

**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 SPSS 19.0

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. Using Pearson's two tailed test of significance the probability of a right hander using the right hand to pick a phone call and placing it on the right ear is 0.99 or 99%, Vis a Vis left hander.

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

The mobile phone has become one of the most frequently used technological innovations in contemporary times. Its use has gone beyond "call and respond" to include sophisticated appliances for multi-tasking with devices such as cameras, storage, and internet access for information and has found increased use in medicare. Mobile phones have various applications which have been found useful in the healthcare sector. It's use in improving outcomes in the management of cancer in Nigeria has been documented.[1] Ibekwe et al found the use of mobile phones application (android boy1) comparable to digital sound level

meter in the measurement and monitoring of the environmental noise level in Abuja, Nigeria.[2] The use of mobile phone application for screening for hearing threshold is well documented.[3],[4] According to Industry statistics, in 2014, Nigeria ranked 7th in the world by the number of mobile phone in use[5] and the number of active mobile phone lines in Nigeria rose to 146 million in January 2018, according to the country's communications commission (NCC).[6] With so great a number of mobile phones in Nigeria, the question is what determines how mobile phone calls are received and the ear with which calls are most likely to be received? Does a person's handedness, auditory dominance or convenience determine how they receive their phone calls? These are questions that this study seeks to answer.

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

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

OBJECTIVE

This study seeks to explore the association, if any between handedness and auditory dominance in the use of mobile phone in our environment (UBTH) as an venue to inquire into what is obtainable in the general population using a modified Edinburgh Handedness Inventory (EHI).[27]

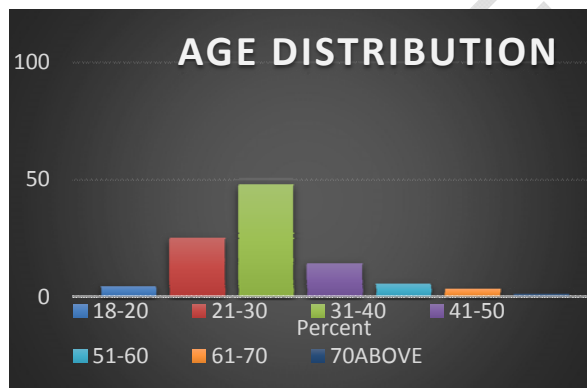
2. METHODOLOGY

This was a three month (1st March- 30th June 2018) prospective cross-sectional **descriptive** study using a modified Edinburgh Handedness Inventory (EHI) [27]. A

85 total of 300 questionnaires were distributed to 300 respondents who consented to
 86 participate in the study. These questionnaires were distributed during the weekly
 87 hospital departmental clinical meetings which have in attendance different cadres of
 88 health workers. Questionnaires were also distributed to respondents in the wards,
 89 laboratories and offices within the University of Benin Teaching Hospital (UBTH)
 90 Nigeria where phone use is very common for medical care and communication.
 91 Questions include sample questions such as which hand is routinely used for
 92 activities like writing and picking up objects, which hand do you use most times to
 93 make or answer phone calls, which ear do you use for phone conversation, what is
 94 the reasons for the answer, if one ear functions better, if use of mobile phone helped
 95 discover which ear functions better. The responses to these questions formed the
 96 data which was analysed using descriptive statistics on SPSS 19.0, Pearson's two
 97 tailed test of significance for our correlation and results presented in figures and
 98 tables.

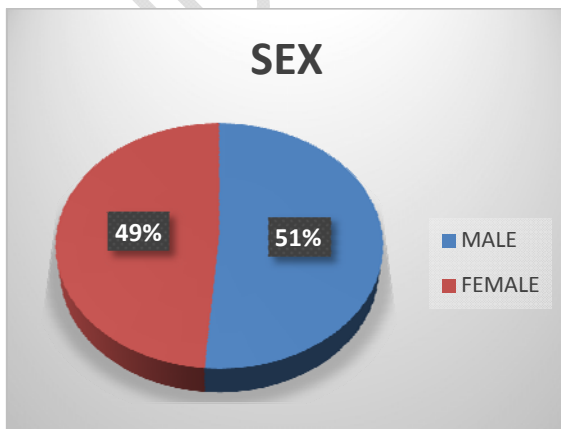
100
 101 **3. RESULTS AND DISCUSSION**

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 103 A total of 234 (78%) out of the 300 questionnaires were completed and returned. Age ranged
 104 from 18- 80years with a peak of 31-40years (47.9%). Fig: I show age distribution of
 105 respondents



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 119 Fig i: Age distribution of respondents

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 121 There were 120 (51.3%) males and 114 (48.7%) females as shown in figure ii.



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 126 Fig ii: Sex distribution of respondents.

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

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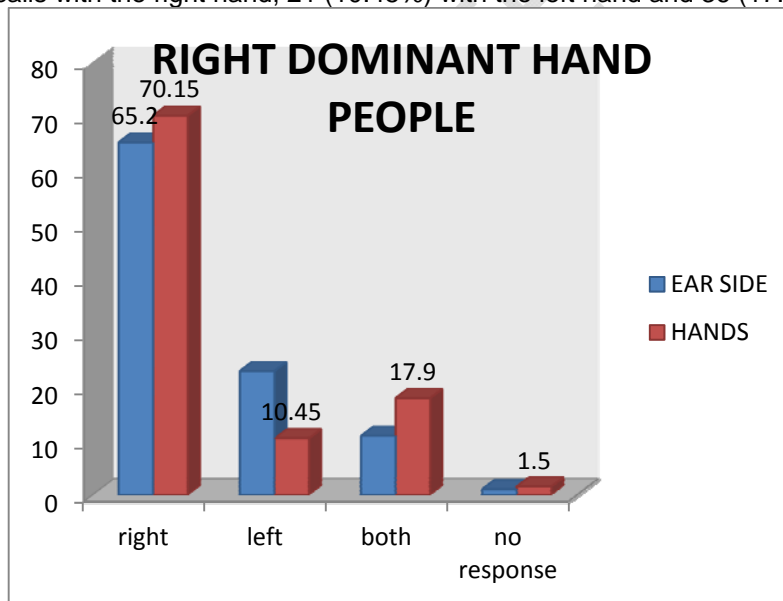
	Frequenc y	Percent
no response	3	1.3
right	201	85.9
left	16	6.8
both	14	6.0
Total	234	100.0

144 Table 1: Response to Dominant Hand

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

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

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

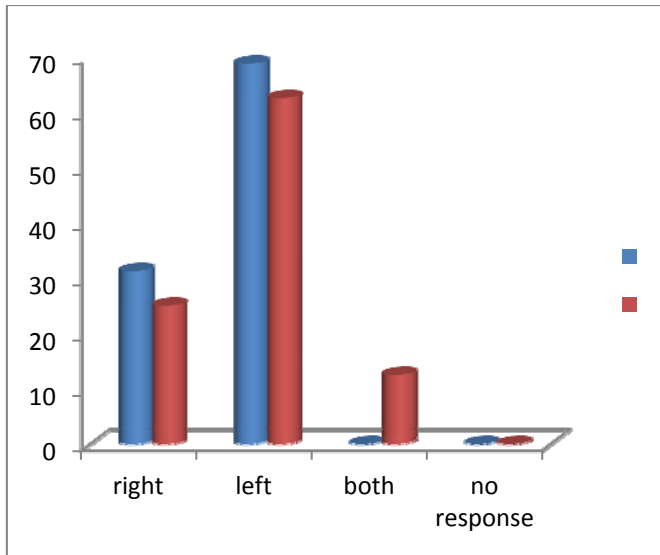


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154 Fig iii: Hand and ear used for mobile phone for right handers

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

159 For the 16 (6.8%) left handed respondents in the surveyed population, 11(68.75%) pick calls
160 with their left hand, and 5(31.5%) pick calls with their right hand. Also 10(62.5%) would
161 converse with the left ear, while 4(25%) routinely converse with the right ear, and 2(2.5%)
162 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 the phone held to the right ear, while 4(28.6%) converse with the phone held to the left ear and 5(35.7%) converse with the phone held to either ear as shown in table 2

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

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Table 2: hand and ear use for the ambidextrous

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Inquiry on reasons for their preference of a particular ear showed that 173 (73.9%) of the respondents did that for convenience, while 38(16.2%) chose a particular ear for clarity. Data on when it was noticed that one side of the ear was clearer showed 52 (22.2%) had discovered their hearing deficiency when they began using mobile phones while 28(12%) had notice a decrease in their hearing acuity before the onset of using mobile phone. In response to the question about whether the use of mobile phone has help in detecting the better ear, 17.9% were able to detect the better ear with the use of mobile phone while 47.9% did not detect their better ear with the use of mobile phone and 26.5% were not sure if the use of mobile phone helped them to detect their better ear or not. Only 4.7% of the respondents have had objective hearing assessment in an ear, nose and throat facility. In using Pearson's two tailed test of significance it clearly showed that the probability of a right hander using the right hand to pick a phone call and placing it on the right ear is 0.99 or 99%, Vis a Vis a left hander.

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DISCUSSION

There is a worldwide increase in the use of mobile phones and its applications in medical care since its first use in 1973. Smartphones and tablets combine both computing and communication features in a single device that can be held in a hand or stored in a pocket, allowing easy access and use at the point of care which include improving cancer care, measuring sound levels, improving data collection for chronic obstructive pulmonary disease and in follow up for psychiatric patients.[1],[2],[28] In addition to voice and text, new mobile device models offer more advanced features, such as web browsing, global positioning

197 systems (GPS), high-quality cameras, and sound recorders. With these features, as well as
198 powerful processors and operating systems, large memories, and high-resolution screens,
199 mobile devices have essentially become handheld computers.[29] Although medical devices
200 and apps inarguably provide the health care professional (HCP) with many advantages, they
201 are currently being used without a thorough understanding of their associated risks and
202 benefits.[30] Rigorous evaluation, validation, and the development of best-practice
203 standards for medical apps are greatly needed to ensure a fundamental level of quality and
204 safety when these tools are used. The ear is the fundamental organ in mobile phone use.
205 This study set out to explore the determinants of mobile phone use with reference to
206 hemispheric and auditory dominance and to determine to which extent mobile phone can be
207 used as a screening tool for hearing impairment.

208 In this study 85.9% of the respondents were right-handed, and thus have left hemispheric
209 dominance while 6.8% were left handed and 6.0% were ambidextrous. This is similar though
210 slightly lower than 90% in a similar study by Seidman et al.[25] and corroborates earlier
211 report by Holder et al which stated that 70%-96% of human population were right
212 handed.[31] Ocklenburga et al believed there is over -representation in favour of right-
213 handers.[32] Reasons for this may not only be due to convenience alone, but also proximity
214 and the discomfort of crossing the hand over to the contralateral side.[24] Besides, in our
215 environment, religious and cultural perceptions play an important role in the restriction of left
216 hand use. This is similarly observed among the Chinese who have a very low prevalence of
217 left handers. [33] It is common for parents, care- givers and even members of the community
218 to try to discourage a child prone to using left hand and thus forcing the child to depart from
219 the natural dominance to “acquired” one. Bias against left handedness continues to be a
220 topical issue as most tools designed have a right handed bias. Other studies have supported
221 cultural effects in gestures and active tool manipulation as one of the overriding factor in
222 human handedness evolution. [34]

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

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

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

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

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

260 Limitations: EHI is a self-reporting tool, over attributing task to the dominant hand cannot be
261 ruled out. This work is preliminary and we hope to compare subjective report of hearing with
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330
331 **Strength:** Edinburgh handedness inventory has been a strong tool for determination of
332 handedness since 1971, using its modification for both hemispheric and auditory dominance,
333 makes this work interesting and attests to its strength. Also, this study, compared to previous
334 work appear to have a small sample size but this notwithstanding, mirrors what happens in
335 the general population in our environment. It is worthy of note that the sample size was
336 drawn from a group of health workers in the University of Benin teaching hospital alone.

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

341
342 **Conclusion:** This work has not only proved the relationship between hemispheric and
343 auditory dominance in use of mobile phone but has also shown that mobile phone
344 applications may be a good instrument for the detection of hearing loss.

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346 **CONSENT:** A written informed consent was obtained from all respondents

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