Macrothink Institute™

International Journal of Learning and Development
ISSN 2164-4063
2019, Vol. 9, No. 4

Educational Inclusiveness: Addressing Society's Failure to Accommodate Left-Handedness

Ms. Benerdeta Malusi (Corresponding author)

Department of Psychology

University of Nairobi, Mombasa Campus, Mombasa, Kenya

Contacts: 254-714-796-919 Email: bentamwikali70@gmail.com

Dr. Luke Odiemo

Department of Psychology

University of Nairobi; Nairobi, Kenya

Contacts: 254-714-099-447 Email: lukke7@gmail.com

Dr. Kimamo Githui

School of Education

Mount Kenya University; Thika, Kenya

Contacts: 254-722-851-104 E-mail: kgithua@mku.ac.ke

Received: October 5, 2019 Accepted: November 14, 2019 Published: November 21, 2019

doi:10.5296/ijld.v9i4.15577 URL: https://doi.org/10.5296/ijld.v9i4.15577

Abstract

Although left-handers are approximately 10% of any indiscriminate general population, they are remarkably over-represented globally in positions of leadership, administration and governance. This has been explained as being due to their right-brain dominance which appears to have made it easier for left-handers to be more elastic in cognitive activities, allowing them to easily cope with challenges, perceive the bigger idea and be self-sustaining. Cross-sectional studies also show meaningfully enhanced left-hander incidences among top athletes exclusively in interactive sports and boxing occasioned by the surprise effect. Despite this, left-handers experience difficulties using everyday tools. Pre-school left-handers

experience hitches primarily in writing left-to-right, expressing and responding to spatial discernments, which has contributed to them being the majority in remedial classes. Mismatches in the teaching/learning environment causes older children to fail to complete timed tasks which negatively affects their academic achievements. In sports, left-handers benefit more from long and intense training because of using training manuals meant for right-handers. The adjustments left-handers have to make in school and at the workplace in order to function comfortably usually causes hand, back, neck and shoulder pains which not only decreases their effectiveness but also compromises their physical and emotional wellbeing. An amalgamation of all these has made left-handedness appear as an obstruction to daily life generally and specifically in school. This review paper that sought to establish that the society's failure to accommodate left-handedness needs addressing, recommended creating societal left-handedness awareness programs, paradigm shifting in initial and continuing teacher training programs and classroom pedagogical approaches, establishment of inclusive teaching/learning resources, and the provision of evenhanded daily use tools by manufacturers at no extra cost.

Keywords: handedness, left-handers, right-handers, adaptation, information processing

1. Background Information

Left-handedness is an individual's inclination to use the left-hand as the lead hand during the performance of tasks (Masud & Ajamal, 2012). Approximately 10% of the world population is left-handed, most of whom are men (Hoffman & Gneezy, 2010). The majority of left-handers have adapted to using right-handed tools both at home, school and at the work place. Numerous scholars claim that left-handers are not only more intelligent (Tigar, 2018), they are more likely to have IQs in excess of 140 (Searleman, 2000). Although various researchers have opined that left-handers make up more of the extremely gifted hitherto severely compromised lot (Willems & Francks, 2014), some scholars have claimed that left-handers are more likely to be schizophrenic, alcoholic, dyslexic and delinquent (Brandler & Paracchini, 2014).

Whereas studies have established that left-handedness persists through all ages, a study by Hugdahl et al. (1993) successfully showed that the preference declines with age. Left-handedness was 15.22% for those aged between 21 and 30 years and only 1.67% for those older than 80 years. The study further established that fewer people were switching hands for writing among the youngest groups (2.69%) compared to the older group (6.75%). This finding seemed to support the modification hypothesis and at the same time questioning the elimination hypothesis. Although changes in social norms towards left-handers seem to be the most likely explanation, left-handers are present in our society and they still face marginalization and discrimination from the right-handed majority.

Amidst the unfortunate cultural reality of discrimination and marginalization, some of the most talented and influential people through history in numerous fields including music, sports, leadership, politics and scientific innovations share the left-handedness trait. This means that in order to benefit more from this minority group, left-handers have to be recognized and supported by the society from the formative age onwards. This assertion puts the educational curriculum and stakeholders at the critical point if the left-handedness narrative has to change.

Currently Kenya is rolling out the competency based curriculum (CBC) of education designed to emphasize the significance of developing skills and knowledge and how to apply those competencies to real life situations. This means that the system is modelled to give all learners a practical experience in specific fields (Nyantino, 2019). The Ministry of Education (MoE) draft bill of 2012 states that educational access and participation of children with special educational needs is low and their needs are not being explicitly addressed, especially children with behavioral difficulties and those with different forms of learning difficulties. According to the document, the emphasis on academic prowess and assessments creates a hostile learning environment for such children and this poses a challenge to educational inclusiveness in the true spirit of education for all (MoE, 2012). The republic of Kenya manuscript is silent on left-handedness which has been shown by researchers to influence academic outcomes negatively despite left-handers being overrepresented in the performance spectrum (Malusi, 2014). The purpose of this review paper is to show that left-handedness is a cry for equal educational opportunities in an attempt to harness the potential of left-handers from the formative stages (school) through to adulthood (workplace).

2. Literature Review

Left-handedness is thought to be partly hereditary (McManus, 1981, McKeever, 2000) partly environmental (Porac et al., 1986; Hopkins et al., 2013; Dixon, 2019) and varies across culture and religion (McManus, 2002; Alhassan, 2018; Lapehn, 2019), age and sex (Gilbert & Wysoski, 1992; Lalumiere, 2002; Papadatou-Pastou & Munafo, 2008; de Kovel et al., 2019) and over time (Denny & O'Sullivan, 2007). Left-handers are also associated with higher intelligence in language, are generally above-average high achievers, were probably born underweight (Yirka, 2018) and have an increased risk for mood disorders, dyslexia and ADHD (Brandler & Paracchini, 2014).

Left-handedness varies naturally though some types of handedness may have resulted from an early fetal disturbance or a genetic defect (Satz et al., 1985; Annette, 1995). The implication is that certain diseases (epilepsy, schizophrenia and autism) and developmental abnormalities (neural tube defects and some types of cleft lip and palate) are more prevalent among persons with left- and extreme right-handedness (Bogaert, 2007). By contrast, there are slightly less left-handers with Parkinson's disease compared to the general population (Dixon, 2019). There are health risks that appear to be greater for left handers; for instance, post-menopausal left-handed women are more likely to get breast cancer (Fritschi et al., 2007), left-handers are more likely to be affected by bilateral limb movement (Roberts, 2011), psychotic disorders compared to mood disorders are more prevalent within left-handers (Webb et al., 2013) and left handers exhibit more learning disabilities, experience more behavior and emotional problems, complete less schooling, work in jobs that require less cognitive skill and tend to have between 10% and 12% lower annual earnings compared to right-handers (Goodman, 2014).

A review by Gutwinski et al., (2011) indicated that certain types of left-handedness show a statistically significant association with delays in childhood development. For example, compared to right-handers, the commencement of sexual maturity is delayed among left-handers, secondary sexual characteristics appear later and at the same time left-handers

tend to be averagely shorter. Such developmental delays have been predicted by Wright and Zecker (2004) to cause impairments which when they continue into adolescence tend to halt at approximately age 10 presumably by sexual maturation. For example, antagonistic effects of early psycho-social deficiency, specifically insecure attachment on IQ at age 12 have been reported by Almas et al., (2016). Such delays have been reported to result to maladjustment and depressing states, truancy, social misfits, psychosomatic complaints, anxiety and a slow complex reaction time signifying slow cognitive information handling (Frisk, 1999). The educational needs of such children ought to be structured so as to help them achieve their educational goals (Collins et al., 2017). However, this may not be possible unless the education ecosystem is privy to the unique needs of left-handers.

Mismatches in the teaching and learning environment negatively influence left-handers' ability to interact with teaching/learning resources and to effectively process, store and retrieve incoming information effectively (Sweller, 1998) and therefore hamper the effective attainment of their academic threshold (Malusi, 2019). When this end-result failure is sustained over time, it may lead to an eventual departure from active participation and effective learning which consequently results to decreased learner outcomes.

In the recent past, different sections of the world population previously opposed to the use of the left hand are realizing that left-handedness can neither be ignored nor wished away and hence a marked increase of left-handers (Bryden et al., 1993; Hugdahl et al., 1993; Salmaso & Longoni, 1985; Kula, 2004). Despite this freedom of expression, left-handers still continue to largely face challenges today just like they did earlier in the century, when working with the left hand was strictly forbidden (Meyer, 1998). In the school context, the probability increases that young left-handers may be performing below their potential in English, science, mathematics, home economics and design technology due to lack of specialist equipment and "obliviousness" of the facet of left-handedness among teachers, parents and caregivers.

According to Paton (2010), many children still find it difficult to cope in traditional subjects, for example, using computer mouse and instructional and laboratory based resources that have fitted controls on the right hand side. Further, during home management classes, commonly used tools are often right-handed, while in woodwork, metalwork and hands-on science lessons, safety overrides on machinery and power tools are tougher to manipulate for left-handers. This implies that there is still a lot of societal ignorance about left-handedness and educational discrimination towards the left-handed (Paton, 2010) which put to uncertainty the aspect of total educational inclusivity.

Milsom (1995) and Townsend (2012) fault and find it insufficient for majority of teachers to suggest that it is enough for left-handers to rest the writing pad on the left hand side of the desk. While this gesture may be of pintsize reprieve, left-handers are not incompetent in doing their tasks. In many cases they turn out to be comparably more ingenious in school since they have to put in more cognitive effort and time in order to succeed at tasks (Malusi & Odiemo, 2018). This development is so because many learning institutions have no provision for left-handers' preferences, and therefore, left-handers have to make numerous adaptations to comfortably fit in and with the operating systems thereof (Malusi, 2014).

The ensuing section looks at left-handedness in specific areas related to an individual's life, that is, in leadership, at the work place, their creativity and experiences in sporting activities.

2.1 Effect of the Lead Hand on an Individual's Life

Handedness affects approximately all aspects of a person's life. An article published in 1991 in *Psychological Bulletin* claimed that the life expectancy of female right-handers was approximately 77 years while that of male left-handers was about 62 years. Further, that of female left-handers and male right-handers was approximated to be 72 years. Overall, right-handers live 9 years longer than left-handers. Despite Hoffman & Gneezy (2010) suggesting that there are more male left-handers compared to female, the life expectancy of these men is still the lowest. This can be explained in part by having to use machinery designed for use by right-handers, safety measures notwithstanding (Altman & Bland, 2005).

A study by Seeley (2012) to find out the role of handedness on startle response reflexes in terms of its ability to predict drivers' reactions during an unanticipated driving situation showed that the lead hand plays a major role in predicting startle responses, that is, people are more likely to respond using their lead hand during normal circumstances. This explains the increased left-hander rate of traffic- and workplace-related accidents as well as left-handers' shorter life expectancy compared to right-handers. In the work place, portable power saws, computer key boards and certain types of heavy machinery create problems for left-handers because they have the on-off and safety switches almost always fitted for the convenience of a right-hander in case of an emergency (Kassim, 2001).

The left-hander inconveniences resulting from these mismatches also explain why a study by Coren (1993) established that 89% of 2000 college student respondents claimed that they had accident related injuries that required medical attention in sports, the work place, at home and most of all while driving. It is from these challenges that some parents and teachers have in the recent past tried to convert left-handers into right-handers. Porac (2016) argues that compelling a left-hander to convert to a right-hander as has previously been the case by teachers and parents (specifically when writing and eating) is a universal sensation that can have and has had adverse effects on the individual. However, insistent conversion efforts have reduced in regions without cultural or religious prejudices against left-handedness (Kula, 2008). Converted left-handers exhibit confusion in hand use patterns (Porac, 2016) while those who remain left-handed tend to adjust to right-handedness.

2.1.1 Left-Handedness and Leadership

A large number of world leaders have been found to be left-handed. These include leaders in business, politics, the arts, innovation, science, music, writers and sportsmen and women. For example, stable empire builders like Alexander the Great, Julius Caesar, Napoleon Bonaparte, France's King Louis XVI, England's King George II and the royal family including Queen Victoria, Queen Elizabeth the Queen Mother, Prince Charles and William, Prince George (and maybe Princes Charlotte) Colombia's Simon Bolivar, Germany's Otto von Bismarck and Adolf Hitler have all been left-handed. Converging on the more recent lefties, left-handed leaders are unusually over-represented in leadership**,** administration and governance positions,

for example, Bill Gates (business magnate), Henry Ford (industrialist), IBM head (IT company), Lou Gerstner (business) and John Rockefeller (business magnate).

From celebrated global craniums to local level front-runners, left-handers top the upper strata of the spectrum. For instance, overall, 16% of American Presidents were left-handed (in 1992, all three presidential candidates; George Bush, Bill Clinton and Ross Perrot were left-handed), Ireland's former Prime Minister, Brian Cowen, his predecessor Bertie Ahern and Kenya's current president, Uhuru Kenyatta are all left-handed. There are also many left-handed innovators, scientists, musicians, actors and athletes such as Jimi Hendrix (guitarist), Babe Ruth (baseball), Da Vinci (polymath), Marie Curie (physicist), Aristotle (philosopher), Judy Garland (actress), Albert Einstein (theoretical physicist), Oprah Winfrey (executive), Whoopi Goldberg (actress), Angelina Jolie (actress), Pele (footballer), Diego Maradona (footballer) and Marilyn Monroe (actress). Other prominent specimens are Charles Darwin (naturalist), Debbie Millman (writer) and Noam Chomsky (linguist). Moreover, four of the five original designers of Apple computer were left-handed (Mediaplanet, 2019).

Whether left-handedness contributes to better leadership has been backed by science. For example, Lafayette and Johns Hopkins University agree that using the left hand has been associated with higher intelligence and even higher wages contrary to Goodman's (2014) findings. This is because leadership plays an important role in sports, politics and mentorship. There is a robust relationship between laterality and teamwork, signifying the acute prominence of left-handedness and effective leadership. The Lafayette and John Hopkins study concur that left-handedness may help in handling the pressure of team leadership. A University of Oxford study suggests a potential correlation between left-handedness and superior verbal skills suggesting that left-handers might have an advantage when it comes to persuasion skills (Dixon, 2019).

Bergland (2013) proposes that environmental forces and neurobiology combine to make left-handers predisposed to be innovators and revolutionaries. He further opines that one of the benefits of being *"different"* is that it forces one to avoid the crowd mentality and to stay nimble and malleable by continually flexing their creativity and divergent thinking abilities. This denotes that being left-handed in a right-handed setting pushes one to break new ground and become a leader in whatever undertaking. Consequently, left-handers are right brain dominants making it possible for them to be more creative than commonsensical (Tigar, 2018). It becomes easier for them to use both sides of the brain simultaneously and hence the added competitive edge of being more elastic in their cognitive activities which impacts their performance in numerous ways including coping with challenges, easily perceiving and making sense of the general idea, following creative intuition, fast-tracking information as well as self-sustaining (Tigar, 2018).

2.1.2 Left-Handedness at the Work Place

Most left-handed employees often face difficulties while using office tools in completing tasks. A left-handed office clerk has to use a right handed keyboard and mouse (Sin, 2015) which forces them to switch to using the non-lead hand, often leading to musculoskeletal disorder. In effect, this affects the employee's work efficiency and performance, and by extension the

organization's output (Sin, 2015). From earlier in life when left-handers realize that there are tools that cause discomfort during use, this may theoretically lead them to avoid choosing careers that expose them to using such tools. For example, it has been suggested that few surgeons are left-handed. This has been attributed to surgical tools and layout of operating theatres not being comfortable or safe for left-handers' use. Consequently, many left-handed medical students opt to specialize in other areas (Milsom, 2007). The explanation lies with the proximal and distal control movements during unimanual activities (Nelson et al., 2013) in that the proximal carries the hand towards the object to be reached and the distal grasps it, while bimanual activities on the other hand involve using both hands to hold a single object, using two different objects in combination or an object and a tool during task performance. All these require the co-ordination between both hands which influences hand preference and task performance (Scharoun & Bryden, 2014). This infers that certain tasks, whether unimanual or bimanual heighten a robust hand preference and are accomplished faster and more accurately with the lead hand. This may not be the case for left-handers because they are habitually forced to work against their natural (Darvik, 2015).

A study by Silva et al., (2012) evaluated the frequency of left-handedness in the School of Dentistry, in São Paulo. The participants reported that they preferred working in the quadrants on the right side of the manikin's mouth during their laboratory practice. This prompted Silva, et al., (2012) to conclude that dentistry schools should be aware of left-handedness with regards to material and equipment availability, since some difficulties for left-handed dentistry students was caused by the *"wrong"* environment and supplies. The study recommended that institutions and trainers should be aware of left-handedness so as to tailor tools for more effective learning, a recommendation informed by the fact that when left-handers grasp instructional tools, they do it in ways as to minimize discomfort at the end of the task. This is done by either shifting the tools or changing positions to a more preferred position. The idea of swapping tools to the left hand side has been executed with astounding results (Malusi, 2014). In fact, Kaya and Recep (2004) had earlier established that the effectiveness of left-handed dental students upgraded if they worked from the left side of their patients. However, regardless of practical modifications to a right-handed world, the insistent conviction that left-handers are generally clumsy persists (Wright, 2007). This leaps back to adaptations made in the use of right-handed teaching/learning resources. Therefore, providing left-handers with the *"right"* resources and support would drastically improve their performance.

Uncomfortable office ergonomics will decrease employees' effectiveness as well as affecting their physical and mental health. The psychological health of left-handed employees is affected in terms of self-esteem when they are not able to fulfill their job performance and personal goals and the feeling of neglect by their employers (Sin, 2015). Prolonged dissatisfaction towards workplace and job would lead to demotivation and depression, which may often end with high employee turnover. There is thus somber need for organizational ergonomics training among employees. Additionally, allowing left-handers to work from their natural side would immensely increase their effectiveness.

2.1.3 Left-Handedness and Creativity

Contrary to scientific and popular literature reporting an over-representation of left-handers among populations of creative artists (Preti & Vellante, 2007) and architects (Peterson & Lansky, 1977), there is evidence that left-handed children in general classes succeeded in learning foreign languages, music, art and sports. Nevertheless, left-handers form the majority of those children in remedial classes (Kula, 2008). According to Paul (2002), most of the difficulties experienced by left-handed children stem from their having to write with the left-hand and sight with the right eye. Young children experience complications in comprehension by reading backwards, experience difficulties getting the exact direction when having to move their hand and creating reflected image of letters (Kove, 1997) a common practice in pre-schoolers. This leads to low outcomes in schools which forces children to repeat classes despite being outlawed several years back in the Kenyan context.

Research has suggested that the unreasonably demonstrated greater creativity by left-handers compared to right-handers emanates from having to learn from an early age to navigate in a right handed world (Townsend, 2012). This may explain the reason left-handers are to some extent seen as more flexible, more easily capable of hand-switching while performing tasks and think faster when playing computer games or some selected sports compared to right-handers (Pawlik-Kienlen, 2008). However, even though life has become slightly better for left-handers in the recent past, living in a world planned and particularly designed to match the needs of right-handers is still tricky (Masud & Ajmal, 2012). It is therefore imperative to allow left-handers an opportunity to explore the world around them freely so as to reach their academic potential. This can be attained if teachers were made aware of the challenges left-handers face so as counteract their effects in the classroom to the advantage and success of the learners.

2.1.4 Left-Handedness and Sports

In the recent past, impartiality and forbearance has widely spread and hence the probability of sustaining left-handedness' uniqueness is in the increase (Kula, 2008). In sport like in other spheres of life, tolerance is an achievement. Left-handers have to take part in training prepared for right-handers or its special version for the left-handed, if and when it is available. That means left-handers have to adjust to the training manuals and therefore, in order to realize a certain percentage of the training prepared for the right-hander is a great accomplishment which is entirely the left-hander's initiative (Silverman, 2009). For example, left-handed sports trainees have to first turn around instructions before embarking on any task training (ibid). In golf particularly, Silverman contents that learning how to stand correctly is a relatively simple and straightforward task but left-handers have the added task of thinking about their posture before swinging in a course designed for right-handers (Jamison, 2002).

Despite the tolerance and adaptations, left-handers have been known to excel among elite athletes exclusively in interactive sports such as baseball, cricket, fencing, tennis (Loffing et al., 2012) and boxing (Gursoy, 2008). This has been supported by the surprise effect advantage hypothesis (Raymond et al., 1996; Gursoy, 2008; Richardson, 2019) which suggests the presence of a higher efficiency level of limiting the direction of turns in sporting exercises

(Holtzen, 2000). Due to concept saturation, right-handed opponents always expect right-handed confrontation so when it comes from a left hander, the probability of being caught flatfooted increases, to the advantage of the left-hander (Wood & Aggleton, 1991).

2.1.5 Lead Hand and Cognitive Development

It is commonly agreed that left-handers' intellectual activity is dominated by the right hemisphere responsible for controlling the activities of the left hand (Porac, 2016; Dixon, 2019). Researchers suggest that this functional organization gives lefties a creative edge and a cognitive style slightly different from that of left-hemisphere dominated righties. Previous studies examining hand preference and cognitive development carried out using older children (e.g., Faurie et al., 2006) or adults (e.g., Resch et al., 1997; Halpern et al., 1998) showed that left-handers scored lower than right-handers. A recent longitudinal study by Johnston et al., (2010) using young children showed that quantitatively, there were large differences in development, with left-handers recording lower standard deviation test scores in memory, comprehension, mathematics and vocabulary. This effect of hand preference on general cognitive ability confirmed the results of similar studies such as Johnston et al., (2009), which also used a large, representative sample of Australian children.

In her study, Kula (2008) established that although writing is the most difficult subject (skill) for pre-school left-handers, teachers give the main techniques from a right-handed standpoint leaving the left-handers with no option but to cope on their own. Left-hander's difficulties with mathematics and reading were attributed to perception of directions which requires accuracy and coordination skills. Kula (2008) concluded that pre-school left-handers need individually adapted guidance despite right-handed teachers claiming they were not well equipped to teach manual techniques to left-handers. Left-handed teachers have been found to poses the relevant skills for instructing left-handed children as a result of concept saturation (Milsom, 1995; Malusi, 2014).

From these study findings, it appears that left-handed children require emotional support since the academic deficits in these studies were beyond fine-motor skills challenges (Johnston et al., 2010). It would therefore be erroneous to assume that lowered academic outcomes by left-handers' point to an inability to effectively process and/or retrieve information from memory stores (Malusi, 2014). As a result, the correct support to left-handed children in the learning environment as Kenya moves to the much hyped CBC would help unleash the power and brilliance in left-handers (Nyantino, 2019).

In conclusion, left-handers' right-brain dominance appears to have made it easier for them to be more elastic in cognitive activities which makes them easily cope with challenges, perceive the bigger idea and be self-sustaining. For this reason, they pass to be good at persuasion and mentoring which explains their exemplary performance in business, leadership and politics. Despite left-handed sports persons being subjected to training manuals designed for right-handers which translates to prolonged and intense training, left-handers are well represented among elite athletes especially in interactive sports mainly due to the surprise effect advantage. Subsequently, there is need to support left-handers both emotionally and in terms of "*physiologically friendly*" equipment in their sporting activities.

2.2 Is Left-Handedness an Interuption to Learning?

Handedness studies show that despite an apparent dominance of symmetry in coordination, there is an in-built asymmetry to movements chastised in lead hand preferences (Amazeen et al., 2005). This implies that individuals will naturally devote more attention to the activities of the preferred hand during bimanual coordination (Peter, 1994). Further, precision tool use typically involves superior use of the dominant hand, which explains left-handers' difficulty in using teaching/learning resources in schools during timed tasks. For a left hander, using such tools presents a challenge that potentially disrupts effective processing of incoming information, thus interfering with successful information organization, storage and retrieval. This is because the left-hander is likely to devote more time and cognitive effort consciously operating resources meant to be operated procedurally by the right hand using the left hand.

The resulting time pressure from the increased cognitive effort may also include heightened feelings of tension and nervousness, as the left-hander realizes that they may be falling behind in reaching the task milestones. This realization possibly pushes the individual into a sense of urgency about completing critical tasks. Furthermore, the urgency and panicky mode can also hinder the left-handers' ability to reach a state of total involvement in the task even when they are intrinsically motivated and actively engaged in the task. When such interruption to information flow occurs, the disturbance may interfere with the focused attention of the person, reinstating time consciousness and a sense of time scarcity especially when there are other pending activities to be performed (Csikszentmihalyi, 2000).

As is the norm during national examinations in the Kenyan context, practical examination rooms are prearranged prior to the commencement of the examination. The arrangement is mainly done for students who are right-handed (Note 1). This arrangement which does not factor in left-handers needs contradicts the assertion by Nelson and Soli (2000) that if classrooms, in this case examination rooms, are not arranged according to the special learning needs of all learners, it will create difficulties and possible interruption which may lead to poor academic performance. Bruin et al., (2016) implied that an object's location in space plays an important role in hand selection. It would therefore seem sensible, for biomechanical reasons nonetheless, for one to grasp an object with the hand ipsilateral to the object. Right handed teaching/learning resources are contralateral to left-handers' physiology and consequently left-handers are forced to make adjustments to and in the context in order to carry out tasks comfortably and effectively (Malusi & Odiemo, 2018). This calls for additional conscious decision maker effort that involves switching and adjusting the task context in order to attain the end-state comfort expected to manipulate these resources (Knudsen et al., 2012).

Despite the switch among and between tasks being in a self-guided manner, a significant portion of task switching and task interleaving potentially causes an interruption to information processing from the memory stores thus causing a cognitive overload (Knudsen et al., 2012). Further to adapting at the work station, practical work requires that learners analyze information using blooms highest level of information processing (Anderson et al., 2001). These adaptations increases task time and cognitive effort of the left-hander which can affect overall achievement negatively (Malusi & Odiemo, 2018).

The following section is a discussion on the effect of mismatches in the classroom as well as during teaching and learning and how it can potentially impact a left-handed learner's overall academic performance negatively.

2.2.1 The Left-Handed Learner in School

In their formative years, left-handed children need specific support with cursive writing (McGuire, 2017). This is because it is not unusual for them to develop an awkward pen grip and an uncomfortable body posture since they have to push the pencil when writing which often leads to a tight grip, causing a wrist ache and hitches to smooth writing (McManus, 1991; Kula, 2004; Lance, 2005). Also, their writing is obliterated from view immediately after they have written and so is easily smudged, a habit that teachers strongly discredit and many times disqualify on the basis of dirty work. Some experts suggest that such problems arising from the struggle with handwriting during pre-school years can result in low self-esteem, which can result in a downward spiral of children losing enthusiasm for school, feeling that their work is slow and messy and avoiding writing as the easy option (Kula, 2004). Poor writing habits can also lead to problems for older left-handers as the demands of taking notes increases, for example, the need to write quickly during lessons and in tests can be very challenging to such youngsters. This can often result in incomplete tests thereby having results not reflecting the children's actual capability, leading to repeating classes and/or loss of interest in school altogether (Nyantino, 2019).

If taught penmanship properly however, left-handed children are able to develop a neat, cursive handwriting style (McManus, 1991). Teachers need to support left-handed students across the board from providing them with correct learning equipment to organizing sensible seating arrangements (Malusi, 2014). This can nonetheless be complicated for a right-handed teacher to teach certain skills to a left-handed child unless the teacher has a clue of the technique. For example, few adults understand that basic life skills such as tying shoelaces to more complicated objectives such as knitting or playing a musical instrument are best taught by sitting opposite the child rather than adjacent, giving them a mirror image to copy (Parish, 2013) a feat that when done at home can help the child adjust better in school and later life.

Left-handers experience confusion in using the left hand and their motion perception is bad. This explains why acquisition of notions expressing motion perception and responding to them makes it more difficult to learn reading, writing and the development of mathematical skill, hence the reason left-handers more frequently experience learning difficulties (Sharma, *et, al*., 1993; Johnston et al., 2010). For instance, in their study, Gregg et al., (2008) showed that left-handers' test scores were 1% below those of right-handers. Johnston et al., (2007) also showed that left-handed children perform significantly worse in nearly all measures of development (learning, social, cognitive and language aspects) except for reading.

2.2.2 The Left-Handed Learner in the Classroom

Contrary to previous findings in favor of right-handers' performance in academics (Gregg et al., 2008; McManus et al., 1993), Emore et al., (2008) looked at the effect of hand dominance on learning for Nigerian older children and found that left-handed children performed

significantly better than right-handed children. This finding was similar to that of Randerson (2001) who established that left-handers have better memory because their brains are structured in a way that widens their range of abilities. Emore's (2008) study is collaborated by recently emerging belief that left-handers are generally more intelligent and creative than right-handers (Tigar, 2018).

Analogous studies have also established that left-handers are adversely affected in the classroom (McManus, 1991; Sharma et al., 1993; Paul, 2002; Lance, 2005; Kula, 2008; Gregg et al., 2008; Parish, 2013; Malusi, 2014). The general setting in the classroom is in favor of the right-handed and therefore the mismatched left-hander has to learn to cope in order to effectively learn. Coping here means learning to use pencil sharpeners, spiral note books, scissors, rulers and laboratory resources designed for effective use by right-handers (McManus, 1991). When using such resources, left-handers either learn to use them right handed or somehow learn to hold it backwards so that it can be manipulated with the left hand (Coren, 1997; Kula, 2008). This means that left-handed children must put in more time and cognitive effort even for simple tasks of life in order to function at par with their right-handed counterparts (Milsom, 1995; Coren, 1997; Malusi, 2019). For example, in the classroom, left-handers have to sit on desks that have the arm rest on the *"wrong"* side, sit next to a right-hander which causes knocking elbows during writing and endure backaches due to concocting the back uncharacteristically. This is despite dealing with poor pen-paper control which causes painful hand spasm (Milsom, 1995), sometimes making them to fail to complete timed tasks (Malusi, 2014). Hand spasms and backaches can result to health challenges leading to missing school. Therefore, giving left-handers the correct and timely support can help them reach their maximum potential in academics and hence achieve their life's goals.

2.2.3 Impact of Handedness on Practical Lessons

As earlier discussed, left-handers are likely to experience difficulties using tools that require left- right- turning and flexing of the muscles. Left-handers turn things against the thread, for example fixing screws, or winding up and unwinding tools. This undertaking is not only strenuous; it is sometimes beyond left-handers' locus of control (Hughes et al., 2011). Despite prolonged exposure to their use, left-handers need to continually adapt to such situations because they are forced to use their non-lead hand which explains the less between-hand differences (Craig et al., 2012). Since they naturally tend to get more practice by using these everyday tools with their non-preferred hand, left-handers find themselves using their weaker hand more frequently (Stone et al., 2013) and more proficiently (Scharoun & Bryden, 2014) compared to right-handers. However, left-handers are still less consistent in their manual preference compared to right-handers (Scharoun & Bryden, 2014).

Research shows that hand preference and overall achievement is dependent on the degree and direction of manual preference, the movement type and its complexity (Scharoun & Bryden, 2014), practice (Chisnall, 2012), number and nature of questions asked and the participants' characteristics (Williams, 2014). Despite Akipnar and Bicer (2014) showing that left-handers demonstrate greater readiness in using the weaker hand when performing unskilled motor tasks, when they are subjected to performing timed laboratory tasks whose knowledge and skill has

not been effectively automated, the probability of ineffective information storage, interpretation and retrieval increases (Kirschner et al., 2006) since automation takes time, effort and practice. The learner has to make deliberate decisions to consciously manipulate the teaching/learning tools that ought to be manipulated procedurally. This not only takes time but tends to increase cognitive effort of the learner.

A study conducted by Malusi (2019, unpublished thesis) to investigate the effect of left-handers' use of right handed instructional resources on overall achievement in chemistry showed that left handers' acquisition and use of psychomotor skills are critical in demonstrating their knowledge and understanding of practical processes during laboratory lessons. Findings showed that on average, the performance of left-handers in laboratory work was lower compared to that of right-handers. This was because the failure to handle *'ungraspable'* right-handed instructional resources fluidly renders the left-handers unable to complete timed tasks.

Analogous studies in the context of mismatches in the learning environment have established negative effects on learning (Dhara et al., 2008; Parish, 2013; Malusi, 2014). This is because left-handers find it challenging to coordinate the movement of the right and left hands simultaneously, especially in tasks that require clockwise turning by both hands. As they handle and manipulate teaching/learning resources, instead of deploying cognitive resources to consciously process new learning, extra cognitive effort is directed to processing extrinsic load generated by intentionally processing what ought to be automatically executed. As a result, the intended learning content is not effectively processed for storage and future retrieval in the long term memory (Sweller, 1988; Baddeley, 1992). A sustained failure to fruitfully reach their intended task goal using the resources within the given time has the potential of causing a ripple effect that negatively changes how the learners perceives and interacts with these resources. As a result, it can also alter the self-esteem of the learner thereby affecting their performance in a negative way.

The challenges associated with left-handedness in the classroom environment appear to be hinged on the 3Rs (reading, writing and arithmetic) and not necessarily caused by any mental disorder (Mäki, 2000) but rather by the mismatches associated with left-handers' physiology and having to adapt to the use of right-handed resources (Casasanto & Chrysikou, 2011). This adaptation is costly as it not only takes time but negatively impacts academic achievements. Paul (2002) asserts that left-handed children might have behavioral problems unless they are supported by the society. If parents notice and support challenges at an early age, when they go to pre-school, the child has already been equipped to cope with some of the challenges. The teacher would find it easier to support the child and build their self-esteem and eventually help subdue some learning difficulties. This sequentially helps left-handers to feel accommodated at school and in everyday life and supported for their future academic development and life's goals.

3. Conclusions and Recommendations

Left-handed people have been marginalized in nearly all spheres of their life. Today, the intrinsic and concept saturation nature of left-handedness has made it draw minimal attention

from the society. Despite the marginalization and minimal attention to left-handedness especially where it massively interrupts normal functioning of the individual, left-handers have achieved immensity in diverse walks of life, particularly in the political, entertainment, sporting, leadership and artistic fields where their natural aptitude for imaginative thinking and originality have made an enormous input.

Nevertheless, left-handers experience more recurrent learning difficulties. Pre-school left-handers experience hitches primarily in writing left-to right-, expressing and responding to spatial discernments which sometimes has contributed to them being the majority in remedial classes. Mismatches in the teaching/learning environment causes older children to fail to complete timed tasks within the stipulated time thereby negatively affecting their academic achievements. The adjustments left-handers have to make in school and at the work place in order to function comfortably more often than not causes hand, back, neck and shoulder pains which not only decreases their effectiveness but also compromises their physical and emotional health. In sporting and professional music activities, left-handers benefit from long and intense training because of being biologically predisposed. A combination of all these have made left-handedness appear as an impediment to daily life generally and specifically in the classroom.

In view of the foregoing, the researchers recommend that policy makers and implementers adopt measures that aim to change the narrative of left-handedness in an effort to influence the society to effectively accommodate left handers in all spheres of their life. This is because the discrimination they face has hampered majority of them from reaching their full potential. To achieve this, the following recommendations were suggested:

1) Awareness programs: What left-handers need is encouragement and support. This can be achieved through the establishment of awareness programs aimed at changing the society's attitudes towards left-handedness in school, at home and at the workplace. The society needs to appreciate that left-handedness exists and cannot be changed or wished away. The current lack of appreciating left-handedness by the society has left the "self-esteem and self-worth" of left-handers at jeopardy because they often have to settle for less. Left-handers themselves also need to be encouraged to operate from where they feel most comfortable without any feelings of threat or ridicule. All learners at all levels ought to be encouraged to appreciate individual differences.

2) Paradigm shifting: It is essential for teachers during the initial and continuing training programs to be trained to appreciate the unique needs of left-handers. Pedagogical approaches that are *"left-hander friendly"* would help in ensuring that left-handers reap maximum benefits from school and classroom experiences. Pedagogical interventions that promote social support for left-handers need to be adopted by teachers in order to help foster a more positive attitude toward left-handedness in school.

3) Inclusive teaching/learning environment: Children at all ages in the school environment need to be psychologically and physically supported through the provision of "graspable" teaching/learning resources. As Kenya rolls out the CBC at the formative ages where skill and cognitive development take center stage, it is important that

education stakeholders appreciate left-handedness as a special learning need so as to support left-handers with the "space" and "correct devices" in the spirit of educational inclusiveness. Older left-handers that are registered in subjects that require the manipulation of teaching/learning resources need additional time to help acclimatize in the task taking environment.

4) Manufacturers need to provide left-handed resources at no extra cost. The affordability of these resources would aid in left-hander's seamless inclusion in the society which in turn may lead to an improved all-round quality of life.

This literature review has highlighted key aspects associated with left-handedness from a pre-schooler to the adult at the work place. More longitudinal studies ought to be carried out to establish the progress from childhood to adulthood for left-handed individuals. Accomplishment stories from successful left-handers may help enlighten the condition and unlock the impasse for those left-handers who still struggle to effectively cope in a right handed world. This would help with testimony reliability and better assessment of left-handedness.

References

Aggleton, P., Kentridge, W., & Good, M. (1994). Handedness and Musical Ability: A Study of Professional Orchestral Players, Composers, and Choir Members. *Psychology of Music., 22*, 148-156. https://doi.org/10.1177/0305735694222004

Alhassan, A. (2019). Left-Handedness, Leadership and Governance: Implications for Parents and Teachers. *Asian Journal of Social Science Management & Economics, 1*(01), 14-9. Retrieved Aug 2019, from http://ajssme.ijrpublications.com/index.php/ajssme/article/view/4

Almas, N., Degnan, A., Nelson, A., Zeanah, H., & Fox, A. (2016). IQ at age 12 following a history of institutional care: findings from the Bucharest early intervention project. *Dev. Psychol., 52*, 1858-1866. https://doi.org/10.1037/dev0000167

Altman, D., & Bland, M. (2005). Do left-handed die young? *Royal statistical society, 2*(4). https://doi.org/10.1111/j.1740-9713.2005.00130.x

Amazeen, E., Ringenbach, S., & Amazeen, P. (2005). The effects of attention and handedness on coordination dynamics in a bimanual Fitts' law task. *Experimental Brain Research, 164*(4), 484-499. https://doi.org/10.1007/s00221-005-2269-y

Annett, M., & Alexander, P. (1996). Atypical cerebral dominance: predictions and tests of the right shift theory. *Neuropsychologia, 34*, 1215-27. https://doi.org/10.1016/0028-3932(96)00048-6

Annett, M. (1995). *Left, Right, Hand and Brain: The Right Shift Theory*. Retrieved from https://www.researchgate.net

Annett, M. (1992). Spatial Ability in Subgroups of Left- and Right-Handers. *British Journal of Psychology, 83*, 492-515. https://doi.org/10.1111/j.2044-8295.1992.tb02455.x

Baddeley, (1992). *Working memory Science, 255*, 556-559.

https://doi.org/10.1126/science.1736359

Bergland, C. (2013). *Are Lefties More Likely to Become Champions and Leaders?* Retrieved Aug, 2019, from https://www.psychologytoday.com/us/blog/the-athletes-way/201308

Bogaert, F. (2007). Extreme right-handedness, older brothers, and sexual orientation in men. *Neuropsychology, 21*, 141-8. https://doi.org/10.1037/0894-4105.21.1.141

Brandler, W., & Paracchini, S. (2014). T*he genetic relationship between handedness and neurodevelopmental disorders, 20*(2). 83-90. https://doi.org/10.1016/j.molmed.2013.10.008

Bruin, N., Bryant, D., MacLean, J., & Gonzalez, C. (2016). Assessing Visuospatial Abilities in Healthy Aging: A Novel Visuomotor Task. *Front Aging Neurosci, 8*, 7. https://doi.org/10.3389/fnagi.2016.00007

Bryden, P., Ardila, A., & Ardila, O. (1993). Handedness in native Amazonians. *Neuropsychologia, 31*, 301-308. https://doi.org/10.1016/0028-3932(93)90094-G

Casasanto, D., & Chrysikou, G. (2011). When Left Is "Right": Motor Fluency Shapes Abstract Concepts. *Psychological Science, 22*(4), 419-422. https://doi.org/10.1177/0956797611401755

Collins, Y., Pringle, B., Alexander, C., Darmstadt, L., Heymann, J., & Huebner, G. (2017). Global services and support for children with developmental delays and disabilities: Bridging research and policy gaps. *PLoS Med, 14*(9). https://doi.org/10.1371/journal.pmed.1002393

Csikszentmihalyi, M. (2000). Happiness, flow and economic equality. *American Psychologist 55*(10), 1163-4. https://doi.org/10.1037/0003-066X.55.10.1163

De Kovel, C, Carrion-Castillo, A., & Francks C. (2019). A large-scale population study of early life factors influencing left-handedness: *Scientific Reports, 9,* 584. https://doi.org/10.1038/s41598-018-37423-8

Denny, K., & O'Sullivan, V. (2007). The Economic Consequences of Being Left-Handed: Some Sinister Results. *Journal of Human Resources, 42*, 353-374. https://doi.org/10.3368/jhr.XLII.2.353

Dhara, C., Khaspuri, G., & Sau, K. (2008). *Complaints arising from a mismatch between school furniture and anthropometric measurements of rural secondary school children during class work*. Retrieved August, 2013, from www.ncbi.nlm.nih.gov

Dixon, E. (2019, 5th Sept). *Scientists have identified the genes linked to left-handedness-Updated 1326 GMT (2126 HKT)*. Retrieved from https://www.cnn.com in Oct 2019

Emore, E., Ebeye, A., Odion-Obomhense, K., & Igbigbi, S. (2008). A Look at the Effect of Hand Dominance on Learning. *Journal of Applied Sciences, 8*, 173-176. https://doi.org/10.3923/jas.2008.173.176

Faurie, C., Vianey-Liaud, N., & Raymond, M. (2006). Do Left-Handed Children Have Advantages Regarding School Performance and Leadership Skills? *Laterality, 11*, 57-70.

https://doi.org/10.1080/13576500601005727

Fritschi, L., Divitini, M., Talbot-Smith, A., & Knuiman, M. (2007). Left-handedness and risk of breast cancer. *Br J Cancer, 97*(5), 686-687. https://doi.org/10.1038/sj.bjc.6603920

Gilbert, N., & Wysocki, J. (1992). Hand preference and age in the United States. *Neuropsychologia, 30*(7), 601-8. https://doi.org/10.1016/0028-3932(92)90065-T

Goodman, J. (2014). The Wages of Sinistrality: Handedness, Brain Structure, and Human Capital Accumulation. *Journal of Economic Perspectives, 28*(4), 193-212. https://doi.org/10.1257/jep.28.4.193

Gregg, P., Janke, C., & Propper, C. (2008). *"Handedness and child development". The centre for market and public organization 08/198, Department of Economics, University of Bristol, UK*. Retrieved from https://www.independent.co.uk

Gursoy, R. (2008). *Effects of left- or right-hand preference on the success of boxers in Turkey*. https://doi.org/10.1136/bjsm.2007.043547

Gutwinski, S., Loscher, A., Mahler, L. Kalbitzer, J., Heinz, A., & Bermpohl, F. (2011). Understanding Left-Handedness. *Dtsch Atztebl Int., 108*(50), 849-853. https://doi.org/10.3238/arztebl.2011.0849

Halpern, F., Haviland, G. &, Killian, D. (1998). Handedness and Sex Differences in Intelligence: Evidence from the Medical College Admission Test. *Brain & Cognition, 38*, 87-101. https://doi.org/10.1006/brcg.1998.1021

Hoffman, M., & Gneezy, U. (2010). *Left Handed Women are More Competitive than Right Handed Men: On the Biological Basis of Gender Differences in Competitiveness*. Retrieved in Aug, 2019 from jenni.uchicago.edu › Spencer_Conference

Holtzen, W. (2000). Handedness and professional tennis. *International Journal of Neuroscience, 105*, 101-119. https://doi.org/10.3109/00207450009003270

Hopkins, W., Adams, M. & Weiss, A. (2013). Genetic and Environmental Contributions to the Expression of Handedness in Chimpanzees (Pan troglodytes). *Genes brain behave, 12*(4), 446-52. https://doi.org/10.1111/gbb.12044

Hugdahl, K., Satz, P., Mitrushina, M., & Miller, E. (1993). Left-handedness and old age: Do left-handers die earlier? *Neuropsychologia, 31*(4), 325-33. https://doi.org/10.1016/0028-3932(93)90156-T

Jamison, S. (2002). *The Differences in Performance of a Left Vs Right Brained Golfer on a Curvilinear Golf Course*. Retrieved Feb. 2015 from https://pdfs.semanticscholar.org

Johnston, W., Nicholls, E., Shah, M., & Shields, A. (2009). Nature's experiment? Handedness and early childhood development. *Demography, 46*, 281-302. https://doi.org/10.1353/dem.0.0053

Johnston, D., Nicholls, M., Shah, M., & Shields, M. (2010). Handedness, Health and

Cognitive Development: Evidence from Children in the NLSY. *Discussion paper series,* No. 4774. Retrieved Feb. 2015, from https://www.ncbi.clm.cih.gov

Johnston, D., Shah, M., & Shields, M. (2007). *Handedness, Time Use and Early Childhood Development*. Retrieved August 2013, from https://d.nb.info

Kassim, S. (2001). *Psychology* (3rd ed.). Prentice Hall, Inc. A Division of Pearson Education. Upper Saddle River, NJ 07458.

Knudsen, B., Henning, A., Wunsch, K., Weigelt, M. & Aschersleben, G. (2012). The End-State Comfort Effect in 3- to 8-Year-Old Children in Two Object Manipulation Tasks. *Front Psychol., 3*, 445. https://doi.org/10.3389/fpsyg.2012.00445

Kula, P. (2004). Peculiarities of left-handed children's success at school. *Education, 6*(7), 44-5. Retrieved July 2011, from https://www.digar.ee in

Kula, P. (2008). Teaching left-handed primary school pupils in Estonia. *Journal of Teacher Education for Sustainability, 9*, 58-67. https://doi.org/10.2478/v10099-009-0019-0

Lalumiere, I. (2002). Sexual orientation and handedness in men and women: a meta-analysis. *Psychological Bulletin, 126*, 575-579. https://doi.org/10.1037/0033-2909.126.4.575

Lance, W. (2005). *Left-handed children in a right-handed world*. Retrieved Feb 2016, from https://www.iched.org/cms/scrripts/page.php?

Lapehn, R. (2019). *Left-Handed Leadership: First Presbyterian Church of Barberton*. Retrieved from https://www.google.com/search?

Loffing, F., Hagemann, N., & Strauss, B. (2012). Left-Handedness in Professional and Amateur Tennis. *PLoS ONE, 7*(11). https://doi.org/10.1371/journal.pone.0049325

Malusi, B. (2014). Challenges left-handed students face in Kenyan High School Science Laboratories. *African Journal for Research in Chemistry Education, 4*(3), 50-81, Special Issue. Retrieved from https://www.ajol.info

Malusi, B., & Odiemo, L. (2018). *Effect of Handedness on Completion Rate of Chemistry Timed Tasks by Left-Handed Learners*. Retrieved from https://papers.iafor.org June 2018

Malusi, B. (2019, Unpublished PhD thesis). *Influence of handedness in manipulating instructional resources on students' achievement in chemistry in selected secondary schools in Kenya*. Unpublished thesis submitted in partial fulfillment of the PhD.

Masud Y. & Ajmal, A. (2012). Left-handed People in a Right-handed World: A Phenomenological Study. *Pakistan Journal of Social and Clinical Psychology, 10*(1), 49-60. Retrieved from https://pdfs.semanticscholar.org

McGuire, J. (20th Sept, 2017). *How can teachers help left-handed children in the classroom? Advice from a former teacher: From scissors to seating arrangements, many things need to be taken into consideration when teaching a left-handed student, but do these children need to be given extra attention? Family & Relationships. South China Morning Post*. Retrieved

Aug 2019 from https://www.scmp.com/lifestyle/families/article/2111783/

McManus, C. & Bryden, P. (1992). The genetics of handedness, cerebral dominance and laterization. In I. Rapin & S. J. Segalowitz (Eds.). *Handbook and neuropsychology, 6:10: child Neuropsychology* (Part 1, pp. 251-81) Amsterdam: Elsevier. Retrieved from https://psycnet.apa.org

McManus, C. (1981). Handedness and birth stress. *Psychol. Med., 11*, 485-496. https://doi.org/10.1017/S0033291700052806

McManus, C. (1991). The inheritance of left-handedness. *Cba Found Symp, 162*, 251-67, discussion 267-81. https://doi.org/10.1002/9780470514160.ch15

McManus, C., Shergill, S, & Bryden, P. (1993). Annett's Theory That Individuals Heterozygous for the Right-Shift Gene Are Intellectually Advantaged: Theoretical and Empirical Problems. *British Journal of Psychology, 84*, 517-37. https://doi.org/10.1111/j.2044-8295.1993.tb02500.x

McKeever, F. (2000). A new family handedness sample with findings consistent with X-linked transmission. *British Journal of Psychology, 91*(1), 21-39. https://doi.org/10.1348/000712600161655

Mediaplanet, (2019). 9 weird advantages of being left-handed. *Education and career news*. Retrieved Oct 2019, from https://www.educationandnewscareernews

Meyer, F. (1998). *The organization of prose and its effect on memory*. Amsterdam: North Holland. Retrieved from https://www.amazon.com April 2014

Ministry of Education (MoE, 2012). *Republic of Kenya draft bill. A Policy Framework for Education Aligning Education and Training to the Constitution of Kenya (2010) and Kenya Vision 2030 and beyond*. Retrieved Sept 2019, from https://www.fieldmarshamfoundation.org

Milsom, L. (1995). Left-handed children are they losing out? *Educational media international, 32*, 107-108. https://doi.org/10.1080/0952398950320213

Nyantino, J. (2019, Aug, 13th). New curriculum has to consider left-handers: Daily nation. Retrieved Aug, 2019, from https://www.nation.co.ke/oped/opinion/.../index.html

Parish, A. (2013). *Effect of handedness on gross motor skill acquisition among college undergraduates*. Retrieved July 2014, from https://journals.sagepub.com

Papadatou-Pastou, M. & Munafo, T. (2008). Sex differences in left-handedness: A meta-analysis of 144 studies. *Psychological Bulletin, 134*(5), 677-699. https://doi.org/10.1037/a0012814

Paul, G. (2002). *The Lefthander's Handbook*. England: The Robinswood Press. Retrieved Aug 2012, from https://www.robnswood.co.uk

Pawlik-Kienlen, L. (2008). *Personality traits of lefties: The psychological characteristics of left-handed people*. Retrieved June 2018, from https://www.psychology.suite 101.com/

Peterson, M., & Lansky, M. (1977). Left-Handedness among Architects: Partial Replication and Some New Data. *Perceptual and Motor Skills, 45*, 1216-8. Retrieved from https://doi.org/10.2466/pms.1977.45.3f.1216

Preti, A. & Vellante, M. (2007). Creativity and Psychopathology: Higher Rates of Psychosis Proneness and Nonright-Handedness Among Creative Artists Compared to Same Age and Gender Peers. *Journal of Nervous and Mental Disease, 195*, 837-845. https://doi.org/10.1097/NMD.0b013e3181568180

Porac, C. (2016). Geography, History and the Left-hand. *Exploring the Enigma of Left-Handedness*, 119-33. https://doi.org/10.1016/B978-0-12-801239-0.00008-9

Porac, C., Coren, S. & Searleman, A. (1986). Environmental factors in hand preference formation: Evidence from attempts to switch the preferred hand. *Behavior genetics*. https://doi.org/10.1007/BF01070800

Randerson, J. (2001). *Ambidextrous tendencies may mean better memory*. New Scientist. Retrieved October 2011 from https://www.newscientist.com

Raymond, M., Pontier, D., Dufour, A.-B., & Moller, P. (1996). Frequency-dependent maintenance of left handedness in humans. *Proc. R. Soc. B, 263*, 1627-33. https://doi.org/10.1098/rspb.1996.0238

Resch, F., Haffner, J., Parzer, P., Pfueller, U., Strehlow, U. & Zerahn-Hartung, C. (1997). Testing the Hypothesis of the Relationships between Laterality and Ability. *British Journal of Psychology, 88*, 621-35. https://doi.org/10.1111/j.2044-8295.1997.tb02661.x

Roberts, S. (2011). *Left-handed people more likely to have sleep disorder American College of Chest Physicians*. Retrieve from https://www.eurekalert.org in Aug 2019

Salmaso, D., & Longoni, M. (1985). Problems in the assessment of hand preference. *Cortex 22*, 533-49. https://doi.org/10.1016/S0010-9452(58)80003-9

Satz, P., Orsini, L., Saslow, E., & Henry, R. (1985). The pathological left-handedness syndrome. *Brain Cogn, 4*, 27-46. Retrieved May 2019 from https://doi.org/10.1016/0278-2626(85)90052-1

Sharma, B., Goyal, M. & Singh, J. (1993). Comparison of scholastic performances of left handed and right handed students. *Indian Pediatr, 30*(10), 1189-92. Retrieved Aug 2019 from https://www.ncbi.nlm.nih.gov/pubmed/8077009

Searleman, A. (2000). *American Psychological Association*. Retrieved Sept 2019 from https://www.independent.co.uk/life-style/health-and-families/

Seeley, J. (2012). *Handedness as A Predictor of Startle Response Reflexes Elicited During Unanticipated Driving Events. A Thesis presented in partial fulfillment of the requirements for the degree of Master of Science in the Department of Psychological Science University of Central Missouri*. Retrieved Aug 2019, from https://jckldigital.ucmo.edu/bitstream

Silverman, S. (2009). *Stance for Left-handed Golfers*. Retrieved June 2013, from www.golflink.com./how_317_stance-lefthanded-golfres.html

Sin, K. (2015). *A Study On the Working Experience of Left-Handed Employees with Office Workstation Ergonomics at Right-Handed Workplace in UNIMAS*. Retrieved Sept 2019, from https://ir.unimas.my/id/eprint/12641/1/A

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*, 257-85. Reprieved from https://doi.org/10.1207/s15516709cog1202_4

Tigar, L. (2018). *Psychologists explain how left-handed people work differently. Living in a world designed for right-handed people forces lefties to come up with creative solutions*. Retrieved Sept 2019, from https://www.fastcompany.com/90215373/

Townsend, M. (2012). *The sinister hand: left-handedness in a right handed world*. Retrieved Feb. 2015, from www.fwquestclub.com

United States Sports Academy. (2008). *Types and Effects of Motor Adaptation a Left- handed Persons in Daily Life and in Contemporary Sport Training*. America's Sports University. May 2013.

Webb, J., Schroeder, M., Chee, C., Dial, D., Hana, R., Jefee, H., Mays, J., & Molitor, P. (2013). *Left-Handedness Among a Community Sample of Psychiatric Outpatients Suffering from Mood and Psychotic Disorders*, 1-5. https://doi.org/10.1177/2158244013503166

Willems, M. & Francks, C. (2014). Your left-handed brain. Front. *Young Minds. 2*, 13. https://doi.org/10.3389/frym.2014.00013

Williams, N. (2014). *"Laterality Across the Lifespan: The Effects of Task Complexity" Theses and Dissertations (Comprehensive)*. Retrieved May, 2018, From http://scholars.wlu.ca/etd/1661

Wright, B., & Zecker, S. (2004). Learning problems, delayed development, and puberty. *Proceedings of the National Academy of Sciences, 101*. https://doi.org/10.1073/pnas.0401825101

Wood, C., & Aggleton, J. (1991). Occupation and Handedness: An Examination of Architects and Mail Survey Biases. *Canadian Journal of Psychology, 45*, 395-404. https://doi.org/10.1037/h0084292

Yirka, B. (2018). *Researchers find a connection between left-handedness and low birth weight*. Retrieved Aug 2019, from https://medicalxpress.com/news/2018-05-

Notes

Note 1. Resources that are meant to be used by the right-hand are placed on the right hand side of the user and those meant to be manipulated by the left hand are placed on the left hand side of the user.