., & Paulesu, E. (2014). Like the back of the (right) hand? A new fMRI look on the hand laterality task. *Experimental Brain Research*, *232*(12), 3873–3895. https://doi.org/10.1007/s00221-014-4065-z

APPENDIX A

Recruitment letter

Normal Aging Study

INVESTIGATORS:

Aneet Saran, MA Student, Psychology
University of Manitoba

Dr. Jonathan Marotta, Professor, Psychology
University of Manitoba

Dear Participant,

You are invited to participate in a research study to evaluate the effects of normal aging on action stimulation.

Purpose of this study: The purpose of this study is to examine how you judge hand images presented in different orientations.

Participation: If you choose to participate, you will be asked to judge hand images of left and right hands displayed from two different viewpoints (palm and back) in four different orientations. Prior to this task, you will be asked to fill out a health questionnaire that will ask you about your age, gender, handedness, vision, memory, cognitive abilities, and reaction time. This study should take you no more than 60 minutes to complete.

Requirements to participate: To participate in this study, you must be competent to provide informed consent. Additionally, you must:

- 65 years of age or older
- Not have any history of motor or neurological disorders
- Have access to a computer with internet or be willing to use a laptop we provide for the experiment

How to participate: Please contact Aneet at sarana3@myumanitoba.ca. If at any time you have further questions about this study, please feel free to contact us.

Thank you for your time,
Aneet Saran

Recruiting script (**phone** and email)

Hello, may I please speak to ________________?

My name is Aneet Saran, and I am a master's student working under the supervision of Dr. Jonathan Marotta in the Perception and Action Lab at the University of Manitoba. I am contacting you because you provided your name and contact details through the Centre on Aging's database and indicated you would be interested in being contacted about future research studies needing participants. The reason I am contacting you today is that we are conducting a study looking at how you judge hand images presented in different orientations. We are currently seeking participants for this study.

Would you like to participant in this research? **[Yes or No]**

If no,

Thank you for your time. Have a great day.

If yes,

Great! This study will involve me visiting your home in order to run the experiment. Are you okay with that [Yes or No]

If no,

I understand. Thank you for your time. Have a great day.

If yes,

I will be bringing a laptop that will have a wireless internet adapter in order to run the experiment. If you like, you are free to use your own computer device. On the day of the visit, I will screen myself and you for any COVID-19 related symptoms for safety purposes. If you'd like to use the lab computer or your personal computer device, I will set-up the online experiment and will monitor the experiment from a distance of at least 2 meters. The experiment itself will not take longer than 45 mins. Once the experiment is complete, I will disinfect the experimental computer or your personal computer device. The duration of the visit will be approximately an hour. Do you have any questions?

[Answer any questions they may have]

The next step will be to send a recruitment letter and a consent form via email providing you with further details about the study. Once you have read the recruitment letter and consent form, please email me back and let me know what date and time works best for you.

Thank you for your time and I hope to hear back from you soon.

Recruiting script (phone and **email**)

Hi,

My name is Aneet Saran, and I am a master's student working under the supervision of Dr. Jonathan Marotta in the Perception and Action Lab at the University of Manitoba. I am contacting you because you provided your name and contact details through the Centre on Aging's database and indicated you would be interested in being contacted about future research studies needing participants. The reason I am contacting you today is that we are conducting a study looking at how you judge hand images presented in different orientations. We are currently seeking participants for this study.

This study will involve me visiting your home in order to run the experiment. I will be bringing a laptop that will have a wireless internet adapter in order to run the experiment. If you like, you are free to use your own computer device. On the day of the visit, I will screen myself and you for any COVID-19 related symptoms for safety purposes. If you'd like to use the lab computer or your personal computer device, I will set-up the online experiment and will monitor the experiment from a distance of at least 2 meters. The experiment itself will not take longer than 45 mins. Once the experiment is complete, I will disinfect the experimental computer or your personal computer device. The duration of the visit will be approximately an hour.

If you would like to participate, please let me know and I will forward you a recruitment letter and a consent providing you with further details about the study. Once you have read the recruitment letter and consent form, please email me back and let me know what date and time works best for you.

I hope to hear back from you soon.

Thank you,
Aneet

Poster advertisement

University of Manitoba

Neuropsychology of Vision
Perception & Action Laboratory

PARTICIPANTS NEEDED

For an in-person study investigating the effects of normal aging on action simulation.

Purpose of this study: The purpose of this study is to examine how you judge hand images presented in different orientations.

Requirements to participate: To participate in this study, you must be competent to provide informed consent. Additionally, you must:

- **65 years of age or older**
- **Not have any history of motor or neurological disorders**
- **Have access to a computer with internet or be willing to use a laptop we provide for the experiment**

APPENDIX B

Study Consent Form

University of Manitoba

The effects of implicit motor imagery in aging using the hand laterality task

PRINICIPAL INVESTIGATORS: Aneet Saran, MA Student, Psychology
University of Manitoba

Dr. Jonathan Marotta, Professor, Psychology
University of Manitoba

SOURCE OF SUPPORT: Research Manitoba & Natural Sciences and Engineering Research Council of Canada (NSERC)

This consent form is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

PURPOSE: We are interested in how you judge hand images presented in different orientations.

DESCRIPTION: This study will take no longer than an hour per subject. During the study, you will be required to judge hand images of left and right hands displayed from two different viewpoints (palm and back) and in four different orientations. Prior to this task, you will be asked to fill out a health questionnaire that will ask you about your age, gender, handedness, vision, and reaction time. In addition, you will be required to fill out a health questionnaire that will ask you about your physical and cognitive activities. Participants over the age of 65 will be given a list of questions to fill and write out about their memory and mental abilities. Participants recruited via the online Department of Psychology sign-up system will earn 1 experimental credit for their participation in this study.

RISKS AND BENEFITS: There are no risks (physical, psychological and/or emotional) inherent in the tasks you will perform but some of the tests may be repetitive. By participating in this study, you will be providing valuable data.

COSTS AND PAYMENTS: There are no fees or charges to participate in this study. Participants recruited via the online Department of Psychology sign-up system will earn 1 experimental credit for their participation in this study.

CONFIDENTIALITY: Your information will be kept confidential. You will be referred to by a code number. Identifying information will be stored separately from data with your code number. Your files will only be accessible by the investigators. Identifying information will be destroyed once the research is completed (estimation completion date May 2021). The data in this study will be anonymized and therefore does not need to be destroyed. The anonymized data will be made available, in accordance with journal and granting agency requirements.

VOLUNTARY CONSENT: By selecting the 'I Consent' option, you are indicating that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities.

WITHDRAW: You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. Participants recruited via the online Department of Psychology sign-up system will still receive 1 participation credit if they choose to withdraw at any point from the study.

This research has been approved by University of Manitoba Research Ethics Board, Fort Garry. If you have any concerns or complaints about this project, you may contact any of the above-named persons or the Human Ethics Coordinator (HEC) by email: humanethics@umanitoba or by telephone: 204-474-7122. Please print a copy of this consent form for your records and reference.

If you would like to receive general summary of the results from this study when it is completed, please complete your mailing (or email) address below:

Mailing Address: ____

____

APPENDIX C

COVID-19 Consent Form

University of Manitoba

The effects of implicit motor imagery in aging using the hand laterality task

PRINICIPAL INVESTIGATORS: Aneet Saran, MA Student, Psychology
University of Manitoba

Dr. Jonathan Marotta, Professor, Psychology
University of Manitoba

SOURCE OF SUPPORT: Research Manitoba & Natural Sciences and Engineering Research Council of Canada (NSERC)

This document contains important information about in-person research during the COVID-19 public health crisis. COVID-19 (also called SARS-CoV2) is an illness caused by the coronavirus. Coronaviruses are most commonly spread from an infected person through: a) respiratory droplets when you cough or sneeze; b) close personal contact, such as touching or shaking hands; or c) touching something with the virus on it, then touching your eyes, nose or mouth before washing your hands.

The University of Manitoba is committed to taking measures to protect the health and safety of their campuses and the wider community. Your safety is important to us. The university has suspended most research that cannot be conducted remotely or virtually. This project requires in-person visits. Therefore, it is important to understand that your participation in this study may increase your exposure to COVID-19.

This consent form is only part of the process of informed consent. It should give you the basic idea of what the research is about and what your participation will involve. If you would like more detail about something mentioned here, or information not included here, you should feel free to ask. Please take the time to read this carefully and to understand any accompanying information.

PURPOSE: We are interested in how you judge hand images presented in different orientations.

DESCRIPTION: This study will take no longer than an hour. During the study, you will be required to judge hand images of left and right hands displayed from two different viewpoints (palm and back) and in four different orientations. Prior to this task, you will be asked to fill out a health questionnaire that will ask you about your age, gender, handedness, vision, and reaction time. In addition, you will be required to fill out a health questionnaire that will ask you about your physical and cognitive activities. Participants over the age of 65 will be given a list of questions to fill and write out about their memory and mental abilities. Participants recruited via the online Department of Psychology sign-up system will earn 1 experimental credit for their participation in this study.

This research has been approved by University of Manitoba Research Ethics Board, Fort Garry, our Faculty, the COVID Recovery Response Team, the COVID Recovery Steering Committee, and the University Provost. In order to gain approval, we created policies to ensure the safety of the research team and participants. These plans were reviewed and approved by the parties above. These precautions include:

- All researchers will wear 3-ply reusable or disposable masks during the experimental session
- All researchers will be fully vaccinated and will ask participants for their Manitoba immunization card or QR code
- All researchers will screen themselves for symptoms before any data collection session and will screen you for symptoms the day of their visit.
- A COVID-19 screening questionnaire will be provided the day of the experimental session. If you answer no to all questions, data collection will proceed as scheduled.
- Disinfected experimental equipment (a computer device) will be setup in the participant’s home while maintaining a 2-meter distance. Participants may use their own computer device if they prefer.
- A researcher will monitor the experimental session from 2 meters away. Upon completion of the experiment, all equipment will be disinfected. The duration of the visit will be <60 minutes.
- Throughout the experimental session, researchers will be following meticulous infection control practices, including disinfection, wearing gloves, and hand washing

COVID-19 is a serious health threat, and the situation is evolving rapidly. If you feel that you are from a group that is more vulnerable to COVID-19 effects (e.g., senior (over the age of 60 years), immuno-compromised), please discuss your participation with the research team before providing your consent. You are under no obligation to participate and can change your mind about participating in the research at any time and without consequence.

The University of Manitoba is closely watching the situation in Manitoba and may restrict in-person research at any time. We will continue to keep you informed as to changes that may occur to this study. If you have any concerns or complaints about this project, you may contact any of the above- named persons or the Human Ethics Coordinator (HEC) by email: humanethics@umanitoba or by telephone: 204-474-7122. Please print a copy of this consent form for your records and reference.

RISKS, CONFIDENTIALITY AND BENEFITS: There is a possibility that during your participation in the study you could come into contact with someone with COVID-19. We are required to collect your personal contact information that we must retain in order to follow up with you and/or conduct contact tracing if you may have been exposed to COVID-19 in coming to the research site. We cannot guarantee anonymity as the personal contact information identifies you as a participant and we may be required to disclose this information in the event of a possible exposure. Identifying information will be stored separately from data with your code number. Your files will only be accessible by the investigators. Identifying information will be destroyed once the research is completed (estimation completion date May 2022). The data in this study will be anonymized and therefore does not need to be destroyed. The anonymized data will be made available, in accordance with journal and granting agency requirements. By participating in this study, you will be providing valuable data.

COSTS AND PAYMENTS: There are no fees or charges to participate in this study. Participants recruited via the online Department of Psychology sign-up system will earn 1 experimental credit for their participation in this study.

WITHDRAW: You are free to withdraw from the study at any time, and /or refrain from answering any questions you prefer to omit, without prejudice or consequence. If you do withdraw from the study, we will still need to continue to maintain your contact information and will only give it to the University’s Environmental Health and Safety (EHS) Office and/or Manitoba Health if required for contact tracing. Please note, Manitoba Health or the University’s EHS office will not have access to your research data. Participants recruited via the online Department of Psychology sign-up system will still receive 1 participation credit if they choose to withdraw at any point from the study.

VOLUNTARY CONSENT: By selecting the 'I Consent' option, you are indicating that you have understood to your satisfaction the information regarding participation in the research project and agree to participate as a subject. In no way does this waive your legal rights nor release the researchers, sponsors, or involved institutions from their legal and professional responsibilities.

If you would like to receive general summary of the results from this study when it is completed, please complete your mailing (or email) address below:

Mailing Address: ____

____

APPENDIX D

Modified Edinburgh Handedness Assessment

ID_______

Sex: _________

Age: _________

Do you have normal or corrected to normal vision? ___________________________

Handedness Inventory: Which hand do you use to do the following?

1. Throw a ball. L/R
2. Brush your teeth. L/R
3. Eat soup with a spoon. L/R
4. Comb your hair. L/R
5. Cut bread with a knife. L/R
6. Swing tennis/badminton racquet or bat. L/R
7. Hammer a nail. L/R
8. Point to something accurately. L/R
9. Write your name. L/R

Is there anything you do consistently with your left hand? _________________________

IPD: __________

APPENDIX E

Modified Mini Mental State Examination

1. What is today's date?
2. What month is it?
3. What year is it?
4. What day of the week is it today?
5. What season is it?
6. What country are we in?
7. What state (or province) are we in?
8. Where are you right now?
9. Starting at 100, count backwards by 7. You can stop after 5 subtractions. Once you have finished, please write down all five subtractions.
10. Bill, Tar, and Can. I have listed three objects and want you to write them down in the answer box. Remember what they are because I am going to ask you to name them again in a few minutes.
11. What is the name of the object shown below?

12. What is the name of the object shown below?

13. Take a plain piece of paper in your hand, fold it in half, and put it on the floor. Please indicate if you have or have not completed all the steps in the answer box.

14. Read the words presented below and then do what it says. Please indicate if you were able to do this task or not.

Close your eyes

15. Write any complete sentence in the answer box provided.

16. Remember the 3 words that were provided to you a few minutes ago; please write them down in the answer box. Refrain from scrolling up to view the words.

APPENDIX F

Debriefing Form

INVESTIGATORS: Aneet Saran
Department of Psychology
University of Manitoba

Dr. Jonathan Marotta
Department of Psychology
University of Manitoba

Thank you for participating in this study. The purpose of this study was to measure the ability to mentally stimulate movements without actually executing them. To test this action stimulation, we used the hand laterality task. In this task, participants are shown left- and right-hand mirror images from two different viewpoints (palm and back) and in different orientations. They have to identify whether the image presented is of the left hand or the right hand. What is currently lacking in this area is a clear understanding of how this action stimulation affects normal aging. Specifically, this study sought to expand current understandings of the relationship between the ability to mentally stimulate movements and normal aging using the hand laterality task. We expect to see that older adults will be less accurate and have slower reaction times than younger adults in their left-right hand judgments when presented with hand-stimuli in the most difficult conditions. We also expect males to respond faster than females in judging hands portrayed from the palm. Additionally, we expect females to be faster than males in judging hands portrayed from the back. Thank you again for participating and have a great day.

If you have any questions about this study, please feel free to contact us:

Aneet Saran (MA Student, Psychology, University of Manitoba, sarana3@myumanitoba.ca)

Dr. Jonathan Marotta (Professor, Psychology, University of Manitoba, Jonathan.Marotta@umanitoba.ca)

APPENDIX G

COVID-19 Screening Questionnaire

1. Do you have a new onset, or worsening, of any ONE of the following symptoms?
   - fever > 38°C or think you have a fever or chills **(YES/NO)**
   - cough **(YES/NO)**
   - sore throat/ hoarse voice **(YES/NO)**
   - shortness of breath/ breathing difficulties **(YES/NO)**
   - loss of taste or smell **(YES/NO)**
   - vomiting or diarrhea for more than 24 hours **(YES/NO)**

2. Do you have a new onset of 2 or more of any of the following symptoms?
   - runny nose **(YES/NO)**
   - muscle aches **(YES/NO)**
   - fatigue **(YES/NO)**
   - conjunctivitis (pink eye) **(YES/NO)**
   - headache **(YES/NO)**
   - skin rash of unknown cause **(YES/NO)**
   - nausea or loss of appetite **(YES/NO)**

3. Have you, or a member of your household, been in close contact (within 2 metres / 6 feet for more than 10 minutes total over 24 hours) in the last 14 days with a confirmed COVID-19 case? **(YES/NO)**

4. Have you been exposed to COVID-19 in a work or public setting? **(YES/NO)**

5. Have you or a member of your household, traveled outside of Manitoba in the past 14 days and are required to self-isolate (quarantine)? **(YES/NO)**

6. Is a member of your household sick with COVID-19 symptoms, and waiting for COVID-19 test results? **(YES/NO)**

7. Are you, or a member of your household, waiting for COVID-19 testing results? **(YES/NO)**

8. Are you full vaccinated? **(YES/NO)**

APPENDIX H

Significant Bonferroni Pairwise Comparisons

Table 1

Accuracy (Orientation)

Post Hoc Comparisons - Orientation

Comparison						
Orientation		Orientation	exp(B)	SE	z	$p_{bonferroni}$
"0"	-	"180"	0.262	0.0378	-9.273	< .001
"0"	-	90L	0.416	0.0638	-5.716	< .001
90L	-	"180"	0.629	0.0616	-4.732	< .001
90M	-	"180"	0.238	0.0326	-10.486	< .001
90M	-	90L	0.378	0.0553	-6.654	< .001

Table 2

Accuracy (View x Orientation)

Post Hoc Comparisons - View ✻ Orientation

Comparison								
View	Orientation		View	Orientation	exp(B)	SE	z	$p_{bonferroni}$
Back	"0"	-	Back	"180"	0.0791	0.0201	-9.99	< .001
Back	"0"	-	Back	90L	0.2496	0.0688	-5.04	< .001
Back	"0"	-	Palm	"0"	0.1468	0.0387	-7.27	< .001
Back	"0"	-	Palm	"180"	0.1273	0.0331	-7.93	< .001
Back	"0"	-	Palm	90L	0.1020	0.0263	-8.85	< .001
Back	"0"	-	Palm	90M	0.3507	0.1030	-3.57	0.010
Back	"180"	-	Palm	"180"	1.6098	0.1903	4.03	0.002
Back	90L	-	Back	"180"	0.3168	0.0473	-7.70	< .001
Back	90L	-	Palm	"180"	0.5100	0.0814	-4.22	< .001
Back	90L	-	Palm	90L	0.4085	0.0639	-5.73	< .001
Back	90M	-	Back	"180"	0.1555	0.0308	-9.39	< .001
Back	90M	-	Back	90L	0.4909	0.1106	-3.16	0.045
Back	90M	-	Palm	"180"	0.2504	0.0516	-6.72	< .001

Post Hoc Comparisons - View ✻ Orientation

Comparison								
View	Orientation		View	Orientation	exp(B)	SE	z	$p_{bonferroni}$
Back	90M	-	Palm	90L	0.2005	0.0408	-7.89	< .001
Palm	"0"	-	Back	"180"	0.5385	0.0679	-4.91	< .001
Palm	"0"	-	Back	90L	1.6998	0.2813	3.21	0.038
Palm	"0"	-	Back	90M	3.4626	0.7295	5.90	< .001
Palm	"0"	-	Palm	90M	2.3880	0.4640	4.48	< .001
Palm	90M	-	Back	"180"	0.2255	0.0408	-8.24	< .001
Palm	90M	-	Palm	"180"	0.3630	0.0687	-5.35	< .001
Palm	90M	-	Palm	90L	0.2908	0.0542	-6.62	< .001

Table 3

Accuracy (Age x View x Sex)

Post Hoc Comparisons - Age ✻ View ✻ Sex

Comparison										
Age	View	Sex		Age	View	Sex	exp(B)	SE	z	$p_{bonferroni}$
Old	Back	Female	-	Old	Palm	Female	0.353	0.0557	-6.6043	< .001
Old	Back	Male	-	Old	Palm	Male	0.462	0.0741	-4.8101	< .001
Old	Palm	Female	-	Young	Back	Male	8.412	3.2620	5.4915	< .001
Old	Palm	Female	-	Young	Palm	Male	3.723	1.2967	3.7748	0.004
Young	Back	Female	-	Old	Palm	Female	0.177	0.0666	-4.5969	< .001
Young	Back	Female	-	Old	Palm	Male	0.172	0.0702	-4.3111	< .001
Young	Back	Male	-	Old	Back	Male	0.250	0.1084	-3.1980	0.039
Young	Back	Male	-	Old	Palm	Male	0.116	0.0484	-5.1572	< .001
Young	Back	Male	-	Young	Palm	Male	0.443	0.1089	-3.3131	0.026
Young	Palm	Female	-	Old	Palm	Female	0.192	0.0713	-4.4413	< .001
Young	Palm	Female	-	Old	Palm	Male	0.186	0.0753	-4.1602	< .001
Young	Palm	Male	-	Old	Palm	Male	0.261	0.0998	-3.5140	0.012

Table 4

Response time (Laterality x Sex)

Post Hoc Comparisons - Laterality ✻ Sex

Comparison									
Laterality	**Sex**		**Laterality**	**Sex**	**Mean Difference**	**SE**	**df**	**t**	$p_{bonferroni}$
Right	Male	-	Left	Male	-165.51	38.6	76.0	-4.2926	< .001

Table 5

Response time (Laterality x Orientation x Age)

Post Hoc Comparisons - Laterality ✻ Orientation ✻ Age

Comparison											
Laterality	Orientation	Age		Laterality	Orientation	Age	Mean Difference	SE	df	t	$p_{bonferroni}$
Right	0	Young	-	Right	0	Old	-1098.16	101.9	76.0	-10.7765	< .001
			-	Right	90M	Old	-877.48	98.5	76.0	-8.9054	< .001
			-	Right	90L	Young	-727.49	88.4	76.0	-8.2281	< .001
			-	Right	90L	Old	-1576.78	133.2	76.0	-11.8369	< .001
			-	Right	180	Young	-794.95	84.7	76.0	-9.3863	< .001
			-	Right	180	Old	-1880.49	120.7	76.0	-15.5791	< .001
			-	Left	0	Old	-1097.05	101.1	76.0	-10.8463	< .001
			-	Left	90M	Old	-1083.07	108.0	76.0	-10.0249	< .001
			-	Left	90L	Young	-623.43	71.9	76.0	-8.6738	< .001
			-	Left	90L	Old	-1745.59	119.7	76.0	-14.5868	< .001
			-	Left	180	Young	-884.58	95.1	76.0	-9.3061	< .001
			-	Left	180	Old	-2080.33	126.7	76.0	-16.4203	< .001
		Old	-	Right	90M	Young	1003.43	98.7	76.0	10.1703	< .001
			-	Right	90M	Old	220.68	53.7	76.0	4.1112	0.012
			-	Right	90L	Old	-478.62	90.1	76.0	-5.3106	< .001
			-	Right	180	Old	-782.33	86.3	76.0	-9.0621	< .001
			-	Left	0	Young	970.55	101.2	76.0	9.5929	< .001
			-	Left	90M	Young	1022.92	107.8	76.0	9.4878	< .001
			-	Left	90L	Young	474.73	119.0	76.0	3.9877	0.018
			-	Left	90L	Old	-647.43	73.3	76.0	-8.8368	< .001
			-	Left	180	Old	-982.17	96.9	76.0	-10.1367	< .001
	90M	Young	-	Right	90M	Old	-782.75	95.2	76.0	-8.2240	< .001
			-	Right	90L	Young	-632.76	91.3	76.0	-6.9336	< .001
			-	Right	90L	Old	-1482.05	130.7	76.0	-11.3353	< .001
			-	Right	180	Young	-700.22	76.7	76.0	-9.1297	< .001
			-	Right	180	Old	-1785.76	118.0	76.0	-15.1358	< .001
			-	Left	0	Old	-1002.32	97.9	76.0	-10.2404	< .001
			-	Left	90M	Old	-988.34	105.0	76.0	-9.4139	< .001
			-	Left	90L	Young	-528.69	82.6	76.0	-6.4034	< .001
			-	Left	90L	Old	-1650.86	116.9	76.0	-14.1194	< .001
			-	Left	180	Young	-789.85	84.1	76.0	-9.3969	< .001
			-	Left	180	Old	-1985.60	124.1	76.0	-15.9999	< .001
		Old	-	Right	90L	Old	-699.31	93.0	76.0	-7.5173	< .001
			-	Right	180	Old	-1003.02	78.2	76.0	-12.8295	< .001
			-	Left	0	Young	749.87	97.8	76.0	7.6691	< .001
			-	Left	90M	Young	802.24	104.6	76.0	7.6670	< .001
			-	Left	90M	Old	-205.59	52.5	76.0	-3.9179	0.023
			-	Left	90L	Old	-868.11	84.2	76.0	-10.3148	< .001
			-	Left	180	Old	-1202.85	85.7	76.0	-14.0390	< .001
	90L	Young	-	Right	90L	Old	-849.29	157.6	76.0	-5.3899	< .001
			-	Right	180	Old	-1153.00	147.2	76.0	-7.8354	< .001
			-	Left	0	Young	599.89	89.3	76.0	6.7154	< .001
			-	Left	90M	Young	652.25	99.5	76.0	6.5547	< .001
			-	Left	90L	Old	-1018.10	146.3	76.0	-6.9589	< .001

Post Hoc Comparisons - Laterality ✻ Orientation ✻ Age

Comparison											
Laterality	Orientation	Age		Laterality	Orientation	Age	Mean Difference	SE	df	t	$p_{bonferroni}$
			-	Left	180	Old	-1352.84	152.1	76.0	-8.8943	< .001
		Old	-	Right	180	Young	781.84	147.6	76.0	5.2985	< .001
			-	Left	0	Young	1449.18	132.7	76.0	10.9247	< .001
			-	Left	0	Old	479.73	91.1	76.0	5.2684	< .001
			-	Left	90M	Young	1501.55	137.8	76.0	10.8979	< .001
			-	Left	90M	Old	493.71	101.4	76.0	4.8673	< .001
			-	Left	90L	Young	953.36	146.7	76.0	6.4968	< .001
			-	Left	180	Young	692.21	152.3	76.0	4.5447	0.002
			-	Left	180	Old	-503.55	106.6	76.0	-4.7230	0.001
	180	Young	-	Right	180	Old	-1085.55	136.4	76.0	-7.9600	< .001
			-	Left	0	Young	667.34	92.2	76.0	7.2367	< .001
			-	Left	90M	Young	719.71	89.2	76.0	8.0641	< .001
			-	Left	90L	Old	-950.64	135.5	76.0	-7.0179	< .001
			-	Left	180	Old	-1285.38	141.7	76.0	-9.0710	< .001
		Old	-	Left	0	Young	1752.89	120.1	76.0	14.5963	< .001
			-	Left	0	Old	783.44	94.0	76.0	8.3345	< .001
			-	Left	90M	Young	1805.26	125.7	76.0	14.3575	< .001
			-	Left	90M	Old	797.42	91.0	76.0	8.7653	< .001
			-	Left	90L	Young	1257.07	135.5	76.0	9.2777	< .001
			-	Left	180	Young	995.92	141.5	76.0	7.0380	< .001
Left	0	Young	-	Left	0	Old	-969.44	100.4	76.0	-9.6548	< .001
			-	Left	90M	Old	-955.47	107.4	76.0	-8.9004	< .001
			-	Left	90L	Young	-495.82	74.4	76.0	-6.6605	< .001
			-	Left	90L	Old	-1617.98	119.0	76.0	-13.5910	< .001
			-	Left	180	Young	-756.97	103.0	76.0	-7.3508	< .001
			-	Left	180	Old	-1952.73	126.1	76.0	-15.4847	< .001
		Old	-	Left	90M	Young	1021.81	107.1	76.0	9.5409	< .001
			-	Left	90L	Young	473.62	118.4	76.0	4.0002	0.017
			-	Left	90L	Old	-648.54	75.9	76.0	-8.5466	< .001
			-	Left	180	Old	-983.28	105.0	76.0	-9.3672	< .001
	90M	Young	-	Left	90M	Old	-1007.83	113.6	76.0	-8.8694	< .001
			-	Left	90L	Young	-548.19	88.3	76.0	-6.2078	< .001
			-	Left	90L	Old	-1670.35	124.7	76.0	-13.3906	< .001
			-	Left	180	Young	-809.34	101.0	76.0	-8.0097	< .001
			-	Left	180	Old	-2005.09	131.5	76.0	-15.2486	< .001
		Old	-	Left	90L	Young	459.65	124.3	76.0	3.6967	0.049
			-	Left	90L	Old	-662.52	90.0	76.0	-7.3601	< .001
	90L	Young	-	Left	90L	Old	-1122.16	134.6	76.0	-8.3389	< .001
			-	Left	180	Old	-1456.91	140.9	76.0	-10.3435	< .001
		Old	-	Left	180	Young	861.01	140.6	76.0	6.1229	< .001
	180	Young	-	Left	180	Old	-1195.75	146.6	76.0	-8.1541	< .001

Table 6

Response time (View x Orientation x Age)

Post Hoc Comparisons - View ✻ Orientation ✻ Age

Comparison											
View	Orientation	Age		View	Orientation	Age	Mean Difference	SE	df	t	$p_{bonferroni}$
Back	0	Young	-	Back	0	Old	-866.3	65.9	76.0	-13.144	< .001
			-	Back	90M	Young	-319.4	52.7	76.0	-6.063	< .001
			-	Back	90M	Old	-1140.4	88.1	76.0	-12.942	< .001
			-	Back	90L	Young	-510.7	62.2	76.0	-8.217	< .001
			-	Back	90L	Old	-1586.5	101.2	76.0	-15.675	< .001
			-	Back	180	Young	-1406.1	100.6	76.0	-13.973	< .001
			-	Back	180	Old	-2405.7	127.4	76.0	-18.877	< .001
			-	Palm	0	Young	-615.1	79.0	76.0	-7.783	< .001
			-	Palm	0	Old	-1816.4	107.8	76.0	-16.850	< .001
			-	Palm	90M	Young	-338.1	64.0	76.0	-5.281	< .001
			-	Palm	90M	Old	-1307.7	93.3	76.0	-14.015	< .001
			-	Palm	90L	Young	-1327.7	101.6	76.0	-13.064	< .001
			-	Palm	90L	Old	-2223.3	131.9	76.0	-16.861	< .001
			-	Palm	180	Young	-760.9	86.2	76.0	-8.832	< .001
			-	Palm	180	Old	-2042.7	108.7	76.0	-18.796	< .001
		Old	-	Back	90M	Young	546.9	87.4	76.0	6.258	< .001
			-	Back	90M	Old	-274.1	53.7	76.0	-5.103	< .001
			-	Back	90L	Old	-720.3	63.4	76.0	-11.367	< .001
			-	Back	180	Young	-539.8	125.7	76.0	-4.295	0.006
			-	Back	180	Old	-1539.4	102.6	76.0	-15.007	< .001
			-	Palm	0	Old	-950.1	80.6	76.0	-11.794	< .001
			-	Palm	90M	Young	528.2	92.4	76.0	5.715	< .001
			-	Palm	90M	Old	-441.4	65.3	76.0	-6.765	< .001
			-	Palm	90L	Old	-1357.0	103.6	76.0	-13.099	< .001
			-	Palm	180	Old	-1176.4	87.8	76.0	-13.394	< .001
	90M	Young	-	Back	90M	Old	-820.9	105.1	76.0	-7.808	< .001
			-	Back	90L	Old	-1267.1	116.3	76.0	-10.891	< .001
			-	Back	180	Young	-1086.7	104.6	76.0	-10.387	< .001
			-	Back	180	Old	-2086.2	139.8	76.0	-14.928	< .001
			-	Palm	0	Young	-295.7	77.4	76.0	-3.819	0.033
			-	Palm	0	Old	-1497.0	122.1	76.0	-12.259	< .001
			-	Palm	90M	Old	-988.3	109.5	76.0	-9.022	< .001
			-	Palm	90L	Young	-1008.3	108.1	76.0	-9.323	< .001
			-	Palm	90L	Old	-1903.9	143.8	76.0	-13.240	< .001
			-	Palm	180	Young	-441.5	92.9	76.0	-4.750	0.001
			-	Palm	180	Old	-1723.3	122.9	76.0	-14.023	< .001
		Old	-	Back	90L	Young	629.6	115.9	76.0	5.430	< .001
			-	Back	90L	Old	-446.2	74.9	76.0	-5.959	< .001
			-	Back	180	Old	-1265.3	106.6	76.0	-11.865	< .001
			-	Palm	0	Young	525.2	121.5	76.0	4.322	0.006
			-	Palm	0	Old	-676.1	78.9	76.0	-8.566	< .001
			-	Palm	90M	Young	802.3	109.4	76.0	7.335	< .001

Post Hoc Comparisons - View ✻ Orientation ✻ Age

Comparison											
View	Orientation	Age		View	Orientation	Age	Mean Difference	SE	df	t	$p_{bonferroni}$
			-	Palm	90L	Old	-1083.0	110.2	76.0	-9.824	< .001
			-	Palm	180	Old	-902.3	94.7	76.0	-9.524	< .001
	90L	Young	-	Back	90L	Old	-1075.8	126.2	76.0	-8.525	< .001
			-	Back	180	Young	-895.4	101.7	76.0	-8.801	< .001
			-	Back	180	Old	-1894.9	148.0	76.0	-12.799	< .001
			-	Palm	0	Old	-1305.7	131.5	76.0	-9.927	< .001
			-	Palm	90M	Old	-797.0	119.9	76.0	-6.645	< .001
			-	Palm	90L	Young	-817.0	94.2	76.0	-8.673	< .001
			-	Palm	90L	Old	-1712.6	151.9	76.0	-11.276	< .001
			-	Palm	180	Old	-1531.9	132.2	76.0	-11.584	< .001
		Old	-	Back	180	Old	-819.1	103.7	76.0	-7.899	< .001
			-	Palm	0	Young	971.4	131.3	76.0	7.397	< .001
			-	Palm	90M	Young	1248.5	120.2	76.0	10.389	< .001
			-	Palm	90L	Old	-636.8	96.0	76.0	-6.632	< .001
			-	Palm	180	Young	825.6	132.0	76.0	6.254	< .001
			-	Palm	180	Old	-456.1	99.9	76.0	-4.564	0.002
	180	Young	-	Back	180	Old	-999.6	166.4	76.0	-6.007	< .001
			-	Palm	0	Young	791.0	121.5	76.0	6.509	< .001
			-	Palm	90M	Young	1068.1	111.6	76.0	9.571	< .001
			-	Palm	90L	Old	-817.2	169.8	76.0	-4.813	< .001
			-	Palm	180	Young	645.2	126.1	76.0	5.117	< .001
			-	Palm	180	Old	-636.6	152.5	76.0	-4.174	0.009
		Old	-	Palm	0	Young	1790.5	152.5	76.0	11.745	< .001
			-	Palm	0	Old	589.2	123.9	76.0	4.757	0.001
			-	Palm	90M	Young	2067.6	143.0	76.0	14.462	< .001
			-	Palm	90M	Old	1098.0	113.8	76.0	9.652	< .001
			-	Palm	90L	Young	1078.0	169.7	76.0	6.353	< .001
			-	Palm	180	Young	1644.7	153.1	76.0	10.746	< .001
Palm	0	Young	-	Palm	0	Old	-1201.3	136.5	76.0	-8.803	< .001
			-	Palm	90M	Old	-692.6	125.3	76.0	-5.526	< .001
			-	Palm	90L	Young	-712.6	103.7	76.0	-6.870	< .001
			-	Palm	90L	Old	-1608.2	156.2	76.0	-10.298	< .001
			-	Palm	180	Old	-1427.6	137.2	76.0	-10.408	< .001
		Old	-	Palm	90M	Young	1478.4	125.8	76.0	11.754	< .001
			-	Palm	90M	Old	508.7	84.0	76.0	6.056	< .001
			-	Palm	90L	Old	-406.9	105.7	76.0	-3.849	0.029
			-	Palm	180	Young	1055.5	137.1	76.0	7.697	< .001
	90M	Young	-	Palm	90M	Old	-969.6	113.6	76.0	-8.536	< .001
			-	Palm	90L	Young	-989.6	119.7	76.0	-8.270	< .001
			-	Palm	90L	Old	-1885.3	146.9	76.0	-12.832	< .001
			-	Palm	180	Young	-422.9	86.6	76.0	-4.886	< .001
			-	Palm	180	Old	-1704.6	126.5	76.0	-13.473	< .001
		Old	-	Palm	90L	Old	-915.6	122.0	76.0	-7.506	< .001
			-	Palm	180	Young	546.8	126.1	76.0	4.337	0.005
			-	Palm	180	Old	-735.0	88.2	76.0	-8.330	< .001
	90L	Young	-	Palm	90L	Old	-895.6	173.0	76.0	-5.176	< .001
			-	Palm	180	Young	566.8	128.5	76.0	4.412	0.004
			-	Palm	180	Old	-715.0	156.1	76.0	-4.581	0.002

Post Hoc Comparisons - View ✻ Orientation ✻ Age

Comparison											
View	Orientation	Age		View	Orientation	Age	Mean Difference	SE	df	t	$p_{bonferroni}$
		Old	-	Palm	180	Young	1462.4	156.8	76.0	9.329	< .001
	180	Young	-	Palm	180	Old	-1281.7	137.8	76.0	-9.300	< .001

Table 7

Response time (Laterality x View x Orientation x Sex x Age)

Laterality	View	Orientation	Sex	Age		Laterality	View	Orientation	Sex	Age	Mean Difference	SE	df	t	pbonferroni
Right	Back	0	Female	Young	-	Right	Back	90M	Male	Old	-1028.86	226	398	-4.55252	0.014
					-	Right	Back	90L	Female	Old	-1377.98	205	398	-6.73725	< .001
					-	Right	Back	90L	Male	Old	-1406.24	226	398	-6.22233	< .001
					-	Right	Back	180	Female	Young	-1467.88	173	833	-8.48784	< .001
					-	Right	Back	180	Female	Old	-2454.13	205	398	-11.99878	< .001
					-	Right	Back	180	Male	Young	-1210.78	211	398	-5.74134	< .001
					-	Right	Back	180	Male	Old	-2053.46	226	398	-9.08616	< .001
					-	Right	Palm	0	Female	Old	-1943.79	205	398	-9.50358	< .001
					-	Right	Palm	0	Male	Old	-1677.68	226	398	-7.42338	< .001
					-	Right	Palm	90M	Female	Old	-1225.54	205	398	-5.99194	< .001
					-	Right	Palm	90M	Male	Old	-1139.16	226	398	-5.04054	0.001
					-	Right	Palm	90L	Female	Young	-1562.64	175	836	-8.93480	< .001
					-	Right	Palm	90L	Female	Old	-2222.07	205	398	-10.86416	< .001
					-	Right	Palm	90L	Male	Young	-1188.72	211	398	-5.63674	< .001
					-	Right	Palm	90L	Male	Old	-2027.85	226	398	-8.97281	< .001
					-	Right	Palm	180	Female	Old	-1863.19	205	398	-9.10951	< .001
					-	Right	Palm	180	Male	Old	-1878.20	226	398	-8.31064	< .001
					-	Left	Back	90M	Female	Old	-1213.98	205	398	-5.93540	< .001
					-	Left	Back	90M	Male	Old	-1227.23	226	398	-5.43025	< .001
					-	Left	Back	90L	Female	Old	-1486.46	205	398	-7.26761	< .001
					-	Left	Back	90L	Male	Old	-1827.51	226	398	-8.08637	< .001
					-	Left	Back	180	Female	Young	-1301.28	175	834	-7.43961	< .001
					-	Left	Back	180	Female	Old	-2579.90	205	398	-12.61369	< .001
					-	Left	Back	180	Male	Young	-1396.46	211	398	-6.62181	< .001
					-	Left	Back	180	Male	Old	-2287.12	226	398	-10.12004	< .001
					-	Left	Palm	0	Female	Old	-1481.57	205	398	-7.24373	< .001
					-	Left	Palm	0	Male	Old	-1914.61	226	398	-8.47178	< .001
					-	Left	Palm	90M	Female	Old	-1161.55	205	398	-5.67908	< .001
					-	Left	Palm	90M	Male	Old	-1456.53	226	398	-6.44484	< .001
					-	Left	Palm	90L	Female	Young	-1224.20	173	835	-7.08922	< .001
					-	Left	Palm	90L	Female	Old	-2249.36	205	398	-10.99763	< .001
					-	Left	Palm	90L	Male	Young	-1087.17	211	398	-5.15519	< .001
					-	Left	Palm	90L	Male	Old	-2146.02	226	398	-9.49572	< .001
					-	Left	Palm	180	Female	Young	-747.31	173	835	-4.32761	0.034
					-	Left	Palm	180	Female	Old	-2108.30	205	398	-10.30791	< .001
					-	Left	Palm	180	Male	Old	-2073.01	226	398	-9.17267	< .001

		-	Right	Back	180	Female	Young	-899.33	205	398	-4.39702	0.028
		-	Right	Back	180	Female	Old	-1885.59	154	833	-12.25416	< .001
		-	Right	Back	180	Male	Old	-1484.92	215	398	-6.90762	< .001
		-	Right	Palm	0	Female	Old	-1375.24	151	556	-9.11070	< .001
		-	Right	Palm	0	Male	Old	-1109.13	215	398	-5.15952	< .001
		-	Right	Palm	90L	Female	Young	-994.10	205	398	-4.86037	0.003
		-	Right	Palm	90L	Female	Old	-1653.52	156	836	-10.62586	< .001
		-	Right	Palm	90L	Male	Old	-1459.30	215	398	-6.78846	< .001
		-	Right	Palm	180	Female	Old	-1294.64	156	836	-8.31961	< .001
		-	Right	Palm	180	Male	Old	-1309.65	215	398	-6.09231	< .001
		-	Left	Back	90L	Female	Old	-917.91	156	834	-5.89808	< .001
		-	Left	Back	90L	Male	Old	-1258.97	215	398	-5.85653	< .001
		-	Left	Back	180	Female	Old	-2011.36	156	834	-12.92403	< .001
		-	Left	Back	180	Male	Old	-1718.57	215	398	-7.99456	< .001
		-	Left	Palm	0	Female	Old	-913.03	155	575	-5.90583	< .001
		-	Left	Palm	0	Male	Old	-1346.07	215	398	-6.26172	< .001
		-	Left	Palm	90L	Female	Old	-1680.82	154	835	-10.93943	< .001
		-	Left	Palm	90L	Male	Old	-1577.48	215	398	-7.33820	< .001
		-	Left	Palm	180	Female	Old	-1539.75	154	835	-10.02130	< .001
		-	Left	Palm	180	Male	Old	-1504.47	215	398	-6.99857	< .001
Male	Young	-	Right	Back	0	Male	Old	-1063.04	221	398	-4.80959	0.004
		-	Right	Back	90L	Female	Old	-1511.39	199	398	-7.59411	< .001
		-	Right	Back	90L	Male	Old	-1539.65	221	398	-6.96597	< .001
		-	Right	Back	180	Female	Young	-1601.28	211	398	-7.59304	< .001
		-	Right	Back	180	Female	Old	-2587.54	199	398	-13.00131	< .001
		-	Right	Back	180	Male	Young	-1344.19	164	833	-8.17150	< .001
		-	Right	Back	180	Male	Old	-2186.87	221	398	-9.89424	< .001
		-	Right	Palm	0	Female	Old	-2077.19	199	398	-10.43703	< .001
		-	Right	Palm	0	Male	Old	-1811.08	221	398	-8.19405	< .001
		-	Right	Palm	90M	Female	Old	-1358.95	199	398	-6.82816	< .001
		-	Right	Palm	90M	Male	Old	-1272.56	221	398	-5.75757	< .001
		-	Right	Palm	90L	Female	Young	-1696.05	211	398	-8.04242	< .001
		-	Right	Palm	90L	Female	Old	-2355.48	199	398	-11.83528	< .001
		-	Right	Palm	90L	Male	Young	-1322.13	166	836	-7.94753	< .001
		-	Right	Palm	90L	Male	Old	-2161.25	221	398	-9.77835	< .001
		-	Right	Palm	180	Female	Old	-1996.59	199	398	-10.03205	< .001
		-	Right	Palm	180	Male	Old	-2011.60	221	398	-9.10127	< .001
		-	Left	Back	0	Female	Old	-950.24	199	398	-4.77458	0.005
		-	Left	Back	0	Male	Old	-1035.59	221	398	-4.68539	0.008
		-	Left	Back	90M	Female	Old	-1347.39	199	398	-6.77006	< .001
		-	Left	Back	90M	Male	Old	-1360.64	221	398	-6.15606	< .001
		-	Left	Back	90L	Female	Old	-1619.87	199	398	-8.13915	< .001
		-	Left	Back	90L	Male	Old	-1960.92	221	398	-8.87195	< .001
		-	Left	Back	180	Female	Young	-1434.69	211	398	-6.80306	< .001
		-	Left	Back	180	Female	Old	-2713.31	199	398	-13.63325	< .001
		-	Left	Back	180	Male	Young	-1529.87	166	834	-9.19534	< .001
		-	Left	Back	180	Male	Old	-2420.53	221	398	-10.95140	< .001
		-	Left	Palm	0	Female	Young	-842.13	211	398	-3.99323	0.157
		-	Left	Palm	0	Female	Old	-1614.98	199	398	-8.11461	< .001
		-	Left	Palm	0	Male	Young	-776.71	165	575	-4.69960	0.007
		-	Left	Palm	0	Male	Old	-2048.02	221	398	-9.26604	< .001
		-	Left	Palm	90M	Female	Young	-369.14	211	398	-1.75040	1.000
		-	Left	Palm	90M	Female	Old	-1294.96	199	398	-6.50664	< .001
		-	Left	Palm	90M	Male	Young	-403.94	164	835	-2.45921	1.000
		-	Left	Palm	90M	Male	Old	-1589.94	221	398	-7.19348	< .001
		-	Left	Palm	90L	Female	Young	-1357.61	211	398	-6.43759	< .001
		-	Left	Palm	90L	Female	Old	-2382.77	199	398	-11.97244	< .001

			-	Left	Palm	90L	Male	Young	-1220.58	164	835	-7.43093	< .001
			-	Left	Palm	90L	Male	Old	-2279.43	221	398	-10.31302	< .001
			-	Left	Palm	180	Female	Young	-880.72	211	398	-4.17625	0.073
			-	Left	Palm	180	Female	Old	-2241.70	199	398	-11.26363	< .001
			-	Left	Palm	180	Male	Young	-953.66	164	835	-5.80593	< .001
			-	Left	Palm	180	Male	Old	-2206.42	221	398	-9.98270	< .001
		Old	-	Right	Back	90M	Female	Young	576.32	226	398	2.55010	1.000
			-	Right	Back	180	Male	Old	-1123.83	188	833	-5.96338	< .001
			-	Right	Palm	0	Female	Old	-1014.16	215	398	-4.71771	0.007
			-	Right	Palm	90L	Female	Old	-1292.44	215	398	-6.01224	< .001
			-	Right	Palm	90L	Male	Old	-1098.22	191	836	-5.76230	< .001
			-	Right	Palm	180	Female	Old	-933.56	215	398	-4.34277	0.036
			-	Right	Palm	180	Male	Old	-948.57	191	836	-4.97709	0.002
			-	Left	Back	0	Female	Young	965.93	226	398	4.27406	0.048
			-	Left	Back	0	Male	Young	1007.92	221	398	4.56023	0.014
			-	Left	Back	90L	Male	Old	-897.88	191	834	-4.71066	0.006
			-	Left	Back	180	Female	Old	-1650.27	215	398	-7.67683	< .001
			-	Left	Back	180	Male	Old	-1357.49	191	834	-7.12196	< .001
			-	Left	Palm	0	Male	Old	-984.98	189	575	-5.20212	< .001
			-	Left	Palm	90L	Female	Old	-1319.74	215	398	-6.13922	< .001
			-	Left	Palm	90L	Male	Old	-1216.39	188	835	-6.46400	< .001
			-	Left	Palm	180	Female	Old	-1178.67	215	398	-5.48299	< .001
			-	Left	Palm	180	Male	Old	-1143.38	188	835	-6.07603	< .001
90M	Female	Young	-	Right	Back	90L	Female	Old	-1024.67	205	398	-5.00985	0.002
			-	Right	Back	90L	Male	Old	-1052.93	226	398	-4.65901	0.009
			-	Right	Back	180	Female	Young	-1114.57	173	833	-6.44486	< .001
			-	Right	Back	180	Female	Old	-2100.82	205	398	-10.27137	< .001
			-	Right	Palm	0	Female	Old	-1590.48	205	398	-7.77618	< .001
			-	Right	Palm	0	Male	Old	-1324.37	226	398	-5.86006	< .001
			-	Right	Palm	90L	Female	Young	-1209.34	175	836	-6.91467	< .001
			-	Right	Palm	90L	Female	Old	-1868.76	205	398	-9.13676	< .001
			-	Right	Palm	90L	Male	Old	-1674.54	226	398	-7.40949	< .001
			-	Right	Palm	180	Female	Old	-1509.88	205	398	-7.38211	< .001
			-	Right	Palm	180	Male	Old	-1524.89	226	398	-6.74731	< .001
			-	Left	Back	90L	Female	Old	-1133.15	205	398	-5.54021	< .001
			-	Left	Back	90L	Male	Old	-1474.20	226	398	-6.52305	< .001
			-	Left	Back	180	Female	Young	-947.97	175	834	-5.41969	< .001
			-	Left	Back	180	Female	Old	-2226.59	205	398	-10.88629	< .001
			-	Left	Back	180	Male	Young	-1043.15	211	398	-4.94647	0.002
			-	Left	Back	180	Male	Old	-1933.81	226	398	-8.55672	< .001
			-	Left	Palm	0	Female	Old	-1128.26	205	398	-5.51633	< .001
			-	Left	Palm	0	Male	Old	-1561.30	226	398	-6.90846	< .001
			-	Left	Palm	90M	Male	Old	-1103.22	226	398	-4.88152	0.003
			-	Left	Palm	90L	Female	Young	-870.89	173	835	-5.04325	0.001
			-	Left	Palm	90L	Female	Old	-1896.06	205	398	-9.27022	< .001
			-	Left	Palm	90L	Male	Old	-1792.71	226	398	-7.93240	< .001
			-	Left	Palm	180	Female	Old	-1754.99	205	398	-8.58051	< .001
			-	Left	Palm	180	Male	Old	-1719.70	226	398	-7.60934	< .001
		Old	-	Right	Back	180	Female	Old	-1610.79	154	833	-10.46829	< .001
			-	Right	Back	180	Male	Old	-1210.12	215	398	-5.62931	< .001
			-	Right	Palm	0	Female	Old	-1100.44	156	836	-7.07166	< .001
			-	Right	Palm	90L	Male	Old	-1184.50	215	398	-5.51014	< .001
			-	Right	Palm	180	Female	Old	-1019.84	156	836	-6.55371	< .001
			-	Right	Palm	180	Male	Old	-1034.85	215	398	-4.81399	0.004

		-	Left	Back	0	Female	Young	879.65	205	398	4.30078	0.043
		-	Left	Back	0	Male	Young	921.63	199	398	4.63083	0.010
		-	Left	Back	90L	Male	Old	-984.17	215	398	-4.57821	0.013
		-	Left	Back	180	Female	Old	-1736.56	156	834	-11.15831	< .001
		-	Left	Back	180	Male	Old	-1443.78	215	398	-6.71625	< .001
		-	Left	Palm	0	Male	Old	-1071.27	215	398	-4.98341	0.002
		-	Left	Palm	90L	Female	Old	-1406.02	154	835	-9.15094	< .001
		-	Left	Palm	90L	Male	Old	-1302.68	215	398	-6.05989	< .001
		-	Left	Palm	180	Female	Old	-1264.95	154	835	-8.23281	< .001
		-	Left	Palm	180	Male	Old	-1229.67	215	398	-5.72025	< .001
Male	Young	-	Right	Back	90L	Female	Old	-1223.29	199	398	-6.14654	< .001
		-	Right	Back	90L	Male	Old	-1251.55	221	398	-5.66250	< .001
		-	Right	Back	180	Female	Young	-1313.19	211	398	-6.22693	< .001
		-	Right	Back	180	Female	Old	-2299.44	199	398	-11.55374	< .001
		-	Right	Back	180	Male	Young	-1056.09	164	833	-6.42012	< .001
		-	Right	Back	180	Male	Old	-1898.77	221	398	-8.59078	< .001
		-	Right	Palm	0	Female	Old	-1789.10	199	398	-8.98946	< .001
		-	Right	Palm	0	Male	Old	-1522.99	221	398	-6.89058	< .001
		-	Right	Palm	90M	Female	Old	-1070.85	199	398	-5.38060	< .001
		-	Right	Palm	90M	Male	Old	-984.47	221	398	-4.45411	0.022
		-	Right	Palm	90L	Female	Young	-1407.96	211	398	-6.67631	< .001
		-	Right	Palm	90L	Female	Old	-2067.38	199	398	-10.38771	< .001
		-	Right	Palm	90L	Male	Young	-1034.03	166	836	-6.21574	< .001
		-	Right	Palm	180	Female	Old	-1708.50	199	398	-8.58448	< .001
		-	Right	Palm	180	Male	Old	-1723.51	221	398	-7.79781	< .001
		-	Left	Back	90M	Female	Old	-1059.29	199	398	-5.32249	< .001
		-	Left	Back	90M	Male	Old	-1072.54	221	398	-4.85259	0.004
		-	Left	Back	90L	Female	Old	-1331.77	199	398	-6.69158	< .001
		-	Left	Back	90L	Male	Old	-1672.82	221	398	-7.56849	< .001
		-	Left	Back	180	Female	Young	-1146.59	211	398	-5.43695	< .001
		-	Left	Back	180	Female	Old	-2425.21	199	398	-12.18568	< .001
		-	Left	Back	180	Male	Young	-1241.77	166	834	-7.46372	< .001
		-	Left	Back	180	Male	Old	-2132.43	221	398	-9.64794	< .001
		-	Left	Palm	0	Female	Old	-1326.89	199	398	-6.66704	< .001
		-	Left	Palm	0	Male	Old	-1759.92	221	398	-7.96258	< .001
		-	Left	Palm	90M	Female	Old	-1006.86	199	398	-5.05907	0.001
		-	Left	Palm	90M	Male	Old	-1301.84	221	398	-5.89002	< .001
		-	Left	Palm	90L	Female	Young	-1069.52	211	398	-5.07147	0.001
		-	Left	Palm	90L	Female	Old	-2094.68	199	398	-10.52487	< .001
		-	Left	Palm	90L	Male	Young	-932.48	164	835	-5.67698	< .001
		-	Left	Palm	90L	Male	Old	-1991.33	221	398	-9.00956	< .001
		-	Left	Palm	180	Female	Old	-1953.61	199	398	-9.81606	< .001
		-	Left	Palm	180	Male	Old	-1918.32	221	398	-8.67924	< .001
	Old	-	Right	Back	180	Female	Old	-1425.27	215	398	-6.63014	< .001
		-	Right	Back	180	Male	Old	-1024.60	188	833	-5.43681	< .001
		-	Right	Palm	90L	Female	Old	-1193.20	215	398	-5.55061	< .001
		-	Right	Palm	90L	Male	Old	-998.98	191	836	-5.24162	< .001
		-	Right	Palm	180	Male	Old	-849.33	191	836	-4.45641	0.019
		-	Left	Back	0	Female	Young	1065.17	226	398	4.71316	0.007
		-	Left	Back	0	Male	Young	1107.16	221	398	5.00921	0.002
		-	Left	Back	180	Male	Old	-1258.25	191	834	-6.60133	< .001
		-	Left	Palm	0	Male	Old	-885.75	188	835	-4.70694	0.006
		-	Left	Palm	90L	Female	Old	-1220.50	215	398	-5.67760	< .001
		-	Left	Palm	90L	Male	Old	-1117.16	188	835	-5.93666	< .001
		-	Left	Palm	180	Female	Old	-1079.43	215	398	-5.02136	0.002

			-	Left	Palm	180	Male	Old	-1044.15	188	835	-5.54868	< .001
90L	Female	Young	-	Right	Back	180	Female	Young	-871.75	173	833	-5.04083	0.001
			-	Right	Back	180	Female	Old	-1858.01	205	398	-9.08422	< .001
			-	Right	Back	180	Male	Old	-1457.34	226	398	-6.44844	< .001
			-	Right	Palm	0	Female	Old	-1347.66	205	398	-6.58902	< .001
			-	Right	Palm	0	Male	Old	-1081.56	226	398	-4.78567	0.005
			-	Right	Palm	90L	Female	Young	-966.52	170	556	-5.69714	< .001
			-	Right	Palm	90L	Female	Old	-1625.95	205	398	-7.94960	< .001
			-	Right	Palm	90L	Male	Old	-1431.73	226	398	-6.33510	< .001
			-	Right	Palm	180	Female	Old	-1267.06	205	398	-6.19495	< .001
			-	Right	Palm	180	Male	Old	-1282.07	226	398	-5.67292	< .001
			-	Left	Back	90L	Female	Old	-890.34	205	398	-4.35305	0.034
			-	Left	Back	90L	Male	Old	-1231.39	226	398	-5.44866	< .001
			-	Left	Back	180	Male	Old	-1691.00	226	398	-7.48233	< .001
			-	Left	Palm	0	Female	Old	-885.45	205	398	-4.32917	0.038
			-	Left	Palm	0	Male	Old	-1318.49	226	398	-5.83407	< .001
			-	Left	Palm	90L	Female	Old	-1653.24	205	398	-8.08307	< .001
			-	Left	Palm	90L	Male	Old	-1549.90	226	398	-6.85801	< .001
			-	Left	Palm	180	Female	Old	-1512.18	205	398	-7.39335	< .001
			-	Left	Palm	180	Male	Old	-1476.89	226	398	-6.53495	< .001
		Old	-	Right	Back	90L	Male	Young	1088.50	199	398	5.46925	< .001
			-	Right	Back	180	Female	Old	-1076.15	154	833	-6.99374	< .001
			-	Right	Palm	0	Female	Young	960.83	205	398	4.69772	0.007
			-	Right	Palm	0	Male	Young	934.73	199	398	4.69660	0.007
			-	Right	Palm	90M	Female	Young	971.13	205	398	4.74806	0.006
			-	Right	Palm	90M	Male	Young	1186.90	199	398	5.96369	< .001
			-	Right	Palm	90L	Female	Old	-844.09	151	556	-5.59190	< .001
			-	Right	Palm	180	Male	Young	890.97	199	398	4.47677	0.020
			-	Left	Back	0	Female	Young	1414.29	205	398	6.91475	< .001
			-	Left	Back	0	Male	Young	1456.28	199	398	7.31717	< .001
			-	Left	Back	90M	Female	Young	1164.68	205	398	5.69439	< .001
			-	Left	Back	90M	Male	Young	1069.59	199	398	5.37426	< .001
			-	Left	Back	90L	Male	Young	1039.12	199	398	5.22115	< .001
			-	Left	Back	180	Female	Old	-1201.92	156	834	-7.72296	< .001
			-	Left	Palm	90M	Female	Young	1142.25	205	398	5.58471	< .001
			-	Left	Palm	90L	Female	Old	-871.38	155	575	-5.63645	< .001
			-	Left	Palm	180	Female	Old	-730.31	154	835	-4.75316	0.005
	Male	Young	-	Right	Back	90L	Male	Old	-1116.76	221	398	-5.05264	0.001
			-	Right	Back	180	Female	Young	-1178.39	211	398	-5.58775	< .001
			-	Right	Back	180	Female	Old	-2164.65	199	398	-10.87646	< .001
			-	Right	Back	180	Male	Young	-921.30	164	833	-5.60069	< .001
			-	Right	Back	180	Male	Old	-1763.98	221	398	-7.98092	< .001
			-	Right	Palm	0	Female	Old	-1654.30	199	398	-8.31218	< .001
			-	Right	Palm	0	Male	Old	-1388.19	221	398	-6.28072	< .001
			-	Right	Palm	90M	Female	Old	-936.06	199	398	-4.70331	0.007
			-	Right	Palm	90L	Female	Young	-1273.16	211	398	-6.03714	< .001
			-	Right	Palm	90L	Female	Old	-1932.58	199	398	-9.71043	< .001
			-	Right	Palm	90L	Male	Young	-899.24	161	556	-5.57253	< .001
			-	Right	Palm	90L	Male	Old	-1738.36	221	398	-7.86502	< .001
			-	Right	Palm	180	Female	Old	-1573.70	199	398	-7.90720	< .001
			-	Right	Palm	180	Male	Old	-1588.71	221	398	-7.18795	< .001
			-	Left	Back	90M	Female	Old	-924.50	199	398	-4.64521	0.009
			-	Left	Back	90L	Female	Old	-1196.98	199	398	-6.01430	< .001
			-	Left	Back	90L	Male	Young	-49.38	140	601	-0.35344	1.000
			-	Left	Back	90L	Male	Old	-1538.03	221	398	-6.95863	< .001
			-	Left	Back	180	Female	Young	-1011.80	211	398	-4.79778	0.005

			-	Left	Back	180	Female	Old	-2290.42	199	398	-11.50839	< .001
			-	Left	Back	180	Male	Young	-1106.98	166	834	-6.65354	< .001
			-	Left	Back	180	Male	Old	-1997.64	221	398	-9.03808	< .001
			-	Left	Palm	0	Female	Old	-1192.09	199	398	-5.98976	< .001
			-	Left	Palm	0	Male	Old	-1625.13	221	398	-7.35272	< .001
			-	Left	Palm	90M	Female	Old	-872.07	199	398	-4.38179	0.030
			-	Left	Palm	90M	Male	Old	-1167.04	221	398	-5.28016	< .001
			-	Left	Palm	90L	Female	Young	-934.72	211	398	-4.43230	0.024
			-	Left	Palm	90L	Female	Old	-1959.88	199	398	-9.84759	< .001
			-	Left	Palm	90L	Male	Young	-797.69	165	575	-4.82651	0.004
			-	Left	Palm	90L	Male	Old	-1856.54	221	398	-8.39970	< .001
			-	Left	Palm	180	Female	Old	-1818.81	199	398	-9.13877	< .001
			-	Left	Palm	180	Male	Old	-1783.53	221	398	-8.06938	< .001
		Old	-	- Right	Back	180	Female	Old	-1047.89	215	398	-4.87464	0.003
			-	Right	Palm	0	Male	Young	962.98	221	398	4.35691	0.034
			-	Right	Palm	90M	Female	Young	999.39	226	398	4.42210	0.025
			-	Right	Palm	90M	Male	Young	1215.16	221	398	5.49786	< .001
			-	Left	Back	0	Female	Young	1442.55	226	398	6.38297	< .001
			-	Left	Back	0	Male	Young	1484.53	221	398	6.71660	< .001
			-	Left	Back	90M	Female	Young	1192.94	226	398	5.27853	< .001
			-	Left	Back	90M	Male	Young	1097.85	221	398	4.96710	0.002
			-	Left	Back	90L	Male	Young	1067.38	221	398	4.82924	0.004
			-	Left	Back	180	Female	Old	-1173.66	215	398	-5.45970	< .001
			-	Left	Back	180	Male	Old	-880.88	191	834	-4.62146	0.009
			-	Left	Palm	90M	Female	Young	1170.51	226	398	5.17927	< .001
			-	Left	Palm	90M	Male	Young	1135.71	221	398	5.13838	< .001
180	Female	Young	-	Right	Back	180	Female	Old	-986.26	205	398	-4.82202	0.004
			-	Right	Palm	0	Female	Young	1050.73	175	836	6.00778	< .001
			-	Right	Palm	0	Male	Young	1024.62	211	398	4.85858	0.003
			-	Right	Palm	90M	Female	Young	1061.02	175	836	6.06666	< .001
			-	Right	Palm	180	Male	Young	980.87	211	398	4.65112	0.009
			-	Left	Back	0	Female	Young	1504.18	175	834	8.59963	< .001
			-	Left	Back	0	Male	Young	1546.17	211	398	7.33169	< .001
			-	Left	Back	90M	Female	Young	1254.58	175	834	7.17261	< .001
			-	Left	Back	90M	Male	Young	1159.49	211	398	5.49810	< .001
			-	Left	Back	90L	Female	Young	897.41	175	834	5.13061	< .001
			-	Left	Back	90L	Male	Young	1129.01	211	398	5.35361	< .001
			-	Left	Back	180	Female	Old	-1112.03	205	398	-5.43694	< .001
			-	Left	Palm	90M	Female	Young	1232.14	173	835	7.13520	< .001
			-	Left	Palm	90M	Male	Young	1197.34	211	398	5.67761	< .001
		Old	-	Right	Back	180	Male	Young	1243.35	199	398	6.24731	< .001
			-	Right	Palm	0	Female	Young	2036.98	205	398	9.95925	< .001
			-	Right	Palm	0	Male	Young	2010.88	199	398	10.10380	< .001
			-	Right	Palm	90M	Female	Young	2047.28	205	398	10.00959	< .001
			-	Right	Palm	90M	Female	Old	1228.59	156	836	7.89515	< .001
			-	Right	Palm	90M	Male	Young	2263.05	199	398	11.37089	< .001
			-	Right	Palm	90M	Male	Old	1314.98	215	398	6.11708	< .001
			-	Right	Palm	90L	Female	Young	891.49	205	398	4.35867	0.034
			-	Right	Palm	90L	Male	Young	1265.41	199	398	6.35815	< .001
			-	Right	Palm	90L	Male	Old	426.29	215	398	1.98302	1.000
			-	Right	Palm	180	Female	Young	1713.01	205	398	8.37527	< .001
			-	Right	Palm	180	Male	Young	1967.12	199	398	9.88397	< .001
			-	Left	Back	0	Female	Young	2490.44	205	398	12.17628	< .001
			-	Left	Back	0	Female	Old	1637.30	156	834	10.52049	< .001
			-	Left	Back	0	Male	Young	2532.42	199	398	12.72437	< .001
			-	Left	Back	0	Male	Old	1551.95	215	398	7.21947	< .001

		-	Left	Back	90M	Female	Young	2240.83	205	398	10.95592	< .001
		-	Left	Back	90M	Female	Old	1240.15	156	834	7.96864	< .001
		-	Left	Back	90M	Male	Young	2145.74	199	398	10.78146	< .001
		-	Left	Back	90M	Male	Old	1226.90	215	398	5.70737	< .001
		-	Left	Back	90L	Female	Old	967.67	156	834	6.21781	< .001
		-	Left	Back	90L	Male	Young	2115.27	199	398	10.62835	< .001
		-	Left	Back	180	Female	Young	1152.85	205	398	5.63655	< .001
		-	Left	Back	180	Male	Young	1057.67	199	398	5.31434	< .001
		-	Left	Palm	0	Female	Young	1745.41	205	398	8.53371	< .001
		-	Left	Palm	0	Female	Old	972.56	154	835	6.32978	< .001
		-	Left	Palm	0	Male	Young	1810.83	199	398	9.09865	< .001
		-	Left	Palm	90M	Female	Young	2218.40	205	398	10.84624	< .001
		-	Left	Palm	90M	Female	Old	1292.58	154	835	8.41261	< .001
		-	Left	Palm	90M	Male	Young	2183.60	199	398	10.97167	< .001
		-	Left	Palm	90M	Male	Old	997.61	215	398	4.64072	0.010
		-	Left	Palm	90L	Female	Young	1229.93	205	398	6.01338	< .001
		-	Left	Palm	90L	Male	Young	1366.96	199	398	6.86841	< .001
		-	Left	Palm	180	Female	Young	1706.82	205	398	8.34500	< .001
		-	Left	Palm	180	Male	Young	1633.88	199	398	8.20956	< .001
Male	Young	-	Right	Palm	0	Male	Young	767.53	166	836	4.61371	0.009
		-	Right	Palm	90M	Male	Young	1019.70	166	836	6.12959	< .001
		-	Right	Palm	90L	Female	Old	-1011.29	199	398	-5.08128	0.001
		-	Right	Palm	180	Male	Young	723.77	161	556	4.48518	0.018
		-	Left	Back	0	Female	Young	1247.09	211	398	5.91349	< .001
		-	Left	Back	0	Male	Young	1289.08	166	834	7.74803	< .001
		-	Left	Back	90M	Female	Young	997.48	211	398	4.72991	0.006
		-	Left	Back	90M	Male	Young	902.39	166	834	5.42386	< .001
		-	Left	Back	90L	Male	Young	871.92	166	834	5.24071	< .001
		-	Left	Back	180	Female	Old	-1369.12	199	398	-6.87925	< .001
		-	Left	Back	180	Male	Old	-1076.34	221	398	-4.86976	0.003
		-	Left	Palm	90M	Female	Young	975.05	211	398	4.62354	0.010
		-	Left	Palm	90M	Male	Young	940.25	164	835	5.72427	< .001
		-	Left	Palm	180	Female	Old	-897.51	199	398	-4.50963	0.017
	Old	-	Right	Palm	0	Female	Young	1636.31	226	398	7.24036	< .001
		-	Right	Palm	0	Male	Young	1610.20	221	398	7.28519	< .001
		-	Right	Palm	90M	Female	Young	1646.61	226	398	7.28592	< .001
		-	Right	Palm	90M	Male	Young	1862.38	221	398	8.42613	< .001
		-	Right	Palm	90M	Male	Old	914.31	191	836	4.79733	0.004
		-	Right	Palm	180	Female	Young	1312.34	226	398	5.80684	< .001
		-	Right	Palm	180	Male	Young	1566.45	221	398	7.08724	< .001
		-	Left	Back	0	Female	Young	2089.77	226	398	9.24680	< .001
		-	Left	Back	0	Female	Old	1236.62	215	398	5.75260	< .001
		-	Left	Back	0	Male	Young	2131.75	221	398	9.64488	< .001
		-	Left	Back	0	Male	Old	1151.28	191	834	6.04012	< .001
		-	Left	Back	90M	Female	Young	1840.16	226	398	8.14235	< .001
		-	Left	Back	90M	Male	Young	1745.07	221	398	7.89538	< .001
		-	Left	Back	90M	Male	Old	826.23	191	834	4.33475	0.033
		-	Left	Back	90L	Female	Young	1482.99	226	398	6.56195	< .001
		-	Left	Back	90L	Male	Young	1714.60	221	398	7.75751	< .001
		-	Left	Palm	0	Female	Young	1344.74	226	398	5.95022	< .001
		-	Left	Palm	0	Male	Young	1410.16	221	398	6.38009	< .001
		-	Left	Palm	90M	Female	Young	1817.73	226	398	8.04310	< .001
		-	Left	Palm	90M	Male	Young	1782.93	221	398	8.06665	< .001
		-	Left	Palm	90L	Male	Young	966.29	221	398	4.37188	0.032
		-	Left	Palm	180	Female	Young	1306.15	226	398	5.77944	< .001
		-	Left	Palm	180	Male	Young	1233.21	221	398	5.57951	< .001

Palm	0	Female	Young	-	Right	Palm	0	Female	Old	-1526.64	205	398	-7.46405	< .001
				-	Right	Palm	0	Male	Old	-1260.53	226	398	-5.57758	< .001
				-	Right	Palm	90L	Female	Old	-1804.92	205	398	-8.82463	< .001
				-	Right	Palm	90L	Male	Old	-1610.70	226	398	-7.12701	< .001
				-	Right	Palm	180	Female	Old	-1446.04	205	398	-7.06998	< .001
				-	Right	Palm	180	Male	Old	-1461.05	226	398	-6.46484	< .001
				-	Left	Back	90L	Female	Old	-1069.31	205	398	-5.22808	< .001
				-	Left	Back	90L	Male	Old	-1410.36	226	398	-6.24057	< .001
				-	Left	Back	180	Female	Young	-884.13	173	835	-5.11989	< .001
				-	Left	Back	180	Female	Old	-2162.75	205	398	-10.57416	< .001
				-	Left	Back	180	Male	Young	-979.31	211	398	-4.64375	0.009
				-	Left	Back	180	Male	Old	-1869.97	226	398	-8.27424	< .001
				-	Left	Palm	0	Female	Old	-1064.43	205	398	-5.20420	< .001
				-	Left	Palm	0	Male	Old	-1497.46	226	398	-6.62598	< .001
				-	Left	Palm	90M	Male	Old	-1039.38	226	398	-4.59904	0.012
				-	Left	Palm	90L	Female	Young	-807.05	175	834	-4.61406	0.009
				-	Left	Palm	90L	Female	Old	-1832.22	205	398	-8.95810	< .001
				-	Left	Palm	90L	Male	Old	-1728.87	226	398	-7.64992	< .001
				-	Left	Palm	180	Female	Old	-1691.15	205	398	-8.26838	< .001
				-	Left	Palm	180	Male	Old	-1655.86	226	398	-7.32686	< .001
			Old	-	Right	Palm	0	Male	Young	1500.53	199	398	7.53953	< .001
				-	Right	Palm	90M	Female	Young	1536.93	205	398	7.51439	< .001
				-	Right	Palm	90M	Female	Old	718.24	154	833	4.66775	0.007
				-	Right	Palm	90M	Male	Young	1752.71	199	398	8.80661	< .001
				-	Right	Palm	180	Female	Young	1202.66	205	398	5.88007	< .001
				-	Right	Palm	180	Male	Young	1456.78	199	398	7.31969	< .001
				-	Left	Back	0	Female	Young	1980.09	205	398	9.68108	< .001
				-	Left	Back	0	Female	Old	1126.95	155	575	7.28955	< .001
				-	Left	Back	0	Male	Young	2022.08	199	398	10.16009	< .001
				-	Left	Back	0	Male	Old	1041.61	215	398	4.84541	0.004
				-	Left	Back	90M	Female	Young	1730.49	205	398	8.46072	< .001
				-	Left	Back	90M	Female	Old	729.81	154	835	4.74986	0.005
				-	Left	Back	90M	Male	Young	1635.40	199	398	8.21718	< .001
				-	Left	Back	90L	Female	Young	1373.32	205	398	6.71444	< .001
				-	Left	Palm	0	Female	Young	1235.07	205	398	6.03851	< .001
				-	Left	Palm	0	Male	Young	1300.48	199	398	6.53437	< .001
				-	Left	Palm	90M	Female	Young	1708.05	205	398	8.35104	< .001
				-	Left	Palm	90M	Female	Old	782.23	156	834	5.02626	0.001
				-	Left	Palm	90M	Male	Young	1673.25	199	398	8.40739	< .001
				-	Left	Palm	90L	Male	Young	856.62	199	398	4.30413	0.043
				-	Left	Palm	180	Female	Young	1196.47	205	398	5.84980	< .001
				-	Left	Palm	180	Male	Young	1123.53	199	398	5.64528	< .001
		Male	Young	-	Right	Palm	0	Male	Old	-1234.42	221	398	-5.58499	< .001
				-	Right	Palm	90L	Female	Young	-1119.39	211	398	-5.30796	< .001
				-	Right	Palm	90L	Female	Old	-1778.81	199	398	-8.93778	< .001
				-	Right	Palm	90L	Male	Young	-745.47	164	833	-4.53178	0.014
				-	Right	Palm	90L	Male	Old	-1584.59	221	398	-7.16929	< .001
				-	Right	Palm	180	Female	Old	-1419.93	199	398	-7.13454	< .001
				-	Right	Palm	180	Male	Old	-1434.94	221	398	-6.49221	< .001
				-	Left	Back	90L	Female	Old	-1043.20	199	398	-5.24165	< .001
				-	Left	Back	90L	Male	Old	-1384.25	221	398	-6.26290	< .001
				-	Left	Back	180	Female	Old	-2136.64	199	398	-10.73574	< .001
				-	Left	Back	180	Male	Young	-953.21	164	835	-5.80315	< .001
				-	Left	Back	180	Male	Old	-1843.86	221	398	-8.34234	< .001
				-	Left	Palm	0	Female	Old	-1038.32	199	398	-5.21711	< .001
				-	Left	Palm	0	Male	Old	-1471.36	221	398	-6.65699	< .001

			-	Left	Palm	90M	Male	Old	-1013.27	221	398	-4.58442	0.012
			-	Left	Palm	180	Male	Old	-1629.76	221	398	-7.37364	< .001
		Old	-	Right	Palm	90M	Female	Young	1270.82	226	398	5.62314	< .001
			-	Right	Palm	90M	Male	Young	1486.60	221	398	6.72594	< .001
			-	Right	Palm	180	Male	Young	1190.67	221	398	5.38704	< .001
			-	Left	Back	0	Female	Young	1713.98	226	398	7.58402	< .001
			-	Left	Back	0	Male	Young	1755.97	221	398	7.94468	< .001
			-	Left	Back	90M	Female	Young	1464.38	226	398	6.47958	< .001
			-	Left	Back	90M	Male	Young	1369.29	221	398	6.19518	< .001
			-	Left	Back	90L	Female	Young	1107.21	226	398	4.89917	0.003
			-	Left	Back	90L	Male	Young	1338.81	221	398	6.05732	< .001
			-	Left	Palm	0	Female	Young	968.96	226	398	4.28745	0.046
			-	Left	Palm	0	Male	Young	1034.37	221	398	4.67990	0.008
			-	Left	Palm	90M	Female	Young	1441.95	226	398	6.38032	< .001
			-	Left	Palm	90M	Male	Young	1407.14	221	398	6.36646	< .001
90M	Female	Young	-	Right	Palm	90L	Female	Young	-1155.79	173	833	-6.68325	< .001
			-	Right	Palm	90L	Female	Old	-1815.22	205	398	-8.87498	< .001
			-	Right	Palm	90L	Male	Old	-1620.99	226	398	-7.17257	< .001
			-	Right	Palm	180	Female	Old	-1456.33	205	398	-7.12032	< .001
			-	Right	Palm	180	Male	Old	-1471.34	226	398	-6.51040	< .001
			-	Left	Back	90L	Male	Old	-1420.66	226	398	-6.28613	< .001
			-	Left	Back	180	Female	Young	-894.43	173	835	-5.17952	< .001
			-	Left	Back	180	Female	Old	-2173.05	205	398	-10.62450	< .001
			-	Left	Back	180	Male	Young	-989.61	211	398	-4.69258	0.007
			-	Left	Back	180	Male	Old	-1880.27	226	398	-8.31980	< .001
			-	Left	Palm	0	Female	Old	-1074.72	205	398	-5.25455	< .001
			-	Left	Palm	0	Male	Old	-1507.76	226	398	-6.67154	< .001
			-	Left	Palm	90M	Male	Old	-1049.67	226	398	-4.64460	0.009
			-	Left	Palm	90L	Female	Young	-817.35	175	834	-4.67293	0.007
			-	Left	Palm	90L	Female	Old	-1842.51	205	398	-9.00844	< .001
			-	Left	Palm	90L	Male	Old	-1739.17	226	398	-7.69548	< .001
			-	Left	Palm	180	Female	Old	-1701.44	205	398	-8.31872	< .001
			-	Left	Palm	180	Male	Old	-1666.16	226	398	-7.37243	< .001
		Old	-	Right	Palm	90M	Male	Young	1034.46	199	398	5.19775	< .001
			-	Right	Palm	90L	Female	Old	-996.52	154	833	-6.47627	< .001
			-	Left	Back	0	Female	Young	1261.85	205	398	6.16944	< .001
			-	Left	Back	0	Male	Young	1303.84	199	398	6.55123	< .001
			-	Left	Back	90M	Female	Young	1012.24	205	398	4.94908	0.002
			-	Left	Back	90M	Male	Young	917.15	199	398	4.60832	0.011
			-	Left	Back	90L	Male	Young	886.68	199	398	4.45520	0.022
			-	Left	Back	180	Female	Old	-1354.36	154	835	-8.81469	< .001
			-	Left	Back	180	Male	Old	-1061.58	215	398	-4.93830	0.002
			-	Left	Palm	90M	Female	Young	989.81	205	398	4.83941	0.004
			-	Left	Palm	90M	Male	Young	955.01	199	398	4.79852	0.005
			-	Left	Palm	90L	Female	Old	-1023.82	156	834	-6.57859	< .001
			-	Left	Palm	180	Female	Old	-882.75	156	834	-5.67215	< .001
	Male	Young	-	Right	Palm	90M	Male	Old	-948.08	221	398	-4.28946	0.045
			-	Right	Palm	90L	Female	Young	-1371.56	211	398	-6.50375	< .001
			-	Right	Palm	90L	Female	Old	-2030.99	199	398	-10.20486	< .001
			-	Right	Palm	90L	Male	Young	-997.64	164	833	-6.06479	< .001
			-	Right	Palm	90L	Male	Old	-1836.77	221	398	-8.31024	< .001
			-	Right	Palm	180	Female	Old	-1672.11	199	398	-8.40163	< .001
			-	Right	Palm	180	Male	Old	-1687.12	221	398	-7.63316	< .001
			-	Left	Back	90M	Female	Old	-1022.90	199	398	-5.13964	< .001
			-	Left	Back	90M	Male	Old	-1036.15	221	398	-4.68795	0.008
			-	Left	Back	90L	Female	Old	-1295.38	199	398	-6.50874	< .001

			-	Left	Back	90L	Male	Old	-1636.43	221	398	-7.40385	< .001
			-	Left	Back	180	Female	Young	-1110.20	211	398	-5.26439	< .001
			-	Left	Back	180	Female	Old	-2388.82	199	398	-12.00283	< .001
			-	Left	Back	180	Male	Young	-1205.38	164	835	-7.33842	< .001
			-	Left	Back	180	Male	Old	-2096.04	221	398	-9.48329	< .001
			-	Left	Palm	0	Female	Old	-1290.49	199	398	-6.48419	< .001
			-	Left	Palm	0	Male	Old	-1723.53	221	398	-7.79793	< .001
			-	Left	Palm	90M	Female	Old	-970.47	199	398	-4.87622	0.003
			-	Left	Palm	90M	Male	Old	-1265.45	221	398	-5.72537	< .001
			-	Left	Palm	90L	Female	Young	-1033.12	211	398	-4.89891	0.003
			-	Left	Palm	90L	Female	Old	-2058.29	199	398	-10.34202	< .001
			-	Left	Palm	90L	Male	Young	-896.09	166	834	-5.38598	< .001
			-	Left	Palm	90L	Male	Old	-1954.94	221	398	-8.84491	< .001
			-	Left	Palm	180	Female	Old	-1917.22	199	398	-9.63321	< .001
			-	Left	Palm	180	Male	Old	-1881.93	221	398	-8.51459	< .001
		Old	-	Right	Palm	90L	Female	Old	-1082.91	215	398	-5.03755	0.001
			-	Right	Palm	90L	Male	Old	-888.69	188	833	-4.71564	0.006
			-	Left	Back	0	Female	Young	1175.46	226	398	5.20118	< .001
			-	Left	Back	180	Male	Old	-1147.96	188	835	-6.10036	< .001
			-	Left	Palm	90L	Female	Old	-1110.21	215	398	-5.16453	< .001
			-	Left	Palm	90L	Male	Old	-1006.87	191	834	-5.28244	< .001
			-	Left	Palm	180	Female	Old	-969.14	215	398	-4.50830	0.017
			-	Left	Palm	180	Male	Old	-933.86	191	834	-4.89940	0.002
90L	Female	Young	-	Right	Palm	180	Female	Young	821.52	173	833	4.75036	0.005
			-	Right	Palm	180	Male	Young	1075.64	211	398	5.10050	0.001
			-	Left	Back	0	Female	Young	1598.95	173	835	9.25932	< .001
			-	Left	Back	0	Male	Young	1640.94	211	398	7.78107	< .001
			-	Left	Back	90M	Female	Young	1349.35	173	835	7.81390	< .001
			-	Left	Back	90M	Male	Young	1254.26	211	398	5.94748	< .001
			-	Left	Back	90L	Female	Young	992.18	174	575	5.71027	< .001
			-	Left	Back	90L	Male	Young	1223.78	211	398	5.80299	< .001
			-	Left	Back	180	Female	Old	-1017.26	205	398	-4.97359	0.002
			-	Left	Palm	0	Female	Young	853.93	175	834	4.88203	0.003
			-	Left	Palm	0	Male	Young	919.34	211	398	4.35937	0.034
			-	Left	Palm	90M	Female	Young	1326.91	175	834	7.58617	< .001
			-	Left	Palm	90M	Male	Young	1292.11	211	398	6.12699	< .001
			-	Left	Palm	180	Female	Young	815.33	175	834	4.66137	0.007
		Old	-	Right	Palm	90L	Male	Young	1033.35	199	398	5.19213	< .001
			-	Right	Palm	180	Female	Young	1480.94	205	398	7.24066	< .001
			-	Left	Back	0	Female	Young	2258.37	205	398	11.04166	< .001
			-	Left	Back	0	Female	Old	1405.23	154	835	9.14579	< .001
			-	Left	Back	0	Male	Young	2300.36	199	398	11.55835	< .001
			-	Left	Back	0	Male	Old	1319.89	215	398	6.13994	< .001
			-	Left	Back	90M	Female	Young	2008.77	205	398	9.82130	< .001
			-	Left	Back	90M	Female	Old	1008.09	154	835	6.56103	< .001
			-	Left	Back	90M	Male	Young	1913.68	199	398	9.61543	< .001
			-	Left	Back	90M	Male	Old	994.84	215	398	4.62784	0.010
			-	Left	Back	90L	Female	Young	1651.60	205	398	8.07502	< .001
			-	Left	Back	90L	Female	Old	735.61	155	575	4.75821	0.005
			-	Left	Back	90L	Male	Young	1883.21	199	398	9.46232	< .001
			-	Left	Back	180	Female	Young	920.79	205	398	4.50193	0.018
			-	Left	Palm	0	Female	Young	1513.35	205	398	7.39909	< .001
			-	Left	Palm	0	Female	Old	740.49	156	834	4.75806	0.005
			-	Left	Palm	0	Male	Young	1578.76	199	398	7.93262	< .001
			-	Left	Palm	90M	Female	Young	1986.34	205	398	9.71163	< .001
			-	Left	Palm	90M	Female	Old	1060.52	156	834	6.81437	< .001

			-	Left	Palm	90M	Male	Young	1951.53	199	398	9.80564	< .001
			-	Left	Palm	90L	Female	Young	997.86	205	398	4.87877	0.003
			-	Left	Palm	90L	Male	Young	1134.90	199	398	5.70239	< .001
			-	Left	Palm	180	Female	Young	1474.75	205	398	7.21038	< .001
			-	Left	Palm	180	Male	Young	1401.81	199	398	7.04353	< .001
	Male	Young	-	Right	Palm	180	Male	Young	701.71	164	833	4.26581	0.045
			-	Left	Back	0	Female	Young	1225.03	211	398	5.80889	< .001
			-	Left	Back	0	Male	Young	1267.02	164	835	7.71364	< .001
			-	Left	Back	90M	Female	Young	975.42	211	398	4.62531	0.010
			-	Left	Back	90M	Male	Young	880.33	164	835	5.35950	< .001
			-	Left	Back	90L	Male	Young	849.86	165	575	5.14220	< .001
			-	Left	Back	180	Female	Old	-1391.18	199	398	-6.99009	< .001
			-	Left	Back	180	Male	Old	-1098.40	221	398	-4.96957	0.002
			-	Left	Palm	90M	Female	Young	952.99	211	398	4.51894	0.017
			-	Left	Palm	90M	Male	Young	918.19	166	834	5.51880	< .001
			-	Left	Palm	90L	Male	Old	-957.30	221	398	-4.33119	0.038
			-	Left	Palm	180	Female	Old	-919.57	199	398	-4.62047	0.010
		Old	-	Right	Palm	180	Female	Young	1286.72	226	398	5.69349	< .001
			-	Right	Palm	180	Male	Young	1540.84	221	398	6.97134	< .001
			-	Left	Back	0	Female	Young	2064.15	226	398	9.13345	< .001
			-	Left	Back	0	Female	Old	1211.01	215	398	5.63344	< .001
			-	Left	Back	0	Male	Young	2106.14	221	398	9.52898	< .001
			-	Left	Back	0	Male	Old	1125.67	188	835	5.98188	< .001
			-	Left	Back	90M	Female	Young	1814.55	226	398	8.02901	< .001
			-	Left	Back	90M	Male	Young	1719.46	221	398	7.77948	< .001
			-	Left	Back	90M	Male	Old	800.61	188	835	4.25453	0.047
			-	Left	Back	90L	Female	Young	1457.38	226	398	6.44860	< .001
			-	Left	Back	90L	Male	Young	1688.98	221	398	7.64162	< .001
			-	Left	Palm	0	Female	Young	1319.13	226	398	5.83688	< .001
			-	Left	Palm	0	Male	Young	1384.54	221	398	6.26420	< .001
			-	Left	Palm	90M	Female	Young	1792.11	226	398	7.92975	< .001
			-	Left	Palm	90M	Male	Young	1757.31	221	398	7.95076	< .001
			-	Left	Palm	180	Female	Young	1280.53	226	398	5.66609	< .001
			-	Left	Palm	180	Male	Young	1207.59	221	398	5.46361	< .001
180	Female	Young	-	Right	Palm	180	Female	Old	-1122.06	205	398	-5.48600	< .001
			-	Right	Palm	180	Male	Old	-1137.07	226	398	-5.03132	0.001
			-	Left	Back	0	Female	Young	777.43	173	835	4.50199	0.015
			-	Left	Back	90L	Male	Old	-1086.39	226	398	-4.80705	0.004
			-	Left	Back	180	Female	Old	-1838.78	205	398	-8.99018	< .001
			-	Left	Back	180	Male	Old	-1546.00	226	398	-6.84072	< .001
			-	Left	Palm	90L	Female	Old	-1508.24	205	398	-7.37412	< .001
			-	Left	Palm	90L	Male	Old	-1404.90	226	398	-6.21640	< .001
			-	Left	Palm	180	Female	Old	-1367.17	205	398	-6.68440	< .001
			-	Left	Palm	180	Male	Old	-1331.89	226	398	-5.89334	< .001
		Old	-	Right	Palm	180	Male	Young	1376.18	199	398	6.91471	< .001
			-	Left	Back	0	Female	Young	1899.49	205	398	9.28701	< .001
			-	Left	Back	0	Female	Old	1046.35	154	835	6.81004	< .001
			-	Left	Back	0	Male	Young	1941.48	199	398	9.75511	< .001
			-	Left	Back	0	Male	Old	961.01	215	398	4.47047	0.021
			-	Left	Back	90M	Female	Young	1649.89	205	398	8.06665	< .001
			-	Left	Back	90M	Male	Young	1554.80	199	398	7.81220	< .001
			-	Left	Back	90L	Female	Young	1292.72	205	398	6.32037	< .001
			-	Left	Back	90L	Male	Young	1524.32	199	398	7.65909	< .001
			-	Left	Back	180	Female	Old	-716.72	155	575	-4.63600	0.009
			-	Left	Palm	0	Female	Young	1154.47	205	398	5.64444	< .001

					-	Left	Palm	0	Male	Young	1219.88	199	398	6.12939	< .001
					-	Left	Palm	90M	Female	Young	1627.45	205	398	7.95697	< .001
					-	Left	Palm	90M	Female	Old	701.63	156	834	4.50836	0.015
					-	Left	Palm	90M	Male	Young	1592.65	199	398	8.00241	< .001
					-	Left	Palm	180	Female	Young	1115.87	205	398	5.45573	< .001
					-	Left	Palm	180	Male	Young	1042.93	199	398	5.24030	< .001
			Male	Young	-	Right	Palm	180	Male	Old	-1391.19	221	398	-6.29427	< .001
					-	Left	Back	90L	Female	Old	-999.45	199	398	-5.02182	0.002
					-	Left	Back	90L	Male	Old	-1340.50	221	398	-6.06495	< .001
					-	Left	Back	180	Female	Old	-2092.89	199	398	-10.51591	< .001
					-	Left	Back	180	Male	Young	-909.45	165	575	-5.50277	< .001
					-	Left	Palm	0	Female	Old	-994.57	199	398	-4.99728	0.002
					-	Left	Palm	0	Male	Old	-1427.61	221	398	-6.45904	< .001
					-	Left	Palm	90M	Male	Old	-969.52	221	398	-4.38648	0.030
					-	Left	Palm	90L	Female	Old	-1762.36	199	398	-8.85510	< .001
					-	Left	Palm	90L	Male	Old	-1659.01	221	398	-7.50602	< .001
					-	Left	Palm	180	Female	Old	-1621.29	199	398	-8.14629	< .001
					-	Left	Palm	180	Male	Old	-1586.00	221	398	-7.17570	< .001
				Old	-	Left	Back	0	Female	Young	1914.50	226	398	8.47128	< .001
					-	Left	Back	0	Female	Old	1061.36	215	398	4.93729	0.002
					-	Left	Back	0	Male	Young	1956.49	221	398	8.85191	< .001
					-	Left	Back	0	Male	Old	976.02	188	835	5.18663	< .001
					-	Left	Back	90M	Female	Young	1664.90	226	398	7.36683	< .001
					-	Left	Back	90M	Male	Young	1569.81	221	398	7.10241	< .001
					-	Left	Back	90L	Female	Young	1307.73	226	398	5.78643	< .001
					-	Left	Back	90L	Male	Young	1539.33	221	398	6.96454	< .001
					-	Left	Palm	0	Female	Young	1169.48	226	398	5.17471	< .001
					-	Left	Palm	0	Male	Young	1234.89	221	398	5.58712	< .001
					-	Left	Palm	90M	Female	Young	1642.46	226	398	7.26758	< .001
					-	Left	Palm	90M	Male	Young	1607.66	221	398	7.27368	< .001
					-	Left	Palm	180	Female	Young	1130.88	226	398	5.00392	0.002
					-	Left	Palm	180	Male	Young	1057.94	221	398	4.78654	0.005
Left	Back	0	Female	Young	-	Left	Back	90M	Female	Old	-1250.28	205	398	-6.11290	< .001
					-	Left	Back	90M	Male	Old	-1263.54	226	398	-5.59089	< .001
					-	Left	Back	90L	Female	Old	-1522.76	205	398	-7.44511	< .001
					-	Left	Back	90L	Male	Old	-1863.81	226	398	-8.24701	< .001
					-	Left	Back	180	Female	Young	-1337.58	173	833	-7.73444	< .001
					-	Left	Back	180	Female	Old	-2616.21	205	398	-12.79119	< .001
					-	Left	Back	180	Male	Young	-1432.77	211	398	-6.79396	< .001
					-	Left	Back	180	Male	Old	-2323.42	226	398	-10.28068	< .001
					-	Left	Palm	0	Female	Old	-1517.88	205	398	-7.42123	< .001
					-	Left	Palm	0	Male	Old	-1950.92	226	398	-8.63242	< .001
					-	Left	Palm	90M	Female	Old	-1197.86	205	398	-5.85658	< .001
					-	Left	Palm	90M	Male	Old	-1492.83	226	398	-6.60548	< .001
					-	Left	Palm	90L	Female	Young	-1260.51	175	836	-7.20727	< .001
					-	Left	Palm	90L	Female	Old	-2285.67	205	398	-11.17513	< .001
					-	Left	Palm	90L	Male	Young	-1123.47	211	398	-5.32734	< .001
					-	Left	Palm	90L	Male	Old	-2182.33	226	398	-9.65636	< .001
					-	Left	Palm	180	Female	Young	-783.62	175	836	-4.48053	0.017
					-	Left	Palm	180	Female	Old	-2144.60	205	398	-10.48541	< .001
					-	Left	Palm	180	Male	Old	-2109.32	226	398	-9.33330	< .001
				Old	-	Left	Back	0	Male	Young	895.13	199	398	4.49765	0.018
					-	Left	Back	90L	Female	Old	-669.62	154	833	-4.35177	0.031
					-	Left	Back	90L	Male	Old	-1010.67	215	398	-4.70151	0.007
					-	Left	Back	180	Female	Old	-1763.06	154	833	-11.45790	< .001
					-	Left	Back	180	Male	Old	-1470.28	215	398	-6.83954	< .001

			-	Left	Palm	0	Female	Old	-664.74	151	556	-4.40375	0.026
			-	Left	Palm	0	Male	Old	-1097.78	215	398	-5.10670	0.001
			-	Left	Palm	90L	Female	Old	-1432.53	156	836	-9.20570	< .001
			-	Left	Palm	90L	Male	Old	-1329.19	215	398	-6.18318	< .001
			-	Left	Palm	180	Female	Old	-1291.46	156	836	-8.29917	< .001
			-	Left	Palm	180	Male	Old	-1256.18	215	398	-5.84355	< .001
	Male	Young	-	Left	Back	0	Male	Old	-980.47	221	398	-4.43603	0.024
			-	Left	Back	90M	Female	Old	-1292.27	199	398	-6.49312	< .001
			-	Left	Back	90M	Male	Old	-1305.52	221	398	-5.90669	< .001
			-	Left	Back	90L	Female	Old	-1564.75	199	398	-7.86222	< .001
			-	Left	Back	90L	Male	Old	-1905.80	221	398	-8.62259	< .001
			-	Left	Back	180	Female	Young	-1379.57	211	398	-6.54171	< .001
			-	Left	Back	180	Female	Old	-2658.19	199	398	-13.35631	< .001
			-	Left	Back	180	Male	Young	-1474.76	164	833	-8.96522	< .001
			-	Left	Back	180	Male	Old	-2365.41	221	398	-10.70203	< .001
			-	Left	Palm	0	Female	Old	-1559.87	199	398	-7.83768	< .001
			-	Left	Palm	0	Male	Young	-721.60	161	556	-4.47169	0.019
			-	Left	Palm	90M	Male	Old	-1534.82	221	398	-6.94412	< .001
			-	Left	Palm	90L	Female	Young	-1302.50	211	398	-6.17624	< .001
			-	Left	Palm	90L	Female	Old	-2327.66	199	398	-11.69550	< .001
			-	Left	Palm	90L	Male	Young	-1165.46	166	836	-7.00577	< .001
			-	Left	Palm	90L	Male	Old	-2224.31	221	398	-10.06366	< .001
			-	Left	Palm	180	Female	Old	-2186.59	199	398	-10.98669	< .001
			-	Left	Palm	180	Male	Young	-898.55	166	836	-5.40130	< .001
			-	Left	Palm	180	Male	Old	-2151.31	221	398	-9.73333	< .001
		Old	-	Left	Back	90L	Male	Old	-925.33	188	833	-4.91009	0.002
			-	Left	Back	180	Female	Old	-1677.72	215	398	-7.80453	< .001
			-	Left	Back	180	Male	Old	-1384.94	188	833	-7.34890	< .001
			-	Left	Palm	0	Male	Old	-1012.44	185	556	-5.47640	< .001
			-	Left	Palm	90L	Female	Old	-1347.19	215	398	-6.26692	< .001
			-	Left	Palm	90L	Male	Old	-1243.84	191	836	-6.52641	< .001
			-	Left	Palm	180	Female	Old	-1206.12	215	398	-5.61069	< .001
			-	Left	Palm	180	Male	Old	-1170.83	191	836	-6.14333	< .001
90M	Female	Young	-	Left	Back	90M	Female	Old	-1000.68	205	398	-4.89254	0.003
			-	Left	Back	90M	Male	Old	-1013.93	226	398	-4.48645	0.019
			-	Left	Back	90L	Female	Old	-1273.16	205	398	-6.22475	< .001
			-	Left	Back	90L	Male	Old	-1614.21	226	398	-7.14257	< .001
			-	Left	Back	180	Female	Young	-1087.98	173	833	-6.29114	< .001
			-	Left	Back	180	Female	Old	-2366.60	205	398	-11.57083	< .001
			-	Left	Back	180	Male	Young	-1183.16	211	398	-5.61038	< .001
			-	Left	Back	180	Male	Old	-2073.82	226	398	-9.17624	< .001
			-	Left	Palm	0	Female	Old	-1268.28	205	398	-6.20087	< .001
			-	Left	Palm	0	Male	Old	-1701.32	226	398	-7.52798	< .001
			-	Left	Palm	90M	Female	Old	-948.25	205	398	-4.63622	0.010
			-	Left	Palm	90M	Male	Old	-1243.23	226	398	-5.50104	< .001
			-	Left	Palm	90L	Female	Young	-1010.91	175	836	-5.78010	< .001
			-	Left	Palm	90L	Female	Old	-2036.07	205	398	-9.95476	< .001
			-	Left	Palm	90L	Male	Old	-1932.72	226	398	-8.55192	< .001
			-	Left	Palm	180	Female	Old	-1895.00	205	398	-9.26505	< .001
		Old	-	Left	Back	90M	Male	Young	905.59	199	398	4.55021	0.014
			-	Left	Back	90L	Male	Young	875.12	199	398	4.39710	0.028
			-	Left	Back	180	Female	Old	-1365.92	154	833	-8.87693	< .001
			-	Left	Back	180	Male	Old	-1073.14	215	398	-4.99209	0.002
			-	Left	Palm	90M	Female	Young	978.25	205	398	4.78287	0.005
			-	Left	Palm	90M	Male	Young	943.45	199	398	4.74042	0.006
			-	Left	Palm	90L	Female	Old	-1035.39	156	836	-6.65359	< .001

			-	Left	Palm	90L	Male	Old	-932.04	215	398	-4.33573	0.037
			-	Left	Palm	180	Female	Old	-894.32	156	836	-5.74705	< .001
	Male	Young	-	Left	Back	90L	Female	Old	-1178.07	199	398	-5.91930	< .001
			-	Left	Back	90L	Male	Old	-1519.12	221	398	-6.87309	< .001
			-	Left	Back	180	Female	Young	-992.89	211	398	-4.70813	0.007
			-	Left	Back	180	Female	Old	-2271.51	199	398	-11.41340	< .001
			-	Left	Back	180	Male	Young	-1088.07	164	833	-6.61453	< .001
			-	Left	Back	180	Male	Old	-1978.73	221	398	-8.95254	< .001
			-	Left	Palm	0	Female	Old	-1173.18	199	398	-5.89476	< .001
			-	Left	Palm	0	Male	Old	-1606.22	221	398	-7.26718	< .001
			-	Left	Palm	90M	Female	Old	-853.16	199	398	-4.28679	0.046
			-	Left	Palm	90M	Male	Old	-1148.14	221	398	-5.19462	< .001
			-	Left	Palm	90L	Female	Young	-915.81	211	398	-4.34265	0.036
			-	Left	Palm	90L	Female	Old	-1940.98	199	398	-9.75259	< .001
			-	Left	Palm	90L	Male	Young	-778.78	166	836	-4.68137	0.007
			-	Left	Palm	90L	Male	Old	-1837.63	221	398	-8.31416	< .001
			-	Left	Palm	180	Female	Old	-1799.91	199	398	-9.04378	< .001
			-	Left	Palm	180	Male	Old	-1764.62	221	398	-7.98384	< .001
		Old	-	Left	Back	180	Female	Old	-1352.67	215	398	-6.29243	< .001
			-	Left	Back	180	Male	Old	-1059.89	188	833	-5.62408	< .001
			-	Left	Palm	90M	Male	Young	956.70	221	398	4.32847	0.038
			-	Left	Palm	90L	Female	Old	-1022.13	215	398	-4.75482	0.006
			-	Left	Palm	90L	Male	Old	-918.79	191	836	-4.82087	0.003
			-	Left	Palm	180	Male	Old	-845.78	191	836	-4.43779	0.021
90L	Female	Young	-	Left	Back	90L	Female	Old	-915.99	205	398	-4.47847	0.020
			-	Left	Back	90L	Male	Old	-1257.04	226	398	-5.56216	< .001
			-	Left	Back	180	Female	Old	-2009.43	205	398	-9.82455	< .001
			-	Left	Back	180	Male	Old	-1716.65	226	398	-7.59583	< .001
			-	Left	Palm	0	Female	Old	-911.11	205	398	-4.45459	0.022
			-	Left	Palm	0	Male	Old	-1344.15	226	398	-5.94757	< .001
			-	Left	Palm	90L	Female	Old	-1678.90	205	398	-8.20848	< .001
			-	Left	Palm	90L	Male	Old	-1575.55	226	398	-6.97151	< .001
			-	Left	Palm	180	Female	Old	-1537.83	205	398	-7.51877	< .001
			-	Left	Palm	180	Male	Old	-1502.54	226	398	-6.64846	< .001
		Old	-	Left	Back	90L	Male	Young	1147.60	199	398	5.76619	< .001
			-	Left	Back	180	Female	Old	-1093.44	154	833	-7.10613	< .001
			-	Left	Palm	90M	Female	Young	1250.73	205	398	6.11508	< .001
			-	Left	Palm	90M	Male	Young	1215.92	199	398	6.10951	< .001
			-	Left	Palm	90L	Female	Old	-762.91	151	556	-5.05411	0.001
	Male	Young	-	Left	Back	90L	Male	Old	-1488.65	221	398	-6.73522	< .001
			-	Left	Back	180	Female	Young	-962.42	211	398	-4.56363	0.014
			-	Left	Back	180	Female	Old	-2241.04	199	398	-11.26029	< .001
			-	Left	Back	180	Male	Young	-1057.60	164	833	-6.42929	< .001
			-	Left	Back	180	Male	Old	-1948.26	221	398	-8.81467	< .001
			-	Left	Palm	0	Male	Old	-1575.75	221	398	-7.12931	< .001
			-	Left	Palm	90M	Male	Old	-1117.67	221	398	-5.05675	0.001
			-	Left	Palm	90L	Female	Old	-1910.50	199	398	-9.59948	< .001
			-	Left	Palm	90L	Male	Young	-748.31	161	556	-4.63722	0.009
			-	Left	Palm	90L	Male	Old	-1807.16	221	398	-8.17629	< .001
			-	Left	Palm	180	Female	Old	-1769.43	199	398	-8.89067	< .001
			-	Left	Palm	180	Male	Old	-1734.15	221	398	-7.84597	< .001
		Old	-	Left	Palm	0	Female	Young	1118.79	226	398	4.95044	0.002
			-	Left	Palm	0	Male	Young	1184.21	221	398	5.35781	< .001
			-	Left	Palm	90M	Female	Young	1591.78	226	398	7.04331	< .001
			-	Left	Palm	90M	Male	Young	1556.98	221	398	7.04436	< .001

				-	Left	Palm	180	Female	Young	1080.20	226	398	4.77965	0.005
				-	Left	Palm	180	Male	Young	1007.26	221	398	4.55722	0.014
	180	Female	Young	-	Left	Back	180	Female	Old	-1278.62	205	398	-6.25146	< .001
				-	Left	Back	180	Male	Old	-985.84	226	398	-4.36214	0.033
				-	Left	Palm	90M	Female	Young	1065.55	175	836	6.09254	< .001
				-	Left	Palm	90M	Male	Young	1030.75	211	398	4.88763	0.003
				-	Left	Palm	90L	Female	Old	-948.09	205	398	-4.63539	0.010
			Old	-	Left	Back	180	Male	Young	1183.44	199	398	5.94628	< .001
				-	Left	Palm	0	Female	Young	1871.18	205	398	9.14862	< .001
				-	Left	Palm	0	Female	Old	1098.33	156	836	7.05806	< .001
				-	Left	Palm	0	Male	Young	1936.60	199	398	9.73059	< .001
				-	Left	Palm	90M	Female	Young	2344.17	205	398	11.46115	< .001
				-	Left	Palm	90M	Female	Old	1418.35	156	836	9.11458	< .001
				-	Left	Palm	90M	Male	Young	2309.37	199	398	11.60361	< .001
				-	Left	Palm	90M	Male	Old	1123.37	215	398	5.22578	< .001
				-	Left	Palm	90L	Male	Young	1492.73	199	398	7.50035	< .001
				-	Left	Palm	180	Female	Young	1832.59	205	398	8.95991	< .001
				-	Left	Palm	180	Male	Young	1759.65	199	398	8.84149	< .001
		Male	Young	-	Left	Palm	0	Male	Young	753.16	166	836	4.52735	0.014
				-	Left	Palm	90M	Female	Young	1160.73	211	398	5.50401	< .001
				-	Left	Palm	90M	Male	Young	1125.93	166	836	6.76813	< .001
				-	Left	Palm	90L	Female	Old	-852.90	199	398	-4.28548	0.046
			Old	-	Left	Palm	0	Female	Young	1578.40	226	398	6.98411	< .001
				-	Left	Palm	0	Male	Young	1643.81	221	398	7.43725	< .001
				-	Left	Palm	90M	Female	Young	2051.39	226	398	9.07698	< .001
				-	Left	Palm	90M	Female	Old	1125.57	215	398	5.23597	< .001
				-	Left	Palm	90M	Male	Young	2016.59	221	398	9.12381	< .001
				-	Left	Palm	90M	Male	Old	830.59	191	836	4.35809	0.030
				-	Left	Palm	90L	Female	Young	1062.91	226	398	4.70319	0.007
				-	Left	Palm	90L	Male	Young	1199.95	221	398	5.42903	< .001
				-	Left	Palm	180	Female	Young	1539.80	226	398	6.81333	< .001
				-	Left	Palm	180	Male	Young	1466.87	221	398	6.63666	< .001
Palm	0	Female	Young	-	Left	Palm	0	Male	Old	-1205.90	226	398	-5.33585	< .001
				-	Left	Palm	90L	Female	Old	-1540.65	205	398	-7.53256	< .001
				-	Left	Palm	90L	Male	Old	-1437.31	226	398	-6.35979	< .001
				-	Left	Palm	180	Female	Old	-1399.58	205	398	-6.84284	< .001
				-	Left	Palm	180	Male	Old	-1364.30	226	398	-6.03673	< .001
			Old	-	Left	Palm	90M	Female	Young	1245.84	205	398	6.09119	< .001
				-	Left	Palm	90M	Male	Young	1211.04	199	398	6.08497	< .001
				-	Left	Palm	90L	Female	Old	-767.79	154	833	-4.98976	0.001
		Male	Young	-	Left	Palm	0	Male	Old	-1271.31	221	398	-5.75189	< .001
				-	Left	Palm	90L	Female	Old	-1606.06	199	398	-8.06978	< .001
				-	Left	Palm	90L	Male	Old	-1502.72	221	398	-6.79887	< .001
				-	Left	Palm	180	Female	Old	-1464.99	199	398	-7.36097	< .001
				-	Left	Palm	180	Male	Old	-1429.71	221	398	-6.46855	< .001
			Old	-	Left	Palm	90M	Female	Young	1678.88	226	398	7.42872	< .001
				-	Left	Palm	90M	Male	Young	1644.08	221	398	7.43845	< .001
				-	Left	Palm	180	Female	Young	1167.30	226	398	5.16507	< .001
				-	Left	Palm	180	Male	Young	1094.36	221	398	4.95131	0.002
	90M	Female	Young	-	Left	Palm	90M	Female	Old	-925.82	205	398	-4.52654	0.016
				-	Left	Palm	90M	Male	Old	-1220.80	226	398	-5.40178	< .001
				-	Left	Palm	90L	Female	Young	-988.47	173	833	-5.71575	< .001
				-	Left	Palm	90L	Female	Old	-2013.63	205	398	-9.84509	< .001
				-	Left	Palm	90L	Male	Old	-1910.29	226	398	-8.45266	< .001
				-	Left	Palm	180	Female	Old	-1872.57	205	398	-9.15537	< .001
				-	Left	Palm	180	Male	Old	-1837.28	226	398	-8.12960	< .001

		Old	-	Left	Palm	90M	Male	Young	891.02	199	398	4.47700	0.020
			-	Left	Palm	90L	Female	Old	-1087.81	154	833	-7.06953	< .001
			-	Left	Palm	90L	Male	Old	-984.47	215	398	-4.57961	0.013
			-	Left	Palm	180	Female	Old	-946.74	154	833	-6.15275	< .001
	Male	Young	-	Left	Palm	90M	Male	Old	-1185.99	221	398	-5.36589	< .001
			-	Left	Palm	90L	Female	Young	-953.67	211	398	-4.52216	0.016
			-	Left	Palm	90L	Female	Old	-1978.83	199	398	-9.94280	< .001
			-	Left	Palm	90L	Male	Young	-816.64	164	833	-4.96443	0.002
			-	Left	Palm	90L	Male	Old	-1875.49	221	398	-8.48543	< .001
			-	Left	Palm	180	Female	Old	-1837.76	199	398	-9.23399	< .001
			-	Left	Palm	180	Male	Old	-1802.48	221	398	-8.15511	< .001
90L	Female	Young	-	Left	Palm	90L	Female	Old	-1025.16	205	398	-5.01223	0.002
			-	Left	Palm	180	Female	Old	-884.09	205	398	-4.32252	0.039
		Old	-	Left	Palm	90L	Male	Young	1162.19	199	398	5.83954	< .001
			-	Left	Palm	180	Female	Young	1502.05	205	398	7.34385	< .001
			-	Left	Palm	180	Male	Young	1429.11	199	398	7.18069	< .001
	Male	Young	-	Left	Palm	90L	Male	Old	-1058.85	221	398	-4.79066	0.005
			-	Left	Palm	180	Female	Old	-1021.13	199	398	-5.13073	< .001
			-	Left	Palm	180	Male	Old	-985.84	221	398	-4.46033	0.021
		Old	-	Left	Palm	180	Female	Young	1398.71	226	398	6.18900	< .001
			-	Left	Palm	180	Male	Young	1325.77	221	398	5.99829	< .001
180	Female	Young	-	Left	Palm	180	Female	Old	-1360.98	205	398	-6.65413	< .001
			-	Left	Palm	180	Male	Old	-1325.70	226	398	-5.86595	< .001
		Old	-	Left	Palm	180	Male	Young	1288.04	199	398	6.47187	< .001
	Male	Young	-	Left	Palm	180	Male	Old	-1252.76	221	398	-5.66796	< .001