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# Ambidexterity in left-handed and right-handed individuals and implications for surgical training

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## ABSTRACT

Surgical training has historically been geared toward right-handed individuals. This could cause mentors to perceive left-handed students and residents as being more difficult to train. This study examined whether differences in dexterity exist between left-handed and right-handed individuals and the implications this may have on surgical training. Recent literature suggests that surgical training may need to be updated to train left-handed students more effectively. In this prospective, crossover study, 50 right-handed and 50 left-handed individuals of varying ages and occupations were evaluated using the O'Conner Tweezer Dexterity Test. Participants were timed while they used flat-tipped forceps to pick up 1″ brass metal pins and sequentially place one pin each in 100 pinholes 1/16″ in diameter on a 21″ × 12″ board. Participants completed this exercise with their dominant hand followed by their nondominant hand. Nondominant hand dexterity was measured by dividing the nondominant hand completion time by the dominant hand completion time, with a higher percentage associated with higher ambidexterity. Using the Student's two-tailed *t* test, we found that left-handed individuals had an 97.2% congruence between dominant and nondominant hands while right-handed individuals had a 71.6% congruence ($P < 0.001$). In conclusion, our results show that left-handed individuals have a greater degree of ambidexterity than their right-handed counterparts. These results suggest that any perceived difference between left-handed and right-handed surgical residents may not be due to innate skill or dexterity, but rather a combination of external influences.

**KEYWORDS** Ambidexterity; dexterity; left-handed; right-handed; surgical training

Left-handed (LH) individuals are a considerable minority compared to the 88% to 92% of right-handed (RH) individuals in the world and, similarly, within the medical profession.[1–3] As a result, many tools used in everyday life, and within health care, are designed for RH people. LH individuals are frequently required to adapt RH-specific instruments or face difficulties in everyday activities. The same can be applied to the use of RH-specific surgical instruments by LH surgeons and personnel within the field of medicine. Dexterity, the ability to perform tasks with the hand, and ambidexterity, the use of the right and left hand equally well, are important for the development of psychomotor skills such as surgery and could even be predictors of greater surgical precision in the operating suite or in robotic surgery procedures.[4] There may also be differences in the development of psychomotor skills based on left- or right-hand dominance; however, the literature is unclear on this topic.[5–9] More knowledge on this subject may help to optimize training of surgical residents. The objective of this study was to determine differences in dexterity between LH and RH individuals.

## METHODS

In this cross-sectional study, we randomly selected 100 volunteers (50 LH and 50 RH) from the University of Texas Medical Branch community between May 2017 and

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September 2017. All individuals were selected based on their hand dominance and age greater than 10 years. Exclusion criteria consisted of individuals with a current upper extremity injury, surgery within the last 2 months, physical rehabilitation, or no stated hand dominance.

Subjects completed the O'Conner Tweezer Dexterity Test, a validated dexterity test.[10] In this test involving a 21″ × 12″ pegboard, subjects pick up 1″ brass metal pins with tweezers using their dominant hand and fill the peg hole furthest from them with a pin. They then fill each peg hole, 1/16″ in diameter, in a row one by one until they move to the next row in a "snake-wise" fashion until each hole is filled with a pin. The objective of this test is to fill the board as quickly as possible. After completion, each participant repeats the exercise with his or her nondominant hand.

Time to completion was measured in seconds, beginning when the participant picked up the tweezers and ending when the participant put down the tweezers after completely filling the board. Time to completion with the nondominant hand was divided by the time to completion with the dominant hand to get a "percentage score." A score of 100% represents no difference in efficacy between dominant and nondominant hands, while any score lower than 100% represents decreased efficiency in the nondominant hand compared to the dominant hand.

Statistical analysis was conducted using the PASW Statistics 18 system. The statistical level of significance was set at $P < 0.001$ for data analysis using the Student's $t$ test for continuous variables.

## RESULTS

Among the 100 participants, the mean age of RH and LH individuals was 29.6 and 31.3 years, respectively. The mean completion times of RH and LH dominant individuals with their dominant hand were 341.32 seconds (5.40 minutes) and 365.06 seconds (6.05 minutes), respectively. The mean completion times of RH and LH dominant individuals when using their nondominant hand were 438.44 seconds (7.19 minutes) and 376.06 seconds (7.16 minutes), respectively. It was determined that RH people had a percent congruence between hands of 71.6% (confidence interval 66.6–76.7), while LH people had a percent congruence of 97.2% (confidence interval 91.1–100.0) ($P < 0.001$) *(Table 1)*.

**Table 1. Mean completion time for the O'Conner Tweezer Dexterity Test of right- and left-handed individuals with their dominant and nondominant hands**

| Variable | Dominant hand | |
|---|---|---|
| | Right | Left |
| Mean age (years) | 29.6 | 31.3 |
| Mean completion time with dominant hand: sec/min | 341.32/5.40 | 365.06/6.05 |
| Mean completion time with nondominant hand: sec/min | 438.44/7.19 | 376.06/7.16 |
| Percent congruence ($P < 0.001$) | 71.6% | 97.2% |

## DISCUSSION

Studies have shown that LH medical trainees are often at a disadvantage compared to their RH counterparts in terms of learning basic medical and surgical skills. Furthermore, LH medical trainees are often viewed more negatively than their RH peers. Schueneman et al reported that LH medical students who performed better than RH counterparts often received lower evaluations from faculty surgeons.[8] This could be due to biases in perception of LH techniques and/or difficulty translating evaluation of RH techniques to fit the LH individual. Hanna et al examined endoscopic manipulations by RH and LH medical students and found that RH subjects had better error rates and first-time accuracy with both their dominant and nondominant hands. Despite this, both groups experienced a significant difference in measurements between their dominant and nondominant hands.[6] In addition, it has been shown that LH and RH medical students perform significantly better when exposed to a hand-congruent training curriculum.[11] A web-based survey examining LH surgeons in Manhattan found that 3% received laterality training, 10% of their residency programs mentored LH residents, and 13% of their programs had LH-specific instruments.[12]

The preceding studies suggest that any apparent struggles that LH surgical residents experience may be due to a lack of technique translatability, inherent biases toward LH technique, or a lack of LH instrumentation rather than innate dexterity differences. Due to training biases, LH residents must often learn to utilize their nondominant RH over their dominant LH to be successful in surgery. This may be due in part to anxiety experienced by surgical instructors who have difficulties translating techniques and/or a lack of available LH instruments.[13–16] The majority of surgical techniques and operations have been created by and for RH surgeons. As such, technical deviations from the surgical status quo, such as a change in spatial orientation by LH trainees, can cause the RH surgeon to view these adjustments as deficiencies, resulting in unmerited negative evaluations.[15] A review of 40 articles supports the use of early identification of LH residents, pairing LH residents with LH mentors, encouraging ambidextrous exercises, and obtaining LH instruments as means for improving training discrepancies.[17]

Our findings echo previous studies highlighting awareness of ambidexterity differences between LH and RH individuals. When possible, LH surgical residents should be paired with LH mentors, and the availability of LH instruments should be increased. Other improvements include altering the schema of the operating room to better accommodate the LH trainee, as literature shows outcomes are best

when the surgical environment is suitable to the surgeon's dominant hand.[7,9,18,19] Further, our study suggests that ambidexterity is likely higher in LH individuals compared to their RH peers. These findings highlight the fact that difficulties experienced by LH surgeons are more likely due to external influences than any deficiencies in dexterity.

External factors such as instrumentation in the surgical environment may ultimately translate into proficiency discrepancies between the technical skills of RH and LH residents and surgeons. For example, one study found that LH students preferred supplemental training with RH instruments, having more availability of LH instruments, and having teachers who can adapt to the student's handedness.[20] If we can continue to identify factors that negatively affect the training of LH individuals in the operating suite, we can work to combat technical discrepancies and perceived difficulties that LH surgeons experience.

Some studies have looked at the effects that hand dominance and ambidexterity have on various types of surgical techniques. It was determined that for both LH and RH surgeons, the dominant hand had greater task proficiency in laparoscopic techniques. More ambidexterity also correlates with higher task proficiency in laparoscopic techniques.[21,22] Interestingly, robotic procedures have been shown to require less ambidexterity than laparoscopic techniques, while other surgical techniques can require more ambidexterity.[23]

The literature is unclear as to whether innate dexterity differences exist between LH and RH individuals. When looking at clinical psychomotor skills, one study found that LH students had a shorter total peg transfer time than RH medical students ($P = 0.83$). However, there was no statistically significant difference between the two groups in any clinical psychomotor skills.[24] Other studies, however, have shown superior dexterity and outcomes in RH individuals over LH individuals.[5,25] One study, stratified by gender, demonstrated that RH males have statistically greater ambidexterity and task quality, and smaller task completion time, than LH males and RH females in a virtual-reality simulator for endoscopic procedures.[5] Our study supports the existence of dexterity differences between LH and RH individuals.

The results of our study may not be generalizable to medical trainees, as our study population was not limited to people in the medical field. The study might also have been strengthened by assessing the effect of demographic variables such as ethnicity, age, and/or gender. Finger thickness has also been shown to be correlated with decreased dexterity.[26,27]

Future research on the relationship between hand dominance, ambidexterity, and surgical technique proficiency is warranted, including psychomotor abilities and surgical or suturing techniques, with hand-congruent and hand-incongruent instruments. If a relationship is determined, RH students may need more mentoring and practice in the operating room to reach the same level of proficiency for certain ambidextrous surgical techniques than their LH colleagues. In addition, future research should focus on medical trainees by specialty and years of training to see if differences exist and if they level out with training. Finally, LH people may be naturally competent with LH and RH tools, while RH students may take longer to become skillful at using certain tools or approaches with those tools. Ambidexterity should also be further assessed with studies that incorporate alternating hand trials to eliminate any intest learning influences.

In conclusion, the present study demonstrates that dexterity and ambidexterity may both be a function of hand dominance. Variance in dexterity between LH and RH individuals may support the need for improvements in the training of LH individuals. Suggested methods to improve training of LH surgical residents include more laterality training, greater availability of LH instruments in the operating room, pairing of LH trainees with LH mentors, and altering the schema of the operating room to facilitate the job of the LH surgeon.

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