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Is there handedness for tactile acuity? A systematic review and meta-analysis

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ABSTRACT

Most people have a strong preference to use one hand over the other for complex motor tasks, and are more skilled at doing so, a phenomenon known as handedness. Is there also handedness for the sense of touch? This paper reports a systematic review and meta-analysis of studies that have compared tactile spatial acuity between the two hands in healthy humans. A total of 107 samples from 85 papers (total $N=4949$) were identified from searches of the PubMed and Scopus databases in September 2024. Potential moderators of such differences were also explored, including psychophysical task, age, and geographic location. Overall, there was no evidence for systematic differences in tactile acuity between the two hands (Hedges's $g = -0.021$, 95% CI $[-0.070, 0.028]$), nor of any effect of potential moderating variables. There was, however, substantial heterogeneity in the results. The implications of these findings are discussed in relation to the links between motor and somatosensory function.

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KEYWORDS Handedness; touch; tactile acuity

Introduction

Population-level right-handedness is culturally-universal in human populations (Longo, 2025; Papadatou-Pastou et al., 2020; Perelle & Ehrman, 1994; Raymond & Pontier, 2004) and has existed for many thousands of years (Coren & Porac, 1977; Lozano et al., 2017; Uomini & Ruck, 2018). In most people, it is obvious from everyday experience that one hand (usually the right) is preferred for skilled motor tasks, and is more dextrous at performing them. Formal laboratory studies measuring motor skill consistently show large laterality effects, for example when participants need to place pegs into holes (Annett, 1970, 1972) or make marks in small circles (McManus et al., 2016; Tapley & Bryden, 1985).

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Is there also handedness for touch? There is reason to think that there might be. The somatosensory and motor cortices are adjacent in the brain, show similar dominance for the contralateral side of the body, and feature broadly similar patterns of somatotopy and cortical magnification (Penfield & Boldrey, 1937). Evolutionarily, the distinct somatosensory and motor cortices appear to have emerged from a single sensorimotor amalgam in early mammals (Lende, 1963). Indeed, recent studies have provided evidence for roles of the motor cortex in somatosensory processing (Hatsopoulos & Suminski, 2011) and of the somatosensory cortex in motor control (Matyas et al., 2010). These close links between motor and somatosensory function provide reason to suspect that the clear lateral asymmetries in motor dexterity might correspond to analogous asymmetries in sensory sensitivity.

Other studies have compared the two hands in haptic tasks, in which the participant makes active hand movements to feel stimuli. Such studies have reported a *left* hand advantage for a variety of tasks, including the discrimination of Braille characters (Hermelin & O'Connor, 1971a, 1971b; Rudel et al., 1974; Wilkinson & Carr, 1987), letters (Hunt et al., 1988; O'Boyle et al., 1987), words (O'Boyle & Murray, 1988), numbers (Harley & Grafman, 1983; Heller et al., 1990; Maxwell et al., 1984), as well as a range of specific object properties, such as weight (Ross & Roche, 1987; Weber, 1834/1996), texture (Tomlinson et al., 2011), shape (Dodds, 1978; Smith, 1933; Tanne & Lechelt, 1991), curvature (Squeri et al., 2012), orientation (Benton et al., 1973, 1978; Varney & Benton, 1975; Zuidhoek et al., 2007), and numerosity (Lechelt & Tanne, 1976; Young & Ellis, 1979). These findings in healthy individuals are supported by neurological studies showing that damage to the right cerebral hemisphere can produce bilateral deficits in haptic perception, whereas only contralateral deficits are seen following left-hemisphere damage (Carmon & Benton, 1969; Fontenot & Benton, 1971). Similarly, split-brain patients show larger haptic deficits for the right hand than for the left hand (Franco & Sperry, 1977; Milner & Taylor, 1972; Zaidel & Sperry, 1973).

Another approach to investigating laterality in touch is the "dichhaptic" paradigm, in which the participant feels two stimuli simultaneously, one with each hand, and then identifies matching stimuli from an array (Bradshaw et al., 1986). In general, these tasks have found a left hand advantage for spatial stimuli, but a right hand advantage for linguistic stimuli (Cioffi & Kandel, 1979; Oscar-Berman et al., 1978; Vargha-Khadem, 1982; Witelson, 1974, 1976). This pattern suggests that the effects of the hand may not reflect somatosensory function *per se*, but rather the more general differences between the two hemispheres for language and spatial cognition (Summers & Lederman, 1990).

In terms of more basic features of tactile sensitivity, such as spatial acuity, results have been inconsistent. At different times evidence has been presented for superior spatial discrimination performance in the right hand

(e.g., Haag et al., 2015; van Biervliet, 1897) and the left hand (e.g., Robinson & Kincaid, 2004; Zamorano et al., 2015), but little research has addressed this issue systematically. The aim of the present study was therefore to conduct a systematic meta-analysis of comparisons between the tactile spatial acuity of the left and right hands in healthy human participants. We focused on studies which used repeated-measures designs in which measures of spatial acuity, referring to the precision with which the spacing or orientation of tactile stimuli can be distinguished, were obtained for each hand separately in the same participants.

Methods

Literature search strategy

A systematic search of the literature was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Moher et al., 2009; Page et al., 2021). As we were uncertain what types of studies existed in the literature that might be relevant and expected that they would be highly variable in their designs and measurements, we did not register the systematic review protocol. We searched the *PubMed* and *Scopus* databases on 24th September 2024 using the following search term:

("touch" or "tactile") and ("acuity" or "sensitivity" or "two-point discrimination" or "two point discrimination" or "grating orientation" or "gap detection") and ("hand" or "finger" or "palm" or "dorsum")

This search returned 1342 studies from *PubMed* and 2714 from *Scopus*. In addition, we reviewed the reference lists of eligible studies and identified more recent studies that had cited them using *Google Scholar*. An additional 32 items were identified by these methods.

Study selection

Identified studies were entered into the *CADIMA* software (Kohl et al., 2018). The literature search and selection process is illustrated in [Figure 1](#). We first identified duplicate items, which resulted in 2867 unique records being screened. The first author then screened the title and abstract of each record to identify studies for full-text screening. To be included, studies needed to: (1) include a measure of tactile spatial acuity on the hands; (2) test both the right and left hands in the same participants; (3) include at least one sample of participants who were not selected for having any clinical condition, any special skill linked to altered acuity (e.g., Braille reading, musical expertise), or occupation hypothesized to affect touch (e.g., power tool operator); and (4) include at least one condition not involving any active intervention (e.g., brain stimulation, pharmacological intervention,

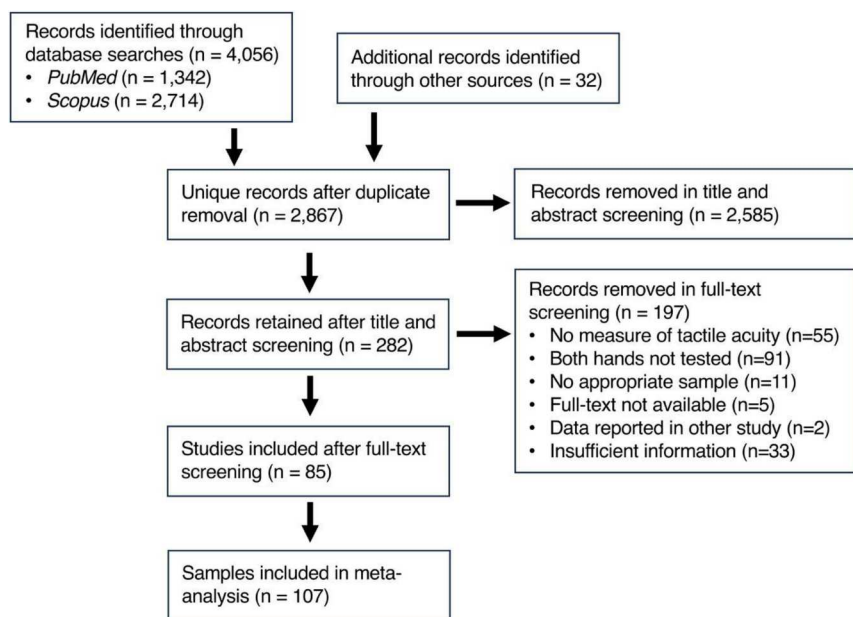


Figure 1. PRISMA flow chart illustrating the literature search and study selection procedure.

wearing of gloves), though pre-intervention baselines and passive interventions (e.g., sham stimulation, placebo) were allowed. A total of 2585 records were removed following title and abstract screening.

Full-text review was conducted on a total of 282 papers. To be included in the meta-analysis, studies needed to meet the four criteria as in the title and abstract screening, plus report sufficient information for calculation or estimation of the mean and standard deviation of a spatial acuity measure on both hands. A further 197 records were excluded following full-text review: 5 records were excluded because the full-text could not be accessed, 55 because they did not measure tactile spatial acuity, 91 because they did not test both hands in the same participants, 11 because no appropriate sample of participants was included, 33 because insufficient information was reported, and 2 because the same data was presented in a different paper from the same research group that was also included in the meta-analysis. Where it was clear that relevant data had been collected but insufficient data was presented in the paper, the authors were contacted; in four cases, the authors provided additional data allowing the studies to be included.

Data extraction was performed at the level of samples by the first author. The second author independently extracted data from 20% of samples to assess reliability; no changes were made to the first author's coding on this

basis. Where a study reported data separately for different groups of participants (e.g., men/women, different age groups, etc.), each group was coded as a separate sample for analyses. A total of 107 samples were included from 85 different published papers (see [Table 1](#) and raw data on the OSF). We extracted information from each sample on various methodological aspects and demographic characteristics, including the sample size, the proportion of female participants, handedness, age, the skin regions tested, the psychophysical task used, and the country where testing occurred. We inferred the country of testing based on several criteria, including the affiliations of the authors, statements about which ethics committee approved the study, statements about the demographic characteristics of the participants, and statements about the language used for testing. Assignment of countries to continents was based on the United Nations Geoscheme. We did not assess either risk of bias or quality of evidence given that no standard guidelines exist for this type of study and because most of the studies included were not actually designed to test the difference between the two hands.

When extracting data, reported statistics were checked for internal consistency where possible. Reported statistics were inspected for obvious inconsistencies (e.g., potential confusion between SDs and SEs). Any ambiguities encountered during extraction were noted and resolved using other information in the article where possible. Where there remained ambiguity about whether a value was a SD or an SE, we adopted the more conservative assumption that it was an SE. When relevant means and SDs were available in the main text, tables, or raw data, these were used directly. Values were estimated from figures only when absolute values were not available from other sources in the paper. Notes about these decisions are available in the datafile on OSF.

Raw data and analysis scripts are available on the Open Science Framework: <https://osf.io/j23yw/>

Measures of tactile spatial acuity

There were a total of five different measures of tactile spatial acuity used in the studies included in this analysis: (1) static two-point discrimination (static 2PDT; 88 samples), (2) moving two-point discrimination (moving 2PDT; 10 samples), (3) grating orientation test (GOT; 17 samples), (4) successive two-point discrimination (1 sample), and (5) two-point orientation discrimination (1 sample). (Note that adding up the number of samples using each task gives a number greater than 107 because some studies used multiple tasks.)

By far the most common task used was static 2PDT, reported for 88 samples. This task was developed by Weber (1834/1996) in his classic studies of the sense of touch in the nineteenth century, and it involves

Table 1. Studies included in the meta-analysis.

Author	Group	N	Age	%F	%R	Task	Body part	L/R or D/ND?	Country
van Biervliet (1897)	–	13	Adults	NR	NR	Static 2PDT	Dorsum	L/R	Belgium
Weinstein (1968-1)	Men	24	Adults	0	100	Static 2PDT	Palm, Thumb, Index finger, Middle finger, Ring finger, Little finger	Both	United States
Weinstein (1968-2)	Women	24	Adults	100	100	Static 2PDT	Palm, Thumb, Index finger, Middle finger, Ring finger, Little finger	Both	United States
Lesný (1971)	Healthy controls	30	Children	NR	NR	Static 2PDT	Middle fingertip, Middle finger centre, Centre of palm	L/R	Czech Republic
Bovenzi and Zadini (1989)	Healthy controls	91	Adults	0	NR	Static 2PDT	Index finger, Middle finger, Ring finger	L/R	Italy
Bovenzi et al. (1990-1)	Forestry controls	31	Adults	NR	NR	Static 2PDT	Index finger, Middle finger, Ring finger	L/R	Italy
Bovenzi et al. (1990-2)	Shoe industry controls	46	Adults	NR	NR	Static 2PDT	Index finger, Middle finger, Ring finger	L/R	Italy
Levin et al. (1989)	–	20	Adults	75	90	Static 2PDT	“Median nerve distribution”	L/R	United States
Cope and Antony (1992)	–	88	Children	NR	NR	Static 2PDT	Index finger, Middle finger	L/R	Australia
Robertson and Jones (1994)	Healthy controls	14	Older adults	42.9	100	Static and Moving 2PDT	Thumb, Index finger	Both	Canada
Cooper et al. (1995)	Healthy controls	41	Children	51.2	85.4	Moving 2PDT	Thumb, Index finger, Little finger	D/ND	Canada
Desrosiers et al. (1996-1)	Women (60–69)	59	Older adults	100	91.4	Static and Moving 2PDT	Index finger, Little finger	L/R	Canada
Desrosiers et al. (1996-2)	Women (70–79)	60	Older adults	100	91.4	Static and Moving 2PDT	Index finger, Little finger	L/R	Canada
Desrosiers et al. (1996-3)	Women (80+)	60	Older adults	100	91.4	Static and Moving 2PDT	Index finger, Little finger	L/R	Canada
Desrosiers et al. (1996-4)	Men (60–69)	61	Older adults	0	91.4	Static and Moving 2PDT	Index finger, Little finger	L/R	Canada
Desrosiers et al. (1996-5)	Men (70–79)	60	Older adults	0	91.4	Static and Moving 2PDT	Index finger, Little finger	L/R	Canada
Desrosiers et al. (1996-6)	Men (80+)	60	Older adults	0	91.4	Static and Moving 2PDT	Index finger, Little finger	L/R	Canada



Hermann et al. (1996)	313	Children	49.2	88.5	Moving 2PDT	Index finger, Little finger	L/R	United States
Sathian and Zangaladze (1996)	7	Adults	42.9	100	GOT	All fingertips	Both	United States
Van Boven et al. (2000)	15	Adults	60	93.3	GOT	Index finger, Middle finger	L/R	United States
Pleger et al. (2001)	16	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Vega-Bermudez and Johnson (2001)	8	Adults	0	100	GOT	Index finger, Middle finger, Ring finger	Both	United States
Chandhok and Bagust (2002)	74	Adults	51.4	86.5	Static 2PDT	Index finger	D/ND	United Kingdom
Dinse et al. (2003a-1)	16	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Dinse et al. (2003a-2)	8	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Dinse et al. (2003b-1)	18	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Dinse et al. (2003b-2)	18	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Pleger et al. (2003)	14	Adults	71.4	100	Static 2PDT	Index finger	Both	Germany
Ragert et al. (2003)	12	Adults	75	100	Static 2PDT	Index finger	Both	Germany
Satow et al. (2003)	8	Adults	NR	100	Static 2PDT	NR	Both	Japan
Hodzic et al. (2004)	11	Adults	NR	100	GOT	Index finger	Both	Germany
Ragert et al. (2004)	16	Adults	18.8	100	Static 2PDT	Index finger	Both	Germany
Robinson and Kincaid (2004)	10	Adults	50	100	Static 2PDT	All fingertips	Both	United States
Heriseanu et al. (2005)	17	Adults	52.9	94.1	Static 2PDT	Middle finger, Ring finger	L/R	Australia
Tegenthoff et al. (2005)	49	Adults	61.2	100	Static 2PDT	Index finger	Both	Germany
Dinse et al. (2006)	28	Older adults	53.6	100	Static 2PDT	Index finger	Both	Germany
Kitada et al. (2006)	16	Adults	37.5	100	GOT	Middle finger	Both	Japan
Bliem et al. (2007)	54	Adults	59.3	100	Static 2PDT	Index finger	Both	Germany
Höffken et al. (2007)	14	Adults	35.7	100	Static 2PDT	Index finger	Both	Germany
Kalisch et al. (2007-1)	10	Adults	70	100	Static 2PDT	Index finger	Both	Germany
Kalisch et al. (2007-2)	10	Adults	60	100	Static 2PDT	Index finger	Both	Germany
Kalisch et al. (2007-3)	6	Adults	50	100	Static 2PDT	Index finger	Both	Germany
Maihöfner and DeCol (2007)	12	Adults	66.7	100	Static 2PDT	Index finger	Both	Germany
Ragert et al. (2007)	4	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Bliem et al. (2008)	13	Adults	61.5	100	Static 2PDT	Index finger	Both	Germany

(Continued)



Table 1. Continued.

Author	Group	N	Age	%F	%R	Task	Body part	L/R or D/ND?	Country
Doh et al. (2008)	Control group	75	Older adults	45.3	94.7	GOT	Index finger	D/ND	South Korea
Ragert et al. (2008)	-	10	Adults	50	100	GOT	Index finger	Both	United States
Kalisch et al. (2009-1)	Young adults	19	Adults	63.2	100	Static 2PDT	Index finger	Both	Germany
Kalisch et al. (2009-2)	Older adults	17	Older adults	47.1	100	Static 2PDT	Index finger	Both	Germany
Lissek et al. (2009)	-	36	Adults	NR	100	Static 2PDT	Index finger	Both	Germany
Shahbazian et al. (2009-1)	Dentists	20	Adults	NR	NR	Static 2PDT	Thumb, Index finger	D/ND	Belgium
Shahbazian et al. (2009-2)	Non-dentists	20	Adults	NR	NR	Static 2PDT	Thumb, Index finger	D/ND	Belgium
Kattenstroth et al. (2010-1)	Amateur dancing group	24	Older adults	79.2	NR	Static 2PDT	Index finger	L/R	Germany
Kattenstroth et al. (2010-2)	Non-dancing group	38	Older adults	78.9	NR	Static 2PDT	Index finger	L/R	Germany
Boles and Givens (2011)	-	168	Adults	50.6	85	Static 2PDT	Little finger, Palm	L/R	United States
Kattenstroth et al. (2011)	Ballroom dancing group	11	Older adults	45.5	NR	Static 2PDT	Index finger	L/R	Germany
Peltz et al., 2011	Control group	30	Adults	63.3	NR	Static 2PDR	Index finger	L/R	Germany
Wong et al. (2011)	Sighted group	55	Adults	47.3	96.4	GOT	Index finger, Middle finger, Ring finger	D/ND	Canada
Eryilmaz et al. (2013)	Non-diabetic group	17	Adults	82.4	NR	Static 2PDT	Middle finger	L/R	Turkey
Freyer et al. (2013)	-	26	Adults	88.5	100	Static 2PDT	Index finger	Both	Germany
Mancini et al. (2014-1)	Simultaneous condition	16	Adults	56.3	100	Static 2PDT	Dorsum, Palm, Index/Middle finger	Both	United Kingdom
Mancini et al. (2014-2)	Successive condition	10	Adults	60	100	Successive 2PDT	Dorsum, Palm, Index/Middle finger	Both	United Kingdom
Muret et al. (2014-1)	RSS Exp 1	15	Adults	53.3	100	Static 2PDT	Index finger	Both	France
Muret et al. (2014-2)	Control Exp 1	15	Adults	53.3	100	Static 2PDT	Index finger	Both	France
Muret et al. (2014-3)	RSS Exp 2	8	Adults	87.5	100	Static 2PDT	Index finger	Both	France
Troise et al. (2014)	Control group	49	Children	0	NR	Static 2PDT	Thumb, Index finger, Palm	D/ND	Brazil



Haag et al. (2015)	–	19 Adults	42.1	100	Static 2PDT	Index finger	Both	Germany
Khoury et al. (2015)	Control group	49 Adults	63.3	NR	Static 2PDT	Index finger	L/R	Brazil
Philipp et al. (2015-1)	Sensory focusing group	10 Adults	40	NR	Static 2PDT	Index finger	L/R	Germany
Philipp et al. (2015-2)	Control group	10 Adults	50	NR	Static 2PDT	Index finger	L/R	Germany
Sims et al. (2015)	Non-musicians	100 Adults	61	91	Static 2PDT	All 5 fingers	L/R	United States
Zamorano et al. (2015)	Pain-free non-musician group	20 Adults	35	90	Static 2PDT and GOT	Middle finger	L/R	Spain
Heba et al. (2016)	–	18 Adults	44.4	100	Static 2PDT	Index finger	Both	Germany
Muret et al. (2016)	–	21 Adults	52	100	Static 2PDT	Index finger, Little finger	Both	France
Pleger et al. (2016-1)	Older adults	20 Older adults	50	100	Static 2PDT	Index finger	Both	Germany
Pleger et al. (2016-2)	Younger adults	20 Adults	50	100	Static 2PDT	Index finger	Both	Germany
Trzcinski et al. (2016)	–	10 Adults	70	90	GOT	Middle finger	L/R	United States
Dane et al. (2017)	–	104 Adults	53.8	89.4	Static 2PDT	Index finger	D/ND	Malaysia
Fujimoto et al. (2017)	–	10 Adults	30	100	GOT	Index finger	Both	Japan
Buitenhuis et al. (2018)	–	25 Children	NR	96	Static 2PDT	Thumb, index finger, Little finger	D/ND	Netherlands
Hirtz et al. (2018)	–	25 Adults	64	100	GOT	Index finger	Both	Germany
Jagad and Dhanesha (2018)	–	450 Adults	NR	NR	Static and Moving 2PDT	Index finger, Little finger	L/R	India
Muret and Dinse (2018)	Exp 1	18 Adults	71.4	100	Static 2PDT	Index finger	Both	Germany
Schmidt-Wilcke et al. (2018)	–	19 Adults	42.1	100	Static 2PDT	Index finger	Both	Germany
Pelletier et al. (2019)	Control group	30 Adults	60	100	2-point orientation discrimination Static 2PDT	Thenar eminence, Hypothenar eminence Index finger	Both	Canada
Brickwedde et al. (2020)	–	10 Adults	57.1	100	Static 2PDT	Index finger	Both	Germany
Lee et al. (2020)	Healthy control group	28 Adults	56.7	NR	Static 2PDT	Index finger	L/R	Australia
Härtner et al. (2021)	–	20 Adults	75	85	Static 2PDT and GOT	Index finger, Little finger	L/R	Germany
Schaefer et al. (2021)	–	95 Adults	56.8	100	Static 2PDT	Index finger	Both	Germany
Tödt et al. (2021)	Healthy control group	36 Adults	44.4	100	GOT	Index finger	Both	Germany
Akçay et al. (2022)	–	75 Adults	77.3	100	Static 2PDT	Index finger	Both	Turkey

(Continued)

Table 1. Continued.

Author	Group	N	Age	%F	%R	Task	Body part	L/R or D/ND?	Country
	Healthy control group								
Bayram et al. (2022-1)	Neural mobilization group	60	Adults	50	NR	Static 2PDT	Thumb, Index finger, Middle finger, Palm	L/R	Turkey
Bayram et al. (2022-2)	Control group	60	Adults	50	NR	Static 2PDT	Thumb, Index finger, Middle finger, Palm	L/R	Turkey
Erçalık and Özkurt (2022)	–	60	Adults	48.3	90	Static 2PDT	Dorsum, Thumb, Middle finger, Little finger	D/ND	Turkey
French et al. (2022)	Exp 1	20	Adults	50	90	GOT	Index finger	L/R	United Kingdom
İşık et al. (2022)	–	70	Adults	100	92.9	Static 2PDT	Index finger	L/R	Turkey
Patbandla and Miriam (2022-1)	Men	48	Adults	0	NR	Static 2PDT	All 5 fingers, palm	L/R	India
Patbandla and Miriam (2022-2)	Women	52	Adults	100	NR	Static 2PDT	All 5 fingers, palm	L/R	India
Ross et al. (2022)	–	14	Adults	71.4	92.9	GOT	Index finger, Middle finger	L/R	Canada
Schaefer et al. (2022)	–	40	Adults	65	100	Static 2PDT	Index finger	Both	Germany
Wolny et al. (2022)	Healthy control group	30	Adults	33.3	100	Static 2PDT	Ring finger, Little finger, Hypothenar eminence	Both	Poland
Jovellar-Isiegas et al. (2023)	Healthy control group	24	Children	41.7	91.7	Static 2PDT	Index finger	D/ND	Spain
Takaoka et al. (2023)	Control group	130	Older adults	60.8	NR	Static 2PDT	Index finger	L/R	Japan
Cook et al. (2024)	–	14	Older adults	50	100	GOT	NR	Both	United States
Magnani et al. (2024)	–	31	Adults	58.1	100	Static 2PDT	Dorsum	Both	Italy
Pandian et al. (2024-1)	Adults	624	Adults	39.1	95.8	Static 2PDT	All 5 fingers, 3 locations on palm	L/R	India
Pandian et al. (2024-2)	Children	172	Children	36	97.1	Static 2PDT	All 5 fingers, 3 locations on palm	L/R	India

measuring the smallest distance between two touches that the participant feels to be two distinct touches. When the touches are moved closer together, the participant feels only one single touch. Static 2PDT can be measured using many psychophysical procedures, such as the method of constant stimuli, the method of limits, or staircase procedures. The 2PDT measure has been criticized as a measure of tactile spatial acuity, and there is evidence that non-spatial factors can be used to make this judgment, at least under some conditions (Craig & Johnson, 2000; Tong et al., 2013). Indeed, highly-trained participants have been shown to be able to discriminate two points from one even when there is literally zero separation between them (Johnson & Phillips, 1981). It is also clear, however, that 2PDT does differ systematically across skin regions of different spatial sensitivity, and whole-body maps measured using static 2PDT correspond well with acuity using the less problematic successive 2PDT task (Mancini et al., 2014). For this reason, we have included this task in analyses, but the limitations of the measure should be kept in mind, especially if the results obtained using this task differ from those of other tasks.

The second task, moving 2PDT was reported for 10 samples. This task is similar to static 2PDT except that the two points are swept across the skin surface rather than placed at a single location. The criticisms of static 2PDT apply to this task as well.

The third task, GOT, was reported for 17 samples. In this task, square-wave gratings of different spatial frequencies are applied to the skin and the participant judges whether the grooves are oriented vertically or horizontally. Acuity is measured as the finest spatial frequency for which the participant can perform this discrimination above some threshold level of performance. GOT avoids the methodological criticisms levelled against 2PDT and is often viewed as the gold-standard method for measuring tactile spatial acuity.

The successive 2PDT task was used only in one sample (Mancini et al., 2014). In this task, the two touches are presented sequentially, one after the other, and the participant's task is to judge whether the second stimulus was located distal or proximal to the first stimulus. Because the judgment requires a directional judgment, rather than only an assessment of whether there were two touches or one (as in static and moving 2PDT), this task avoids the criticisms levelled against other 2PDT measures.

Finally, one sample (Pelletier et al., 2019) reported acuity using the two-point orientation discrimination task. In this task, two points are presented simultaneously on the skin, as in static 2PDT. The participant's task, however, is to judge whether the two points are oriented vertically or horizontally on the skin, as in GOT. The task thus requires the same type of spatial judgement as GOT, but uses a stimulus like static 2PDT.

Analysis

Meta-analysis was conducted using the *metafor* package in R (Viechtbauer, 2010) using multi-level models implemented using the *rma.mv* function. Egger's test (Egger et al., 1997) was used to assess publication bias. As only studies using repeated-measures comparison of the two hands in the same participants were included in this study, estimation of effect sizes requires the correlation between the two hands, in addition to means and SDs. A preliminary meta-analysis was therefore conducted on the subset of studies for which the correlation coefficient between measures of tactile acuity on the left and right hands was available (either because it was reported directly, could be calculated from raw data, or could be estimated from available statistics). Correlations were obtained from 19 samples from 18 papers, involving a total of 628 people. The correlations ranged from 0.187 to 0.862. A random-effects meta-analysis resulted in a mean estimate of $r = 0.616$ [95% CI: 0.555–0.678]. In cases for which the actual correlation was not available, this meta-analytic estimate of $r = 0.616$ was imputed.

Where acuity was tested at multiple skin sites in the same sample, these were averaged. As calculation of the SD of this average requires an estimate of the correlation between measures (Borenstein et al., 2009), we used the same estimate ($r = 0.616$) as for the correlation between the two hands. Similarly, when two different measures of acuity were collected in the same sample, an overall estimate was calculated by averaging the measures, using the same estimate of correlation. As the most common measure of standardized effect size (Cohen's d) introduces a small bias for small samples, the corrected effect size Hedges's g was used.

Finally, we used Robust Bayesian Meta-Analysis (RoBMA) analyses to assess the strength of evidence for or against the null hypothesis and publication bias (Bartoš et al., 2025; Maier et al., 2023).

Results

Overall meta-analysis

We first conducted an overall meta-analysis including all studies, including 107 samples and a total of 4949 participants. This analysis produced an overall mean estimate of Hedges's $g = -0.021$, 95% CI $[-0.070, 0.028]$, $z = -0.84$, $p = 0.399$. Critically, this confidence interval includes 0, indicating the absence of any overall laterality effect. There was clear evidence for heterogeneity, $Q(106) = 259.43$, $p < 0.0001$. Figure 2 shows a funnel plot of the standard error of estimates against effect size estimates. Despite one seeming outlier, there was no evidence for systematic publication bias. Consistent with this, Egger's test found no evidence for publication bias, $z = 1.01$, $p = 0.313$.

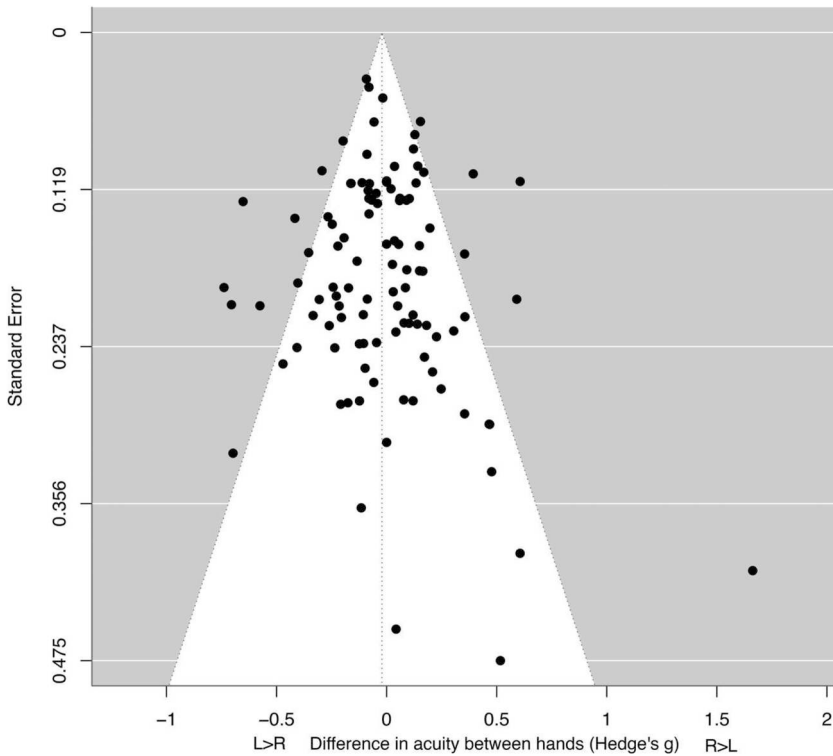


Figure 2. Funnel plot for the overall meta-analysis showing the standard error of estimates as a function of the estimated effect size. There was no evidence for systematic publication bias.

Robust Bayesian meta-analysis found strong evidence in support of the null hypothesis of no difference between hands, $BF_{01} = 18.18$, with an overall estimate of $\mu = -0.002$, 95% CI $[-0.037, 0.000]$. There was extreme evidence for heterogeneity, $BF_{rf} > 4 \times 10^9$, and moderate evidence against publication bias, $BF_{pb} = 0.103$.

Analysis by task

Figure 3 shows a forest plot of results from static 2-point discrimination, including 88 samples and a total of 4229 participants. The overall mean estimate was Hedges's $g = -0.034$, 95% CI $[-0.087, 0.019]$, $z = -1.27$, $p = 0.206$. Again, this confidence interval includes 0, indicating no overall laterality effect. There was clear evidence for heterogeneity, $Q(87) = 222.44$, $p < 0.0001$. Egger's test found no evidence for publication bias, $z = 0.65$, $p = 0.513$.

Robust Bayesian meta-analysis found strong evidence in support of the null hypothesis $BF_{01} = 13.89$, with an overall estimate of $\mu = -0.003$, 95%

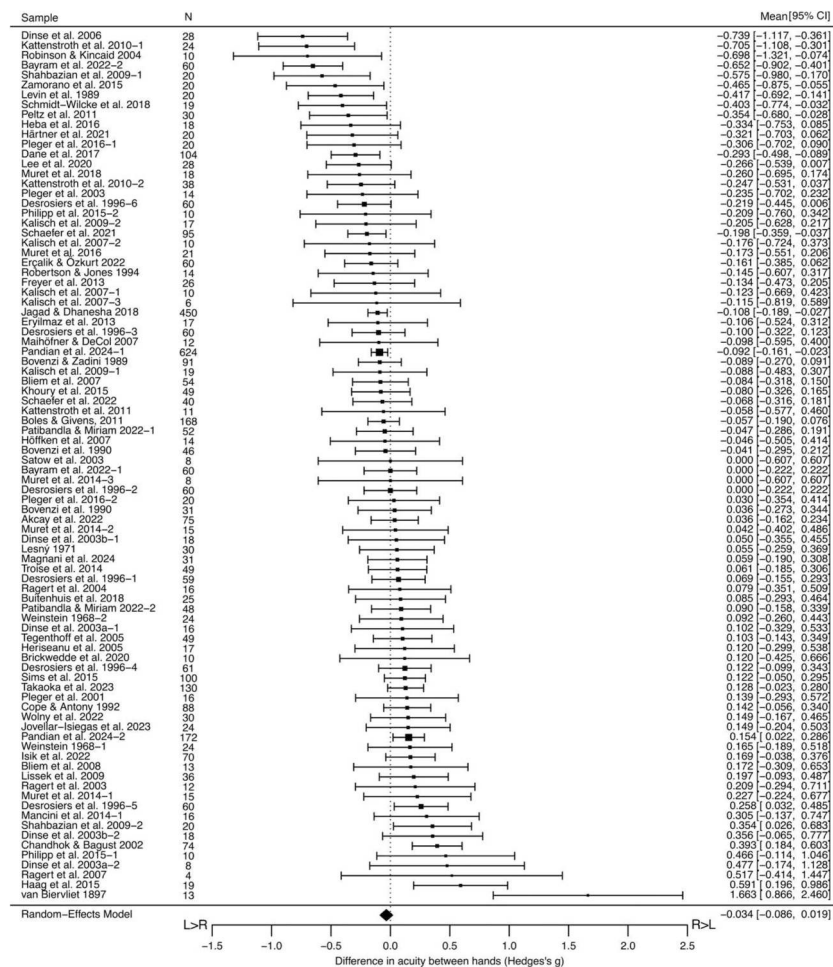


Figure 3. Forest plot showing studies measuring static 2-point discrimination. The mean and confidence interval indicate standardized mean differences comparing tactile acuity on the right (R) and left (L) hands. Positive values indicate higher acuity on the right hand and negative values indicate higher acuity on the left hand.

CI [-0.053, 0.000]. There was extreme evidence for heterogeneity, $BF_{rf} > 1.8 \times 10^6$, and moderate evidence against publication bias, $BF_{pb} = 0.148$.

Figure 4 shows a forest plot of results from moving 2-point discrimination, including 10 samples and a total of 1178 participants. The overall mean estimate was Hedges's $g = -0.048$, 95% CI [-0.098, 0.003], $z = -1.86$, $p = 0.063$, which again includes 0. There was no evidence for heterogeneity, $Q(9) = 4.37$, $p = 0.885$. Egger's test found no evidence for publication bias, $z = -1.10$, $p = 0.269$. Robust Bayesian meta-analysis found moderate evidence in support of the null hypothesis $BF_{01} = 6.49$, with an overall estimate of

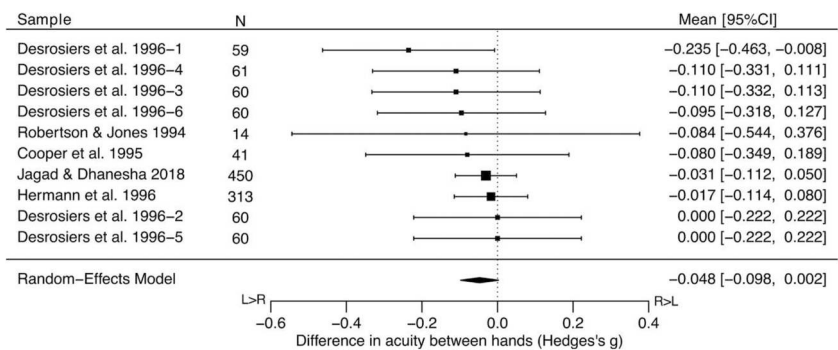


Figure 4. Forest plot showing studies measuring moving 2-point discrimination. The mean and confidence interval indicate standardized mean differences comparing tactile acuity on the right (R) and left (L) hands.

$\mu = -0.007$, 95% CI [-0.074, 0.000]. There was strong evidence against heterogeneity, $BF_{rf} = 0.090$, and moderate evidence against publication bias, $BF_{pb} = 0.293$.

Figure 5 shows the results for the grating orientation task, including 17 samples involving a total of 366 participants. The overall mean estimate was Hedges's $g = 0.037$, 95% CI [-0.119, 0.193], $z = 0.469$, $p = 0.639$, again including 0. There was clear evidence for heterogeneity, $Q(16) = 46.44$, $p < 0.0001$. Egger's test found no evidence for publication bias, $z = 0.36$, $p =$

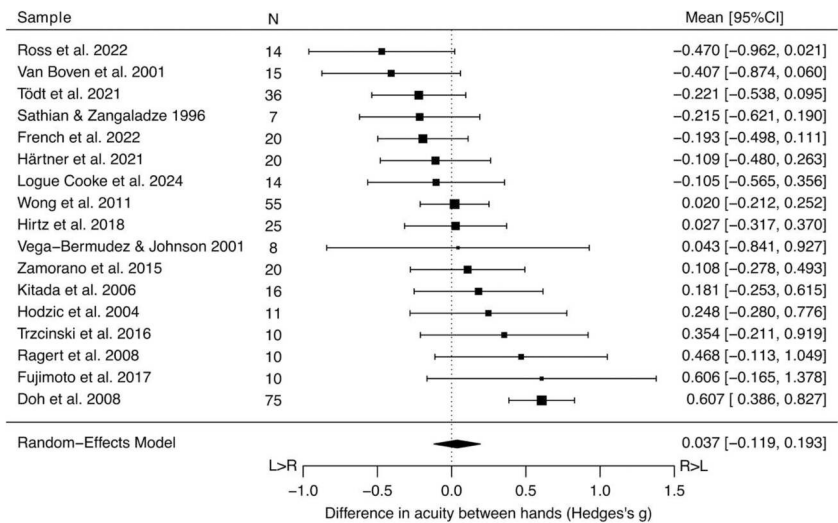


Figure 5. Forest plot showing studies measuring discrimination of grating orientation. The mean and confidence interval indicate standardized mean differences comparing tactile acuity on the right (R) and left (L) hands.

0.720. Robust Bayesian meta-analysis found strong evidence in support of the null hypothesis $BF_{01} = 10.64$, with an overall estimate of $\mu = -0.001$, 95% CI $[-0.033, 0.065]$. There was strong evidence for heterogeneity, $BF_{rf} = 2554.86$, and moderate evidence against publication bias, $BF_{pb} = 0.331$.

Laterality versus dominance

The studies included in the previous analyses varied in whether they reported mean values for the right vs. the left hand or for the dominant vs. the non-dominant hand. In cases where the entire sample was right-handed,¹ these ways of describing the data are interchangeable. But in samples with mixed handedness, they differ. We therefore conducted separate analyses including studies that compared the left vs. right hand and those that compared the dominant vs. non-dominant hand. Studies that included exclusively right-handed participants were included in both analyses.

For comparison of the left vs. right hand, 96 samples were included comprising 4402 participants. The overall mean estimate was Hedges's $g = -0.039$, 95% CI $[-0.085, 0.007]$, $z = -1.65$, $p = 0.099$. There was clear evidence for heterogeneity, $Q(95) = 189.01$, $p < 0.0001$. Egger's test found no evidence for publication bias, $z = 1.26$, $p = 0.209$. Robust Bayesian meta-analysis found moderate evidence in support of the null hypothesis $BF_{01} = 6.21$, with an overall estimate of $\mu = -0.008$, 95% CI $[-0.097, 0.000]$. There was strong evidence for heterogeneity, $BF_{rf} = 13,014.62$, and moderate evidence against publication bias, $BF_{pb} = 0.151$.

For comparison of the dominant vs. non-dominant hand, 66 samples were included comprising a total of 1690 participants. The overall mean estimate was Hedges's $g = 0.009$, 95% CI $[-0.058, 0.077]$, $z = 0.275$, $p = 0.783$. There was clear evidence for heterogeneity, $Q(65) = 141.31$, $p < 0.0001$. Egger's test found no evidence for publication bias, $z = 0.39$, $p = 0.694$. Robust Bayesian meta-analysis found strong evidence in support of the null hypothesis $BF_{01} = 23.81$, with an overall estimate of $\mu = 0.000$, 95% CI $[0.000, 0.000]$. There was extreme evidence for heterogeneity, $BF_{rf} > 1.5 \times 10^6$, and moderate evidence against publication bias, $BF_{pb} = 0.199$.

Thus, there are no apparent effects of laterality or hand dominance on tactile acuity, either overall, or for any of the specific tasks used.

Analysis of age

The samples in this analysis included a wide range of ages. There is evidence for substantial developmental changes in tactile acuity, both during childhood and adolescence (Bleyenheuft et al., 2006; Peters & Goldreich, 2013)

¹None of the samples consisted exclusively of left-handed participants.

and during older adulthood (Kalisch et al., 2009; Stevens, 1992; Stevens & Choo, 1996; Vega-Bermudez & Johnson, 2004). We therefore divided the samples into three groups on the basis of the mean age of the participants: children (under 18 years), adults (18–60 years), and older adults (>60 years), and conducted a meta-analysis using age group as a moderator. Figure 6 shows the overall effect size estimates for each group separately. Age showed a significant moderating effect on the lateral asymmetry of tactile acuity, $QM(3) = 10.19$, $p < 0.02$. In children, there was some evidence for a right-hand advantage, while no significant asymmetry was found in the two adult groups. This effect of age was unexpected, and there are comparatively few studies that have tested children. But these results do provide suggestive evidence that there may be changes in lateral asymmetries in tactile acuity with age.

Analysis of geography

The 107 samples included in this meta-analysis come from 18 countries from all around the world, including substantial numbers of participants from every populated continent except for Africa. In recent years, there has been increasing concern about the fact that much research in psychology and neuroscience focuses heavily on participants in affluent Western countries (Henrich et al., 2010). This issue has also been raised specifically in the context of laterality research (Ocklenburg et al., 2021). In the case of handedness, there is universality across cultures in the fact that most people prefer to use the right hand, but substantial variability in the exact prevalence of left-handedness (Longo, 2025; Perelle & Ehrman, 1994; Raymond & Pontier, 2004). The wide geographic diversity of studies in the present analysis is therefore notable.

To assess whether there was evidence for geographic variability, we therefore conducted a meta-analysis including continent as a moderator. Figure 7

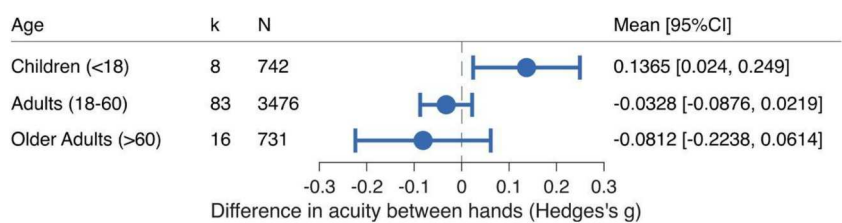


Figure 6. Meta-analytic estimates as a function of age. There was no evidence for laterality effects on tactile acuity in any age group, nor any evidence for age differences. k indicates the number of samples, and N the total number of participants. The mean and confidence interval indicate standardized mean differences comparing tactile acuity on the right (R) and left (L) hands. Error bars are 95% CIs. [To view this figure in color, please see the online version of this journal.]

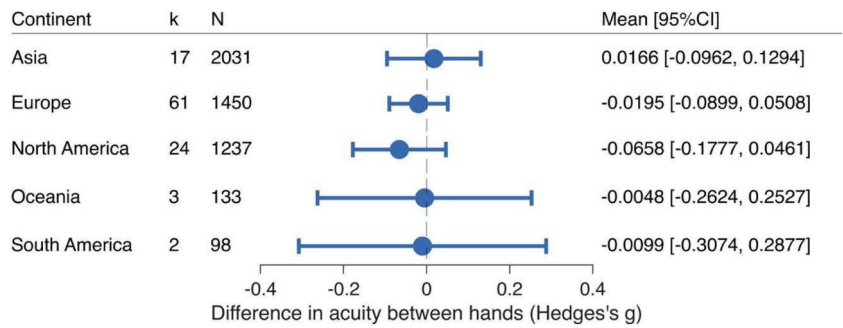


Figure 7. Meta-analytic estimates for each continent. There was no evidence for laterality effects on tactile acuity in any continent, nor any evidence for geographic differences. *k* indicates the number of samples, and *N* the number of participants. The mean and confidence interval indicate standardized mean differences comparing tactile acuity on the right (R) and left (L) hands. Error bars are 95% CIs. [To view this figure in color, please see the online version of this journal.]

shows the overall effect size estimates for each continent separately. As is clear from the figure, the results were similar in all continents, and there was no significant moderating effect of continent, $QM(5) = 1.71$, $p = 0.887$.

Tactile acuity vs. motor dexterity

As noted in the introduction, studies of motor dexterity have found large laterality effects (e.g., Annett, 1970, 1972, 1992; McManus et al., 2016; Tapley & Bryden, 1985), which is the familiar phenomenon we know as “handedness”. Figure 8 shows the overall estimates for tactile acuity in the present study (in blue) together with estimates from five tasks measuring laterality of manual dexterity in large samples of participants reported by Annett (1992). For motor function, substantial laterality effects with large effect sizes are apparent for all tasks. In striking contrast, as described above there are no significant effects for any of the tactile tasks. Indeed, the largest point estimate for any of the tactile tasks (0.065 for GOT) is an order of magnitude smaller than the smallest estimate among the motor tasks (0.639 for Line Drawing).

Discussion

The difference in manual dexterity between the hands—handedness—is one of the most striking behavioural effects in all human psychology and neuroscience. In striking contrast, the present study found no evidence at all for an analogous difference between the hands in tactile spatial acuity. There was no overall effect of laterality or hand preference on tactile acuity. Similarly,

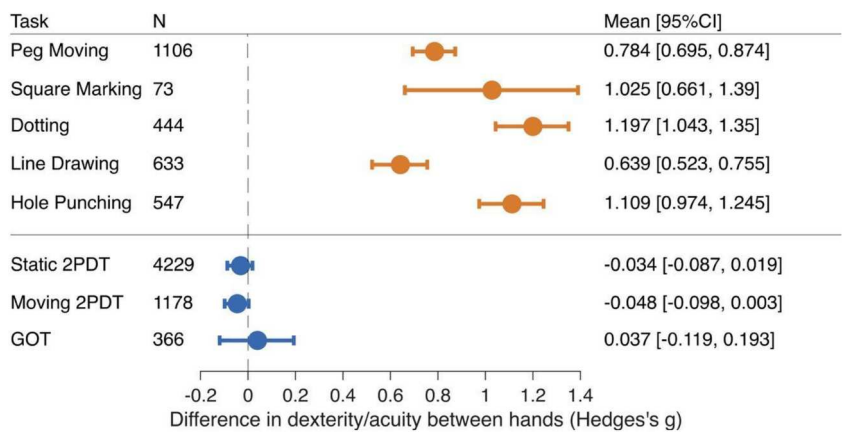


Figure 8. Comparison of meta-analytic estimates laterality effects for tactile acuity from this study (in blue) with comparable estimates (in orange) for 5 tasks of motor dexterity reported by Annett (1992). The mean and confidence interval indicate standardized mean differences comparing tactile acuity on the right (R) and left (L) hands. Error bars are 95% CIs. [To view this figure in color, please see the online version of this journal.]

no such effect was found for any specific task individually, or for any geographic regions.

The one case in which a significant effect was present was for age. There was a statistically significant moderating effect of age on lateral asymmetries in tactile acuity. For children, there was some evidence for a right-hand advantage, with no significant laterality effect found in adults or older adults. This effect is suggestive that there may be changes in lateral asymmetries in the somatosensory system with age. However, these results should be interpreted cautiously given the relatively small number of studies included which tested children. This will be an interesting topic for future research to address.

The present results indicate a profound difference in the nature of laterality effects between the motor system and the somatosensory system. As described in the Introduction, both of these systems feature predominantly contralateral control, in which the left hemisphere is responsible for the right hand and the right hemisphere for the left hand. Despite broadly similar organization and close interaction between the motor and somatosensory systems, the nature of lateral asymmetries in each appears to be fundamentally different. There is no handedness for tactile spatial acuity mirroring the large handedness effects on manual preference and skill.

This study focused specifically on tactile spatial acuity, which may have affected the outcome. It is conceivable that different results might occur for analyses of either more basic aspects of touch (e.g., simple detection

thresholds) or more complex aspects (e.g., haptic object recognition, graphesthesia, etc.). In the context of measuring handedness in non-human primates, Fagot and Vauclair (1991) emphasized the importance of considering task complexity in assessing handedness. Simple, low-level tasks might not be expected to show lateral differences, which might be more apparent in higher-level, bimanually-differentiated tasks. Indeed, in non-human primates, complex bimanually-differentiated tasks like the “tube task” (Hopkins, 1995) show clearer evidence for hand preferences than simpler tasks (Meguerditchian et al., 2013; Nelson, 2022). It is possible that similar differences between the hands would be apparent for more complex tactile tasks. Indeed, as discussed in the introduction, there are numerous studies showing left hand advantages for tasks such as reading Braille (Hermelin & O'Connor, 1971a, 1971b; Rudel et al., 1974; Wilkinson & Carr, 1987) or recognizing numbers (Harley & Grafman, 1983; Heller et al., 1990; Maxwell et al., 1984). It is important to note, however, that a glance at the forest plots in this study shows that it would be easy to cherry-pick examples of studies showing significant advantages for the right hand in tactile acuity (e.g., Chandhok & Bagust, 2002; Doh et al., 2008; Haag et al., 2015) or for the left hand (e.g., Dinse et al., 2006; Levin et al., 1989; Zamorano et al., 2015), despite the lack of any overall evidence for any laterality effect. It will thus be important for future studies investigating handedness for higher-order tactile tasks to look systematically at all available evidence.

There was substantial heterogeneity across studies in most of the analyses reported in this paper. The factors driving this are not clear. We investigated several potential factors that might drive effects, including different tasks used to assess tactile acuity, different ways of contrasting the hands (i.e., laterality vs. dominance), age, and geography. None of these factors appeared to have a substantial effect on the results. It is easy to imagine factors which would affect absolute tactile acuity thresholds, such as the specific stimulator used, timing and pressure of stimulation, etc. It is less clear, however, why any such factor should differentially affect the left and right hands. Summers and Lederman (1990) suggested that tactile performance on each hand could be higher for tasks relating to the broader specializations of the contralateral hemisphere. Critically, however, this should not vary substantially across the studies included in the present meta-analysis, which focuses on simple measures of tactile spatial acuity.

More generally, the literature reviewed here varies substantially in both the task used and the intensity of testing, ranging from brief clinical assessments to extended laboratory-based psychophysical paradigms designed to precisely estimate thresholds. While these sorts of differences are likely to affect the precision of obtained acuity estimates, there is little reason to expect that they should systematically favour either the left or the right hand. Indeed, the absence of a consistent laterality effect across studies

using a wide range of methodologies suggests that the null result observed in the present meta-analysis is unlikely to solely reflect methodological limitations in the existing literature. A definitive test of tactile laterality would ideally involve large sample sizes and extensive psychophysical testing of both hands under tightly controlled conditions. However, the available evidence does not suggest that studies approximating this ideal produce systematically different results from the wider literature. For example, given the interpretative difficulties involved with 2PDT (Craig & Johnson, 2000; Tong et al., 2013), GOT may in some sense be viewed as a gold-standard method, and certainly involves rigorous psychophysical testing. Nevertheless, similar null results were obtained for analyses using GOT and both static and moving 2PDT. Taken together, these findings suggest that the absence of a laterality effect is unlikely to be explained solely by methodological variability across studies.

The possibility of publication bias is an important consideration for any meta-analysis. There are, however, reasons to think that this is not a substantial problem in the present analysis. First, this is not a topic for which only one potential outcome would likely have been considered publishable, as laterality effects in either direction would be interesting. Indeed, as noted above, there are numerous published reports of lateral asymmetries in both directions. Second, few of the studies in this analysis actually set out to investigate lateral asymmetries in tactile acuity. In most cases, this data was collected incidentally in studies motivated by other questions. Indeed, in many cases, no statistical comparison of the two hands is presented in the paper itself. Nevertheless, publication bias was assessed by visual inspection of funnel plots, by Egger's test, and using Robust Bayesian Meta-Analysis. No evidence for publication bias was apparent from any of these assessments.

In conclusion, this study found no evidence for lateral asymmetries in tactile acuity on the hand. There does not appear to be handedness for somatosensory function mirroring that found for motor skills, at least in the case of tactile spatial acuity. There was no evidence for an overall lateral asymmetry in tactile acuity, nor for any of the specific tests used. Similarly, there was no evidence for differences as a function of age or geographic location. Overall, the present results provide clear evidence that there is not handedness for tactile acuity.

Studies included in the meta-analysis

(Akçay et al., 2022; Bayram et al., 2022; Bliem et al., 2007, 2008; Boles & Givens, 2011; Bovenzi et al., 1990; Bovenzi & Zadini, 1989; Brickwedde et al., 2020; Buitenhuis et al., 2018; Chandhok & Bagust, 2002; Cooper et al., 1995; Cope & Antony, 1992; Dane et al., 2017; Desrosiers et al., 1996; Dinse et al., 2003a, 2003b, 2006; Doh et al., 2008; Erçalık & Özkurt, 2022; Eryılmaz et al., 2013;

French et al., 2022; Freyer et al., 2013; Fujimoto et al., 2017; Haag et al., 2015; Härtner et al., 2021; Heba et al., 2016; Heriseanu et al., 2005; Hermann et al., 1996; Hirtz et al., 2018; Hodzic et al., 2004; Höffken et al., 2007; Işık et al., 2022; Jagad & Dhanesha, 2018; Jovellar-Isiegas et al., 2023; Kalisch et al., 2007, 2009; Kattenstroth et al., 2010, 2011; Khoury et al., 2015; Kitada et al., 2006; Lee et al., 2020; Lesný, 1971; Levin et al., 1989; Lissek et al., 2009; Cook et al., 2024; Magnani et al., 2024; Maihöfner & DeCol, 2007; Mancini et al., 2014; Muret et al., 2014, 2016; Muret & Dinse, 2018; Pandian et al., 2024; Patibandla & Miriam, 2022; Pelletier et al., 2019; Peltz et al., 2011; Philipp et al., 2015; Pleger et al., 2001, 2003, 2016; Ragert et al., 2003, 2004, 2007, 2008; Robertson & Jones, 1994; Robinson & Kincaid, 2004; Ross et al., 2022; Sathian & Zangaladze, 1996; Satow et al., 2003; Schaefer et al., 2021, 2022; Schmidt-Wilcke et al., 2018; Shahbazian et al., 2009; Sims et al., 2015; Takaoka et al., 2023; Tegenthoff et al., 2005; Tödt et al., 2021; Troise et al., 2014; Trzcinski et al., 2016; van Biervliet, 1897; Van Boven et al., 2000; Vega-Bermudez & Johnson, 2001; Weinstein, 1968; Wolny et al., 2022; Wong et al., 2011; Zamorano et al., 2015)

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