

**HEMISPHERIC DOMINANCE AND LATERALITY IN MOBILE PHONE USE IN ADULTS:
AN OBSERVATIONAL STUDY.**

ABSTRACT

Aims: Mobile/cell phone use has become an important socio-medical means of communication. The reason people use a particular ear to answer phone calls more frequently may be associated with hemispheric dominance/ handedness. we aim to determine association between hemispheric and or auditory dominance in laterality in mobile phone use

Study design: This was a three month prospective cross-sectional study involving all consenting medical and paramedical respondents.

Place and Duration of study: Hospital community in the University of Benin Teaching Hospital (UBTH), Benin City , between 15th March to 15th June 2018.

Method: A modification of the Edinburgh handedness inventory (EHI) was the survey tool. Information retrieved included social demographics, hand most commonly used for activities like writing and picking of phone calls and ear used for phone conversation and the reasons. Data was analyzed using Microsoft excel.

Results: Of the 300 questionnaires distributed, 234 (78%) were completed by the respondents. There were 120(51.3%) males and114 (48.7%) females. Age ranged from 18 - 80years. A total of 201(85.9%) were right handed, 16(6.8%) left handed and 14(6.0%) ambidextrous. One hundred and fifty four (66%) routinely use their right hand to pick phone calls, 50(21.4%) left and 27 (11.5%) use both hands.

A total of 141(60%) receive calls with the right ear, 60 (25.6%) with left, and 31(13.2%) had no preference. Reasons advanced for the use of any particular ear included convenience 173 (73.9%), and better acuity 35(15%). Forty two (17.9%) agreed that the use of cell phone made them aware of their poor hearing in a particular ear. The probability of a right hander using the right hand to picking a phone call and placing it on the right ear vis a vis a left hander is 0.99

Conclusion: There appears to be an association between hemispheric dominance and laterality when using the mobile phone.

Keywords: Hemispheric dominance, Auditory acuity, Cell phone, Handedness.

INTRODUCTION

INTRODUCTION

25 The mobile phone has become one of the most frequently used technological innovation in
26 contemporary times. Its use has gone beyond “call and respond” to include sophisticated
27 appliances for multi-tasking with devices such as cameras, storage, and internet access for
28 information and has found increased use in medicare. Mobile phones have various
29 applications which have been found useful in the healthcare sector. It's use in improving
30 outcomes in the management of cancer in Nigeria has been documented.[1] Ibekwe et al
31 found the use of mobile phones application (android boy1) comparable to digital sound level
32 meter in the measurement and monitoring of the environmental noise level in Abuja,
33 Nigeria.[2] The use of mobile phone application for screening for hearing threshold is well
34 documented.[3],[4] According to Industry statistics, in 2014, Nigeria ranked 7th in the world
35 by the number of mobile phone in use[5] and the number of active mobile phone lines in
36 Nigeria rose to 146 million in January 2018, according to the country's communications
37 commission (NCC).[6] With so great a number of mobile phones in Nigeria, the question is
38 what determines how mobile phone calls are received and the ear with which calls are most
39 likely to be received? Does a person's handedness, auditory dominance or convenience
40 determine how they receive their phone calls? These are questions that this study seeks to
41 answer.

42 The Neuropsychologist Roger W. Sperry developed the right brain - left brain theory in 1960.
43 He believed that the human brain has either right or left sided dominance and that each side
44 of the brain controls different types of thinking.[7] Some individuals utilize both sides of their
45 brains equally, but most people have a greater tendency to think in a certain way. Ever since
46 then a lot of research on functionality of the brain had been carried out using various
47 methods such as magnetic resonance imaging, and positron emission
48 tomography(PET)[8],[9],[10], Others have determined language laterality using a combination
49 of PET and magnetoencephalographic scans.[11] A study using functional magnetic
50 resonance imaging data showed functional language lateralization to the left hemisphere in
51 right-handed individuals.[12] However, Knecht et al postulated that the distribution of left
52 hemispheric dominance (LHD) varied with the degree of handedness; the more right-
53 handed the individuals, the lower the relative incidence of right-brain dominance and vice
54 versa.[13]

55 The aetiology of handedness is multifactorial. Hepper GP et al had proposed a prenatal
56 cause after studying foetuses in utero and determined that handedness in the womb was a
57 very accurate predictor of handedness after birth.[14] In a 2013 study, Nelson et al showed
58 39% of infants aged 6 to 14 months and 97% of toddlers aged 18 to 24 months
59 demonstrated a hand preference.[15] It has also been observed that handedness displays a
60 complex inheritance pattern in that if both parents of a child are left-handed, there is a 26%
61 chance of that child being left-handed.[16] A large study of twins from 25,732 families by
62 Medland et al, indicated that the heritability of handedness is about 24%.[17]
63 Diethylstilboestrol animal studies suggest that oestrogen affects the developing brain
64 including the part that governs sexual behaviour and right and left dominance.[18] Dieterich
65 et al suggested that asymmetry of the vestibular cortex is strongly correlated with the
66 direction of handedness.[19] Ultrasonography used to check on the healthy development of
67 the foetus and mother during pregnancy has been associated with left-handedness.[20]
68 Whatever the aetiology of handedness, it is estimated 70-95% of people globally are right
69 handed while less than 10% are left handed.[21],[22] Pointer et al showed a direct
70 correlation with handedness and eye dominance in right-handed children. In his study, the
71 left-handed individuals were also more likely to display right eye preference.[23] Marzoli and
72 Tommasi on the other hand performed 3 observational studies to determine ear preference.
73 Their study found that 58% of participants responded positively to a request if the request
74 were made in their right ear, and they also found that 72% of the time a person will present
75 their right ear to hear speech.[24] Seidman MD et al reported an association between hand
76 dominance and laterality of cell phone use (73%) and the ability to predict hemispheric
77 dominance.[25] He concluded that most right-handed people have left-brain dominance and

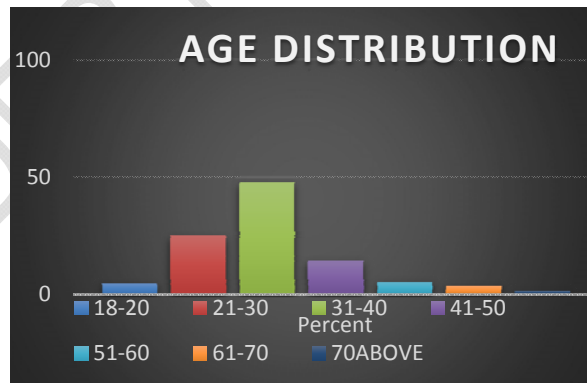
78 use their cell phone in their right ear. In a recent study Shu et al stated that regions with
79 leftward asymmetries are mainly related to language, visual processing, and sensory
80 functions. [26]
81 This study seeks to explore any association if any between handedness in the usage of
82 mobile phone in our environment using a modified Edingburgh Handedness Inventory
83 (EHI).[27]
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86 2. METHODOLOGY

87 This was a three month (1st March- 30th June 2018) prospective cross-sectional
88 study using a modified Edinburgh Handedness Inventory (EHI)[27]. A total of 300
89 questionnaires were distributed to 300 respondents who consented to participate in
90 the study. These questionnaires were distributed during the weekly hospital
91 departmental clinical meetings which have in attendance different cadres of health
92 workers. Questionnaires were also distributed to respondents in the wards,
93 laboratories and offices within the University of Benin Teaching Hospital (UBTH)
94 Nigeria where phone use is very common for medicare and communication.
95 Questions include sample questions such as which hand is routinely used for
96 activities like writing and picking up objects, which hand do you use most times to
97 make or answer phone calls, which ear do you use for phone conversation, what is
98 the reasons for the answer, if one ear functions better, if use of mobile phone helped
99 discover which ear functions better. The responses to these questions formed the
100 data which was analysed using Microsoft excel[®] and results presented as figures
101 and tables.
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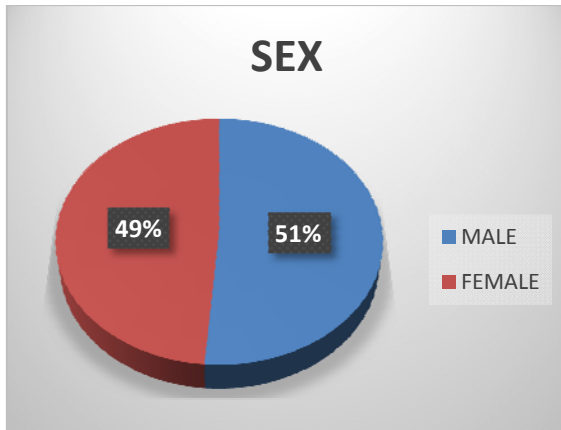
104 3. RESULTS AND DISCUSSION

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106 A total of 234 (78%) out of the 300 questionnaires were completed and returned. Age ranged
107 from 18- 80years with a peak of 31-40years (47.9%).Fig:i shows age distribution of
108 respondents
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122 Fig i:Age distribution of respondents

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124 There were 120 (51.3%) males and 114 (48.7%) females as shown in figure ii.
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Fig ii: Sex distribution of respondents.

Response to dominant hand shows 201(85.9%) respondents were right handed, 16 (6.8%) were left handed and 14 (6.0%) were capable of using both hands proficiently (ambidextrous) as shown in table 1.

	Frequenc	Percent
y		
no response	3	1.3
right	201	85.9
left	16	6.8
both	14	6.0
Total	234	100.0

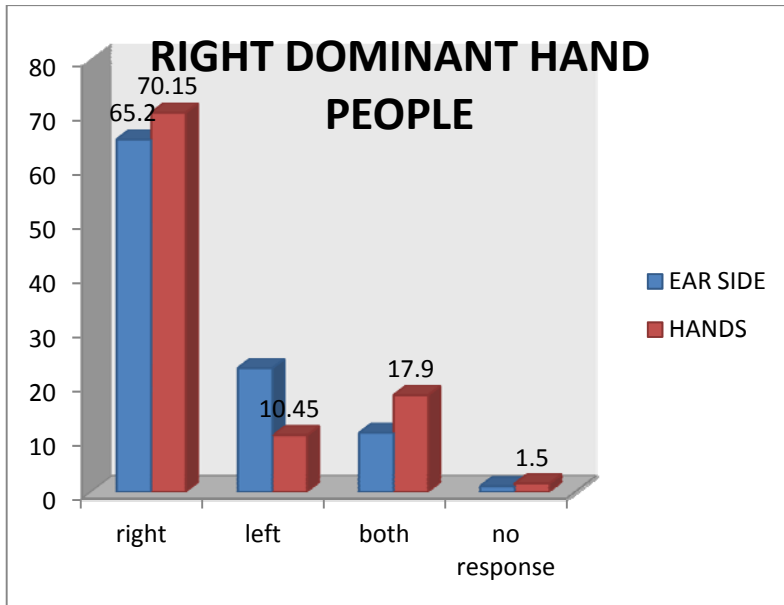
Table 1:Response to Dominant Hand

In response to the question as to which hand is routinely used picking up the phone for conversation, 155 (66%) picked their mobile phones with the right hand, while 50 (21.4%) use the left hand and 27 (11.5%) claimed they had no hand preference.

In response to the question on the ear used frequently for phone conversation, 141(60.3%) received calls with their right ears, 60 (25.6%) with the left ear and 31(13.2%) had no ear preference.

Fig iii showed that for the right- handed respondents, 141 (70.2%) were likely to pick their calls with the right hand, 21 (10.45%) with the left hand and 36 (17.9%) use both hands.

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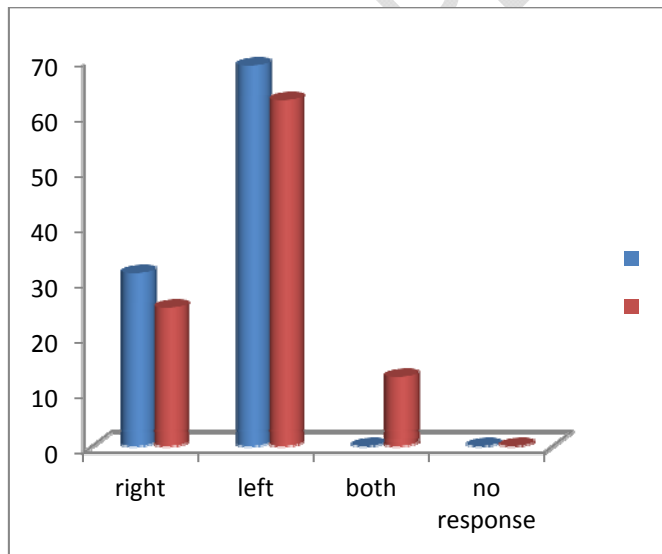


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Fig iii: Hand and ear used for mobile phone for right handers

In response to which ear they were likely to use to listen to a phone call, 131 (65.2%) of them were likely to receive calls with the right ear, while 46 (22.9%) receive phone calls with the left ear and 22 (10.9%) receive with either of their ear without any preference. (Fig iv).

For the 16 (6.8%) left handed respondents in the surveyed population, 11(68.75%) pick calls with their left hand, and 5(31.5%) pick calls with their right hand. Also 10(62.5%) would converse with the left ear, while 4(25%) routinely converse with the right ear, and 2(2.5%) converse with either ear. This is illustrated in figure iv below



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Fig iv: Hand and ear used for mobile phone for left handers

For the ambidextrous, 6(42.9%) pick calls with the right hand, while 3(21.43%) pick calls with the left hand, and 5(35.71%) use either hand to pick calls. Of these, 5(35.7%) converse with

174 the phone held to the right ear, while 4(28.6%) converse with the phone held to the left ear
 175 and 5(35.7%) converse with the phone held to either ear as shown in table 2
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BOTH DOMINANT HANDS PEOPLE		
PREFERENCE	HANDS	EAR SIDE
Right	42.86	35.7
Left	21.43	28.6
Both	35.71	35.7
no response	0	0

178 Table 2: hand and ear use for the ambidextrous
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180 Inquiry on reasons for their preference of a particular ear showed that 173 (73.9%) of the
 181 respondents did that for convenience, while 38(16.2%) chose a particular ear for clarity.
 182 Data on when it was noticed that one side of the ear was clearer showed 52 (22.2%) had
 183 discovered their hearing deficiency when they began using mobile phones while 28(12%)
 184 had notice a decrease in their hearing acuity before the onset of using mobile phone. In
 185 response to the question about whether the use of mobile phone has help in detecting the
 186 better ear, 17.9% were able to detect the better ear with the use of mobile phone while
 187 47.9% did not detect their better ear with the use of mobile phone and 26.5% were not sure
 188 if the use of mobile phone helped them to detect their better ear or not. Only 4.7% of the
 189 respondents have had objective hearing assessment in an ear, nose and throat facility. The
 190 probability of a right hander using the right hand to pick a phone call and placing it on the
 191 right ear vis a vis a left hander is 0.99

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 193 **DISCUSSION**

194 There is a worldwide increase in the use of mobile phones and its applications in medical
 195 care since its first use in 1973. Smartphones and tablets combine both computing and
 196 communication features in a single device that can be held in a hand or stored in a pocket,
 197 allowing easy access and use at the point of care which include improving cancer care,
 198 measuring sound levels, improving data collection for chronic obstructive pulmonary disease
 199 and in follow up for psychiatric patients.[1],[2],[28] In addition to voice and text, new mobile
 200 device models offer more advanced features, such as web browsing, global positioning
 201 systems (GPS), high-quality cameras, and sound recorders. With these features, as well as
 202 powerful processors and operating systems, large memories, and high-resolution screens,
 203 mobile devices have essentially become handheld computers.[29] Although medical devices
 204 and apps arguably provide the health care professional (HCP) with many advantages, they
 205 are currently being used without a thorough understanding of their associated risks and
 206 benefits.[30] Rigorous evaluation, validation, and the development of best-practice
 207 standards for medical apps are greatly needed to ensure a fundamental level of quality and
 208 safety when these tools are used. The ear is the fundamental organ in mobile phone use.
 209 This study set out to explore the determinants of mobile phone use with reference to
 210 hemispheric and auditory dominance and to determine to which extent mobile phone can be
 211 used as a screening tool for hearing impairment.

212 In this study 85.9% of the respondents were right-handed, and thus have left hemispheric
 213 dominance while 6.8% were left handed and 6.0% were ambidextrous. This is similar though
 214 slightly lower than 90% in a similar study by Seidman et al.[25] and corroborates earlier
 215 report by Holder et al which stated that 70%-96% of human population were right
 216 handed.[31] Ocklenburga et al believed there is over -representation in favour of right-

217 handers.[32] Reasons for this may not only be due to convenience alone, but also proximity
218 and the discomfort of crossing the hand over to the contralateral side.[24] Besides, in our
219 environment, religious and cultural perceptions play an important role in the restriction of left
220 hand use. This is similarly observed among the Chinese who have a very low prevalence of
221 left handers.[33] It is common for parents, care-givers and even members of the community
222 to try to discourage a child prone to using left hand and thus forcing the child to depart from
223 the natural dominance to “acquired” one. Bias against left handedness continues to be a
224 topical issue as most tools designed have a right handed bias. Other studies have supported
225 cultural effects in gestures and active tool manipulation as one of the overriding factor in
226 human handedness evolution.[34]

227 From the study, the probability of a right-handed person picking his call with the right hand
228 and conversing with the right ear and vis-a-vis left handers is nearly 1. This was attributed to
229 convenience and habitual behaviour. This also corroborates findings of Seidman et al, and
230 Corballis et al who postulated that the long association of vocalization with manual gesture
231 left us a legacy of right-handedness.[35] The strong predominance of right-handedness
232 appears to be a uniquely human characteristic, whereas the left-cerebral dominance for
233 vocalization occurs in many species, including frogs, birds, and mammals. Right-
234 handedness may have arisen because of an association between manual gestures and
235 vocalization in the evolution of language³³. In the hospital setting where a lot of dexterity is
236 needed and often the dominant hand is engaged there may be increased use of the
237 contralateral side which might explain the reason for the use of the non- dominant side for
238 picking calls and conversation as seen in this study.

239 Among the ambidextrous(6.0%) who had no hand preference, majority would still use their
240 right hand to pick a phone and place on the right ear for conversation suggesting that right-
241 handedness is a bias of human population.

242 The authors observed a percentage of our respondent who were right-handed would still
243 pick phone with their left hand and same as those who are left-handed would pick with the
244 right hand . This could be attributed to multi-tasking as the dominant hand would be engaged
245 in more tasking activities like writing, operating and cleaning especially in the environment
246 where this study was conducted. The same was found in the ear where 22.9% of right-
247 handed individuals would listen to conversation with left ear and vice versa for left handers
248 where we found 25% using the right ear. This could be attributed not only to clarity but also
249 to auditory dominance and calls for more studies. We think that though many people are
250 either LHD or RHD, there may be a cross dominance in a few individuals. This corroborates
251 studies by Knect et al[13] which states that strong left-handers demonstrated a nearly
252 sevenfold higher incidence of right-hemisphere language dominance than strong right-
253 handers.[12] In extreme left-handers the incidence of right-hemisphere language dominance
254 was 27%, whereas in extreme right-handers it was 4%. Again most individuals may not want
255 to cross their hand over the dominant ears when busy and so they use the other ear for
256 ease/convenience.

257 This is a self-reporting data, and the authenticity could not be confirmed by objective
258 audiological evaluation, but it is interesting that 22.2% had noticed their hearing deficiency
259 when they began using mobile phones. Currently, many audiological screening are carried
260 out using phone apps.

261 Strength: Edinburgh handedness inventory has been strong tools for determination of
262 handedness since 1971, using its modification for both hemispheric and auditory dominance
263 makes this work interesting and attests to its strength

264 Limitations: EHI is a self-reporting tool, over attributing task to the dominant hand cannot be
265 ruled out. This work is preliminary and we hope to compare subjective report of hearing with
266 audiometric assessment

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337 Limitations: EHI was used by self-reporting, over attributing task to the dominant hand
338 cannot be ruled out. This work is preliminary and we hope to compare subjective report of
339 hearing with audiometric assessment.

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342 **CONSENT:** a written informed consent was obtained from all respondents

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