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“Investigating the relationship between handedness and professional career”

Helen Koutsonika

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INVESTIGATING THE RELATIONSHIP BETWEEN HANDEDNESS AND PROFESSIONAL CAREER

POSTGRADUATE THESIS

OF

HELEN KOUTSONIKA

A thesis submitted to the authorised Master Thesis committee in partial fulfilment of requirements for the postgraduate Master degree in “Cognitive & Motor Development” awarded by the Department of Early Childhood Education of the University of Western Macedonia & the Department of Physical Education and Sport Science of the Aristotle University of Thessaloniki

Approved by the body of Master Thesis committee professors:

Supervisor: George Grouios, Professor

Members: Helen Tsakiridou, Professor &

Nikolaos Tsigilis, Associate Professor

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“The most meaningful method of assessment is direct observation by the investigators. This has been done with some success <182>, but can become expensive and time consuming. The question of how many activities to observe then becomes an issue.”

(Crowley, 1989, p. 30)

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Abstract

Present study examined handedness, particularly left-handedness, in professions and sports. The purpose of the study was to investigate handedness, particularly left-handedness, in professions. The aim of the study was to investigate whether a statistically significant different incidence of left-handedness is observed in nine professions (see [1.3.2].) by comparison to general population's one. The analysis revealed that no statistically significant difference exists in left-handedness incidence between each one of the nine professional groups and the general population. Results are approached in the light of the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b, 1986) as well as the Levy theory (as cited in Gilbert, 1977). Future practical implications and research suggestions are in brief set forth.

Keywords: profession(s), skill(s), brain, hemisphere(s), handedness, hand preference, sinistrality/left-handedness, dextrality/right-handedness, ambidexterity.

CONTENTS

TABLES AND FIGURES

PROLOGUE

The topic of the present study is handedness in professions.

A questionnaire consisting of the 12-item Briggs and Nebes' Inventory (1975) and three additional questions (a family handedness question, a special one hand practice/ an encouragement for one hand usage question and a head injury one) is administered in f2f mode at workplace˙ in parallel, subjects' observation by student-researcher takes place, too.

The Google form version of the questionnaire is sent to Architectural Engineers via e-mail. Professionals are recruited via the Technical Chamber of Greece (TEE-TCG)] (http://portal.tee.gr/portal/page/portal/mhtrwo/mitrwo/mix_search) or via specific websites˙ all receive the e-tool [https://docs.google.com/forms/d/13Jqon0HqwQaxMse6e42F_WSTBPFQIH74NyZvJwZib6M/edit] after phone communication either directly with them personally or after obtaining permission by one's affiliation contact person in charge. All agree a confirmed by them personal and/or professional email of theirs to be used.

Statistical comparisons are performed using the I.B.M. Statistical Package for the Social Sciences (I.B.M.® S.P.S.S.®), Version 25 [via the Aristotle University of Thessaloniki Students' License].

Conclusions are drawn and thoughts arise for further practical application and research.

CHAPTER 1st - INTRODUCTION

[1.1]. First comes "the Word" and the Art

Handedness had been very well conceptualized as a phenomenon and function, as corpus of writings and artefacts prove, centuries before scientific investigations were initiated.

Numerous references for it are encountered in literature, as in biblical accounts or other works, historic or art sources (e.g., sculptures, paintings, statues, byzantine icons). In the Old Testament Book of Judges, according to Perelle and Ehrman (1994), "a special slingshot unit of 700 left-handers" is referred. According to Kant Emmanuel (as cited in Klukowski, Wierzchowska, & Bielecki, 2007), "The hand is the external brain of the human being" (p. 461). Douka Maro in 2009 writes in one of her books "Always, whetever she started to do, she did it with the right hand, …". As an anonymous poet writes for the Kerrs' legend in Scotland (as cited in Harris, 2010), "the deadliest foes/That e'er to Englishmen were known/For they were all bred left-handed men/And fence against them there was none." (p. 26). An example of artwork, as referred in Klukowski et al. (2007) is presented in Appendix A.

[1.2]. Handedness

[1.2.1]. Introduction

The terms "handedness" and "hand preference" (see [2.1.2].) refer to the functional dominance of one hand, the preferred hand, over the other, the non-preferred one, in individuals and thus to the most frequent and effective usage of it in an action.

People using the right hand are labelled as "dextrals" and their handedness condition is called "dextrality" while people using the left hand are labelled as "sinistrals" and the handedness condition of theirs is called "sinistrality". Those who use either hand almost equally or equally are called "ambidextrals" or "ambidextrous" or "mixed" and the term "ambidexterity" is used for their handedness condition (Oldfield, 1971; Crowley, 1989; Wood & Aggleton, 1989; Cosenza & Mingoti, 1993; Preti & Vellante, 2007; Klukowski et al., 2007)[1].

Handedness is a multi-characteristic phenomenon, indicative aspects of which are the degree, the direction, the steadiness, the strength, the speed and the consistency [Annett, 1970; Annett, 1972; Briggs & Nebes (as cited in Raczkowski, Kalat, & Nebes, 1974); Humphrey, 1951; Crowley, 1989].

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[1]Other terms that are, also, used for the three cases are, respectively: "right-handed", "right-handers", "right-handedness", "left-handed", "left-handers", "left-handedness", "mixed handed" or "mixed-handed", "indeterminate handedness".

Handedness has been thoroughly examined for possible correlation with a number of variables such as cognitive abilities and generation (Ashton, 1982), birth order, according to Bakan as well as Coren and Porac (as cited in Ashton, 1982), birth stress, according to Bakan et al. (as cited in Ashton, 1982), parental, and more specifically maternal age, according to Coren and Porac (as cited in Ashton, 1982), maternal reporting[2] of birth stress, according to Coren and Porac (as cited in Ashton, 1982), other human body preferences, as for instance, eye preference, otherwise called eyedness, ear preference, otherwise called earedness, and foot preference, otherwise called footedness (Crowley, 1989), position of infant in birth canal, manual skill and personality (Crowley, 1989), being blonde/brunette as well as homosexuality, according to Geschwind and Galaburda (as cited in Crowley, 1989), brachial and ipsilateral ophthalmic artery pressure, according to Carmon and Gombos (as cited in Crowley, 1989), hair colour as well as learning disabilities, according to Schachter, Ransil, and Geschwind (as cited in Schachter & Ransil, 1996), schizophrenia, according to Dragovic and Hammond as well as Satz and Green as well as Sommer, Aleman, Ramsey, Bourna, and Kahn (as cited in Preti & Vellante, 2007), creativity according to Aggleton, Kentridge, and Good as well as Hassler and Gupta (as cited in Preti & Vellante, 2007).

[1.2.1.1]. Right-Handedness

Humans among dextrals who use only the right hand for all actions are referred in literature as “clearly right-handed”, “extremely right-handed”, “strongly right-handed”, “complete right-handers”, “fully dextrals” (Dumas & Morgan, 1975; Bryden, 1977; Schachter & Ransil, 1996; Preti & Vellante, 2007).

Inferences about dextrals drawn by researchers from data are of remarkable value and of great interest as they describe in detail a plethora of characteristics of the specific handedness group. Annett (1972) explained that “… the majority of right handers have consistent dextral preference and left-hemisphere representation of speech …” (p. 346). In Crowley (1989) it is said that “Most right-handers have the same general geographical layout of cerebral function. However, left-handers can be shown to have a more variable organization of such lateralized functions as speech or visuospatial skills.” (p. 2). Hicks and Kinsbourne (as cited in Crowley, 1989) demonstrated that “… right-handers are more lateralized than are left-handers.” (p. 33). Shanon (as cited in Crowley, 1989) concluded

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[2] “… (premature birth, prolonged labor, breech birth, “blue baby”, low birth weight, Caesarian birth, multiple births, Rh incompatibility, instrument birth, and other medical difficulties) …” (p. 136).

that “right-handers are more resistant to cultural pressure than left-handers.” (p. 35). As Carroll as well as Merrell (as cited in Crowley, 1989) observed, “About 70% of right-handers are also right-eyed; …” (p. 38). As Thomas and Campos (as cited in Crowley, 1989) found, “… the spatial performance of subjects who were said to be … or strongly right-handed was superior to those whose hand preference was less extreme.” (p. 40). Finally, as Mascie-Taylor (as cited in Crowley, 1989) reported, “Dextrals have been reported to be less neurotic than either left or mixed handers.” (p. 49).

Regarding the characteristics particularly within the group of dextrals descriptive inferences are also gleaned from research literature. As is written in Crowley (1989), “… the left hand has been found to be about 10% weaker than the right hand.” (p. 39). In addition, it is described in Crowley (1989) that “right-handers recall significantly more verbal stimuli from the right ear than from the left ear, …” (p. 38). According to LeMay (as cited in Crowley, 1989), “…, in right-handers, the left occipital lobe of the brain is wider and/or longer than the right.” (p. 13). According to Damon, Stoudt, and McFarland (as cited in Crowley, 1989), “…, the left leg is about 10% weaker than the right leg.” (p. 39). As Sheeran (as cited in Crowley, 1989) found, on novice marksmanship performance “… right-eye dominant dextrals had significantly higher scores than left-eye dominant dextrals.” (p. 42). Pendse (as cited in Crowley, 1989) found that, “… right-handed females are superior using the right nostril.” (p. 38).

[1.2.1.2]. Left-Handedness

Literature, analogously, refers to individuals among sinistrals who use only the left hand for all actions as “clearly left-handed”, “extremely left-handed”, “strongly left-handed”, “completely left-handers”, “fully sinistrals” [Enslin in Miles (as cited in Downey, 1933); Bryden, 1977; Oldfield, 1969; Provins & Cunliffe, 1972; Preti & Vellante, 2007].

A number of details about the sinistrals group complete fairly enough the picture of handedness in humans. More precisely, as Annett (1972) clarified a previous analysis of hers, “the majority of ‘left’ handers reported in the literature probably have inconsistent preferences and a facility for developing speech in either hemisphere.” (p. 346). Geschwind and Behan (as cited in Crowley, 1989) “have found higher rates of dyslexia and stuttering among strong left-handers than among strong right-handers.” (p. 23). According to Levy’s contention (as cited in Crowley, 1989), “left-handers possess superior language ability.” (p. 42). As in the Bradshaw, Nettleton, and Taylor’s study as well as in the Briggs, Nebes, and Kinsbourne’s study (as cited in Crowley, 1989) has been respectively reported, “familial sinistrals do worse on the Wechsler Adult Intelligence Scale (WAIS) performance subscale, and the full-scale WAIS score.” (p. 42). According to observations by Kilshaw and Annett as well as Peters (as cited in Crowley, 1989), “Left-handers usually display smaller differences in performance and

strength between the two hands than right-handers." (p. 40). As Carroll as well as Merrell (as cited in Crowley, 1989) observed, "… among left-handers, left-eyedness occurs only in about half." (p. 38). As Reiter (as cited in Crowley, 1989) found, "left-handers are significantly higher in socialization than right-handers." (p. 47). According to Tisserand (as cited in Crowley, 1989), "…significantly more patients with cleft lip are left-handed than controls." (p. 48).

Within the group of sinistrals in particular the following characteristics are further noticed in literature. As Bear, Schiff, Saver, Greenberg, and Freeman as well as Kertesz, Black, Polk, and Howell as well as Le May and Kido (as cited in Schachter & Ransil, 1996) suggest in their studies, "… lefthandedness is associated with nearly symmetrical development of the frontal and occipital lobes." (p. 62). As it is described in Crowley (1989) "right-handers recall significantly more verbal stimuli from the right ear than from the left ear, whereas left-handers as a group show smaller differences between the ears." (p. 38). As Reijs (as cited in Crowley, 1989) found, "30% of left-handers had a stronger grip in the right hand." (p. 39).

Aspects of interest of the left-handedness issue, having already attracted researchers' attention, are the higher incidence of left-handedness in children's population as compared with previous generation's one due to under-reported data by subjects, according to Ramaley (as cited in Ashton, 1982), or as other researchers suggest, cultural pressures' gradual slackening over the years (Ashton, 1982) or diminishing of initial left-handedness index throughout one's life, according to McGee and Cozad (as cited in Ashton, 1982), the different left-handedness incidence between males and females due to genetic mechanisms or social conformism or research methodology reasons˙ explanations are thriving (Annett, 1972; Bryden, 1977), left-handedness in families as it results from both mating types and maternal influence (Annett, 1972; Ashton, 1982), and, finally, the association of left-handedness with numberless variables such as epilepsy and autism, according to Bishop (as cited in USAFAM, 1989), immune disorders, according to Geschwind and Behan (as cited in Crowley, 1989), increased sports injuries, according to Bhairo, Nijsten, Van Dalen, and Ten Duis (as cited in Adusumilli, Kell, Chang, Tuorto, & Leitman, 2004) and motor vehicle accidents, according to Coren (as cited in Adusumilli et al., 2004)˙ all variables are encountered in human being's everyday life.

[1.2.2]. Theories

Numerous theories have been proposed by theorists regarding origin and prevalence of handedness in humans˙ a complex condition.

Handedness theories of differential perspective lay concomitantly on a time continuum on which prior[3] theories and more up-to-date ones are positioned as well as on an influential factor continuum on which biological and environmental theories are set (Ashton, 1982; Crowley, 1989). Biological theories include besides others the genetic, the hormonal and the somatic maturation rate theories (Papadatou-Pastou et al., 2008). Environmental theories focus on crucial factors influencing hand preference development such as, for example, the exposure to exogenous chemicals, according to Gordon (as cited in USASFAM, 1989).

No matter their theoretical perspective the blood supply of the brain theory by Leuddeckens (1900), Lombroso (1903) and Judd (1911), the Cunningham's superior development of one cerebral hemisphere theory (1902) as well as the Gould's ocular dominance theory (1908) (Schiller, no date), the Bakan's birth trauma (1971, 1977)/brain's oxygen deprivation at birth theory (1971, 1977, 1978), the Levy and Nagylaki's two-locus model (1972) as well as the Morgan and Corballis' non-genetic theory (1978) (Ashton, 1982), the Annett's right shift (RS) theory (1972) (Cosenza & Mingoti, 1993; Papadatou-Pastou et al., 2008), the Geschwind and Behan's theory (1984) (Casey & Nuttall, 1990), the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b, 1986) (Casey & Nuttall, 1990; Holtzen, 2000; Papadatou-Pastou et al., 2008), the McManus and Bryden's modifier-gene theory (1992) as well as the Jones G. V. and Martin's recessive model (2000) (Papadatou-Pastou et al., 2008) illustrate the continuously expanding mosaic of the views on handedness in science· combinations' variations are suggested and prove to be endless.

A number of practical key-points are highlighted so as to deeper and more clearly comprehend how this "world" of theories is constructed and functions. As subsequently proved, the anterior communicating artery part of the "arch of Willys" allows for equal quantity of blood to both hemispheres and hence the blood supply of the brain theory has been discredited (Schiller, no date). Furthermore, the most influential theories of all are the Annett's right shift (RS) theory (1972) and the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b) (Cosenza & Mingoti, 1993). In addition, the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b, 1986) is in fact an extension of the originally proposed Geschwind and Behan's theory (1984) (Casey & Nuttall, 1990) as well as the mirror of Annett's right shift theory (Crowley, 1989). Finally, this theory has been tested indirectly by investigating left-handedness and enhanced performance in groups of athletes in specific sports (e.g., fencing, tennis) (Holtzen, 2000) and many psychological

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[3]Prior ways of thinking attribute handedness to primitive warfare or the act of nursing (Pyykönen, 2015) as well as to musculoskeletal system, according to Schaeffer (as cited in Crowley, 1989).

phenomena such as “special talents”, “masculinity/feminity”, “sex role orientation” seem to be explained on the basis of it.

[1.2.3]. Measurement

Handedness has been assessed on the basis of divergent methodologies, quantitative and/or qualitative.

Measurement tools that have more or less been employed are the inventories - questionnaires, the performance tasks, the self-report single question/statement, the direct observation, the subject’s “writing hand” or “bowling hand” or “batting hand” as the preferred hand (Peterson & Lansky, 1974; Ashton, 1982; Crowley, 1989; Wood & Aggleton, 1989; Aggleton, Bland, Kentridge, & Neave, 1994).

Inventories - Questionnaires that have been administered to research subjects include the Jasper’s Handedness Inventory (Jasper, 1932; Annett, 1970), the Test for Handedness (Crovitz & Zener, 1962), the Questionnaire including “handedness inventory” used by Oldfield in musicians (Oldfield, 1969), the Hand-Preference Questionnaire (Annett, 1970), the Handedness Inventory (Oldfield, 1971), the Edinburgh Handedness Inventory (E.H.I.) (Oldfield, 1971), the Handedness Questionnaire used by Raczkowski et al. in undergraduates, Duke University (Raczkowski et al., 1974), the Handedness Inventory developed by Bryden in 1977 (as cited in Sandry & Wickens, 1982), the Handedness Questionnaire used by Pipraiya and Chowdhary in 2006 [R. Pipraiya, personal communication (e-mail), January 26, 2018, 15.49], the Fazio Laterality Inventory (F.L.I.) (Fazio, Dunham, Griswold, & Denney, 2013). In addition, many other tools such as Durost’s (1934), Hull’s (1936), Humphrey’s (1951) have also been used in assessments (Oldfield, 1971).

Performance tasks, an alternative, more realistic and objective approach, which have been used in research besides other include the task of pressing a dynamometer by either hand, in which strength was measured (Annett, 1972), the tracking task, in which accuracy was investigated in 1952, according to Simon, DeCrow, Lincoln, and Smith (as cited in Crowley, 1989), the task of moving dowelling pegs from one row to another having measured time difference between hands, according to Annett (as cited in Annett, 1972), the tasks of performing a handedness initial questionnaire’s (Q1) items, in other words, a handedness questionnaire item-based performance tasks, after experimenter’s instructions had been given (Raczkowski et al., 1974), the task of tapping, in which speed was measured, according to Bryden (as cited in Crowley, 1989) as well as the match-sorting task, at the end of which total transfer time was calculated for each hand separately (Bishop, 1984).

Self-report single questions are included in the (a), (c), (e) and (h) inventories - questionnaires (see Appendix B). “I am totally left-handed” (Peterson & Lansky, 1974) or “I believe myself to be: Left-handed” (Fazio et al., 2013) are self-report statements provided along with two additional choices in both cases to be checked or not by research subjects.

Direct observation is, according to Crowley (1989), “The most meaningful method of assessment… This…, … can become expensive and time consuming.” (p. 30).

Special attention should be drawn on the “writing hand” method due to problems arisen from social pressure on hand usage.

Following elements clarify the most what pragmatically occurs in the above-stated fascinating and complicated “world” of measuring. To begin with, the Hand-Preference Questionnaire (Annett, 1970), according to Annett as well as Bishop (as cited in Preti & Vellante, 2007), “… is one of the most commonly used and highly respected inventories…” (p. 840). In addition, most inventories result in a “laterality quotient” (LQ) for each subject, a number on handedness continuum (Crowley, 1989). Moreover, according to Crowley (1989), “… generally a … questionnaire asks subjects to state which hand they prefer to use for a set of common activities.” (p. 30) as well as “The nature and number of questions varies from inventory to inventory, …”[4] (p. 30) while Oldfield (1971) stated that, “… *any* set of items afford a view of handedness…” (p. 104). Furthermore, item No 11, “Tennis Racket”, in the Handedness Inventory (Oldfield, 1971), found to be unanswerable by Oldfield’s undergraduate subjects as well as by Dr Newcombe’s patients (Oldfield, 1971). What is more, using different measurement tools seems to result in dissimilar left-handedness incidences regarding sexes (Cosenza & Mingoti, 1993). Additionally, adapting original questionnaires is an established practice in research, an example of which is the Handedness Questionnaire used by Pipraiya and Chowdhary in 2006. Finally, as Fazio et al. (2013) pointed up, “The E.H.I. has some weaknesses: … is outdated; the instructions are frequently misunderstood…; and the response format produces skewed responses in those who…” (p. 197).

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[4]See Appendix B for a comparative look.

[1.2.4]. History

Of historical importance unfolds the issue of man's perception along with behaviour alteration towards left-handedness in the course of time. As Herron (1980) describes, left-handers were "Derided, chided — the offending hand smacked with a ruler, even tied behind the back. Shamed and blamed, …" (p. xiii). Godfrey, according to Harris (2010), named left-handers "… undesired Race…" (p. 39). The last decades there has been constant attentiveness to the left-handed people's needs and our era, nowadays, - nevertheless, discriminating and contemptuous attitudes of the past still exist - presents a wide range of specially and very sophisticatedly designed tools for their everyday, educational and/or professional life, such as scissors for children, https://www.anythinglefthanded.co.uk/acatalog/childs_scissors.html or rulers for children, https://www.anythinglefthanded.co.uk/acatalog/child_left_handed_rulers.html as well as professional surgical scissors or professional needle holders for surgeons (Burdett, Theakston, Dunning, Goodwin, & Kendall, 2016).

Table 1 depicts, indicatively, handedness research from a chronological viewpoint.

Table 1: History of Handedness Research

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
Oldfield, 1969	Left-handedness prevalence. Left-handedness and any possible difficulty faced. Musicians.	The Questionnaire including "handedness inventory" used by Oldfield in musicians.	No statistically significant difference. No special difficulty was faced by musicians.
Peterson & Lansky, 1974	Left-handedness incidence. Architects.	Three statements [totally left-handed, either hand equally, totally right-handed].	29,4% of male faculty architects were left-handed˙ two right-handed were left-handers as children. Architecture students' percentages of left-handedness ranged between 10,8% (min., 1st y.) to 23,9% (max., 4th y.). Freshmen's percentage did not differ a lot from the maximum one of the "normal" population and in each of all years later it was higher enough than in the first year.
Peterson & Lansky, 1974	Left-handedness and spatial flexibility. Architects.	Three statements [totally left-handed, either hand equally, totally right-handed]. Design task: to design a space maze.	Left-handed architecture students did better than right-handed ones in terms of correctness of design (χ^2=12.95, df=1, p<.001).
Byrne, 1974	Handedness pattern. Musicians.	Short form of the Edinburgh Handedness Inventory (E.H.I.) (Oldfield, 1971).	Excess of mixed-handed musical students, instrumentalists. Statistically significant difference (χ^2=4.078, p<.05).
Byrne, 1974	Handedness, bilateral language representation and certain musical abilities. Subjects.	Short form of the Edinburgh Handedness Inventory (E.H.I.) (Oldfield, 1971). Seashore battery subtests: Timbre and Tonal Memory. A.C.E.R. AL Test (Verbal Intelligence).	No statistically significant difference.
Sandry & Wickens, 1982	A model for stimulus-response compatibility as well as resource competition, especially as far as it concerns verbal and spatial tasks, in an F-18 flight simulator. Pilots.	Bryden (1977) Inventory. Crovitz and Zener (1962) Inventory.	Model was upheld.
Bisiacchi, Ripoll, Stein, Simonet, & Azémar, 1985	Handedness and performance. Fencers.	Oldfield's Questionnaire (1971). Attentional Reaction Time (R.T.) task: to respond to the onset of a Light Emitting Diode (L.E.D.).	Statistically significant difference ($F_{1, 20}$=21.2, p<.01, $F_{2, 40}$=4.95, p<.05, t=2.73, p<.05). Left-handed fencers error rate was 4.86%˙ the least percentage of all.

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
Wood & Aggleton, 1989	Left-handedness in "fast ball" sport tennis. Professional tennis players.	Preferred hand to hold a racquet.	Both males and females in all cases examined [1. all professionals by year, 2. top 100 professionals by year, 3. N_m & N_f] showed higher percentages in left-handedness than the control group. Statistically significant differences (χ_2=3.14, df=1, p<.05: 1981, top 100 male professional tennis players; χ_2=3.45, df=1, p<.05: 1987, all male professional tennis players; χ_2=2.72, df=1, p<.05: 1981, all female professional tennis players). No differences were found (a) between the two halves of the rankings, (b) between the top 25 of the rankings, and, (c) between the top four of the rankings, for any of the above years.
Wood & Aggleton, 1989	Left-handedness in "fast ball" sport cricket. Professional cricketers.	Bowling hand. Batting hand(edness). 10-item Edinburgh Handedness Inventory (Oldfield, 1971).	**Bowlers:** Left-handedness incidence range in all years examined: 15.3%-26.1%. Statistically significant differences (χ_2=11.40, df=1, p<.001: 1949; χ_2=5.37, df=1, p<.025: 1961; χ_2=21.18, df=1, p<.001: 1973; χ_2=8.09, df=1, p<.005: 1985). Comparison group I: school age (11-18 ys) boys. Statistically significant differences (χ_2=3.51, df=1, p<.05: 1937; min χ_2=7.24, df=1, p<.005: 1949-1986). Comparison based on item "throwing a ball". No statistically significant difference (χ_2=2.46, df=1, .1>p>.05: 1937). Comparison group I. No statistically significant differences were found between two halves of bowling averages (χ_2=1.28, df=1: 1937; χ_2=.14, df=1: 1949; χ_2=1.13, df=1: 1961; χ_2=2.38, df=1: 1985; χ_2=.98, df=1: 1973), for any season examined. **Batsmen:** The proportion of left-handers was greater in the middle third of combined career averages than in the top third. Measure [a]: Bowling hand.

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
			Proportion of players batting left-handed since 1949: 18.7%-19.6%. Measure [b]: Batting hand. Statistically significant difference (χ_2=5.26, df=1, p<.025: top two thirds). Comparison group I. Statistically significant difference (χ_2=8.49, df=1, p<.005: top two thirds). Comparison based on item “throwing a ball”. Statistically significant differences (min. χ_2=14.24, df=1, p<.001; since 1949, players batting L-H, in every season examined; min. χ_2=4.77, df=1, p<.025: since 1949, top two thirds/top half/top one third, for every season examined). Comparison group I. Measure [b]. No statistically significant differences (χ_2=.62, df=1: upper half; χ_2=.35, df=1: top one third). Comparison group I. No statistically significant differences (χ_2=1.21, df=1: upper half; χ_2=.68, df=1: top one third). Comparison based on item “throwing a ball”. No statistically significant differences (t=1.22, df=29.2, p=.23: players batting L-H & bowling L-H *vs* players batting L-H & bowling R-H; t=1.31, df=297, p=.19: players batting R-H & bowling R-H *vs* players batting R-H & bowling L-H) in upper two thirds. No statistically significant differences of same groups of players above in top half and in top third (min p=.24). No statistically significant differences were found between top and middle third of combined career averages (χ_2=3.02, df=1).

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
Wood & Aggleton, 1989	Left-handedness in "fast ball" sport football (soccer). Professional football (soccer) goalkeepers.	A questionnaire containing the original 22-item version of the Handedness Inventory (Oldfield, 1969) and 2 additional questions on importance attached to laterality.	Statistically significant differences in some comparisons either by the R-L-E χ_2 analysis or by the R - Non-R one. Statistically significant difference (χ_2=6.78, df=2, p<.05: preference of left-handed goalkeepers for the direction of shots). No statistically significant difference (χ_2=.94, df=2: preference of goalkeepers for the direction of crosses).
Götestam, 1990	Left-handedness - along with reading problems, dyslexia, stuttering and twinning -. Students of Architecture. Students of Music: instrument players and choir members.	A four-questions [writing, throwing a ball, threading a needle, kicking a ball], 3-point scale [3 responds: always right, either right or left, always left] measure.	No results for twinning. **Students of Architecture:** Highest frequency of "Lefts" among all groups (5%). Highest frequency of "always left" writing among three groups (13.3%). Statistical significant values emerged between (a) left-handedness and reading problems (φ=-.299, p<.10), (b) left-handedness and dyslexia (φ=-.279, p<.10), and (c) left-handedness and stuttering (φ=.316, p<.05). **Students of Music:** Highest frequency of choir members among three groups (64.3%). Highest frequency of "always right" writing among three groups (89.8%). Highest frequency of "Rights" among three groups (21.7%). Statistical significant difference was observed in choir membership between students of music and control group. Statistical significant values emerged between (a) left-handedness and reading problems (φ=-.247, p<.10), (b) left-handedness and dyslexia (φ=.230, p<.10), and (c) left-handedness and stuttering (φ=-.261, p<.05).

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
Cosenza & Mingoti, 1993	Handedness patterns. Differences in laterality. Among all professional courses of the Federal University of Minas Gerais (State of Minas Gerais, Brazil), who had been asked to participate in the questionnaire-based research, applicants (a) the respondents and (b) the finally admitted respondents.	The 10-question short version of the Edinburgh Handedness Inventory (E.H.I.).	**University all professional courses' applicants:** Left-handed [L.Q.=<0]: 7.91%. Statistically significant difference [χ_2=17.13, df=1, p<.0001: left-handedness by sex, males (8.89%), females (7.14%)]. Statistical significant difference was observed in left-handedness incidence in laterality quotient distributions in university professional courses offered grouping [3 clusters]˙ excess of left-handedness was observed for the Statistics course (20.29%) as well as for the Music course (20.00%). Statistical significant difference was observed in left-handedness incidence in laterality quotient distributions in three areas of knowledge grouping [4 classes]˙ the highest percentage of left-handers was observed in the Mathematical Sciences area of knowledge (6.26%) and the lowest in the Humanities area of knowledge (4.80%). Statistical significant difference [χ_2=26.346, df=12, p<.01: left-handedness incidence in laterality quotient distributions in five blocks of (related) occupations grouping [4 classes]]˙ the Mathematical block of (related) occupations and the Verbal block of (related) occupations are the ones being responsible for statistical difference (χ_2=17.236, df=3, p<.001). **The finally admitted applicants:** More left-handers [L.Q.=≤0] were observed in each of the three areas of knowledge in comparison with the right-handers. More left-handers [L.Q.=≤0] were observed in each of the five blocks of (related) occupations in comparison with the right-handers. No statistically significant difference [χ_2=3.762, df=6, p=.7088: left-handedness

Researcher(s)/Date[yr]	Research Topic(s) Research Subject(s)	Measurement Tool(s)	Result(s)
			incidence in laterality quotient distributions in three areas of knowledge grouping [4 classes]]. No statistically significant difference [χ_2=10.338, df=12, p=.0586: left-handedness incidence in laterality quotient distributions in five blocks of (related) occupations grouping [4 classes]. **Comparison between the university all professional courses' applicants and the finally admitted ones:** Higher proportion of left-handers was observed in the finally admitted applicants (9.43%) in comparison with the university all professional courses' applicants (7.91%)˙ analogous observation was made for each of the two sexes separately. Statistical significant difference was observed in left-handedness incidence in laterality quotient distributions [20 classes]˙ no statistically significant differences were observed when same comparisons were made for each sex separately.
Christman, 1993	Handedness and bimanual musical instrument playing. Musicians.	The 10-item Edinburgh Handedness Inventory (E.H.I.). Questions on: - principal instrument - familial sinistrality.	Statistically significant difference between integrated and independent instruments in degree of handedness˙ weaker degree for the first group. Analysis I: [F(1, 161)=4.98, p<.03]. Analysis II: χ_2=3.123, p<.08, χ_2=6.985, p<.01. [different cut-off point in each χ_2 analysis case]. No statistically significant difference between integrated and independent instruments in direction of handedness [F<1], (χ_2=.451, p>.50). No statistically significant difference between woodwind and string instruments in degree of handedness. Analysis a: [F(1, 80)=1.45, p>.20]. Analysis b: [F<1].

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
			[LQ and absolute value score computation, respectively].
Aggleton et al., 1994	Handedness and longevity. First class male cricketers.	Bowling hand. Terms descriptive restrictedly of right-handed players: bowling “off break”, bowling “leg break”, bowling “leg break googly”.	No statistically significant relation was observed between handedness and longevity. Left-handedness association with serious accidents/unnatural death is further explained due to warfare conditions.
Schott & Puttick, 1995	Left-handedness influence on a doctor’s career choice. A group of physicians and surgeons.	Questionnaire.	No left-handedness incidence was observed at all, that is none of the 36 surgeons was left-handed.
Schachter & Ransil, 1996	Relationship between handedness and professions. Professional group of accountants. Professional group of architects. Professional group of dentists. Professional group of lawyers. Professional group of librarians. Professional group of mathematicians. Professional group of orthodontists. Professional group of orthop(a)edic surgeons. Professional group of psychiatrists.	A modified version of the 10-item Edinburgh Handedness Inventory (E.H.I.) - a five scale one [5 responds: always left, usually left, no preference, usually right, always right] - and a self-report global handedness question, containing three statements [righthanded, ambidextrous, lefthanded]. Questions about original hair colour, history of learning disabilities.	**Architects:** They were the most left-handed among the nine professions: E.H.I. laterality score (weighted average total mean): 41.82 (min.: 41.82, max.: 45.13)˙ highest left relative frequency (.1757) as well as highest left laterality index (3.46) of all in the self-reported global handedness question. They were found to be: - the most right-handed of all in the item related to scissors. - the most left-handed of all in the items related to (a) draw, (b) throw, (c) toothbrush, (d) match, (e) box/lid. They showed the least right relative frequency (.7770) and the least right laterality index (36.89) of all in the self-reported global handedness question. **Librarians:** They were: - of the most right-handed (2nd in turn) professions among the nine examined: E.H.I. laterality score (weighted average total mean): *44.98* (min.: 41.82, max.: 45.13). - the most right-handed in comparison with the co-classified professions in the verbal skills category of professions. - the first among the nine professions to be “completely right-handed” (L.Q.=50) [*f*(50)=52.5] (min.: 27.6,

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
			max.: 52.5). - the only profession of all in which over half [*f*(50)=52.5] of the professionals were found to be “completely right-handed”. They were found to be the most right-handed of all in the items related to (a) scissors, (b) knife, (c) broom. They showed the highest right laterality score (*48.49*) and the lowest ambilateral relative frequency (.0125) as well as the lowest ambilateral laterality index (.41) of all in the self-reported global handedness question. **Orthop(a)edic surgeons:** They were: - the most right-handed among the nine professions: E.H.I. laterality score (weighted average total mean): *45.13* (min.: 41.82, max.: 45.13). - the most right-handed among the co-classified professions in the bimanual fine motor skills category of professions. They were found to be the most right-handed of all in items related to (a) draw, (b) write, (c) throw, (d) toothbrush, (e) spoon, (f) box/lid. They showed the highest ambilateral laterality score (36.17), the least right laterality score (46.93), the least left laterality score (12.40) as well as the highest right relative frequency (.9166), the least left relative frequency (.0379) and, the least left laterality index (.47) of all in the self-reported global handedness question. For results of other professional groups, please, see paper.

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
Grouios, Tsorbatzoudis, Alexandris, & Barkoukis, 2000	Left-handedness and factors associated with it. Sporting competitors: class A (very good) athletes in northern Greece of both interactive - direct and indirect - and non interactive sports.	The Briggs and Nebes' (1975) 12-item Handedness Inventory, a 5-point scale one [5 responds: always left, usually left, no preference, usually right, always right].	Fencing Athletes: left-handedness incidence [total sample: *37.7%*, male: *42.9%*, female: *33.3%*]. Tennis Players: left-handedness incidence [total sample: *17.3%*, male: *18.2%*, female: *16.6%*]. For percentages of other sports players, please, see paper. Statistically significant difference in left-handedness incidence between sporting competitors and nonsporting university students˙ higher incidence was observed in the first group (*14.8%*), (χ^2=18.07, p<.001). Statistically significant difference in left-handedness incidence between interactive sporting competitors and non interactive sporting competitors˙ higher incidence was observed in the first group (*19.6%*), (χ^2=21.6, p<.001). Statistically significant difference in left-handedness incidence between direct interactive sporting competitors and indirect interactive sporting competitors˙ higher incidence was observed in the first group (*25.1%*), (χ^2=17.7, p<.001).
Holtzen, 2000	Left-handedness incidence. A group of professional tennis players.	Compiled from different sources (e.g., six internet tennis websites, Wood & Aggleton, 1989, archival sources) data set of handedness information (plays/playing hand, preferred hand to hold a racquet, handedness usage) covering totally a 32 years (1968-1999) time period.	Neither male (χ^2=3.133, df=1, p=ns) nor female (χ^2=.111, df=1, p=ns) professional tennis players showed statistically significant difference in incidence of left-handedness with comparison to the general population. High classification left-handed professional tennis players showed a statistically significant over-representation with comparison to the respective right-handed ones (according to 38 out of 40 tests of association, both sexes).
Grantcharov, Bardram, Funch-Jensen, & Rosenberg, 2003	Impact of gender, hand dominance and experience with computer games on a surgeon's operative psychomotor performance.	The Minimally Invasive Surgical Trainer - Virtual Reality (M.I.S.T.-V.R.), Mentice Medical Simulator, with six, specific in nature tasks. Parameters measured: time,	Statistical significant difference between left-handed surgeons and right-handed ones in favour of the latter (Mann-Whitney test, p=.045).

History of Handedness Research			
Researcher(s)/Date[yr]	**Research Topic(s)** **Research Subject(s)**	**Measurement Tool(s)**	**Result(s)**
	Sample of surgical residents (surgeons in training).	errors, and number of unnecessary movements.	
Adusumilli et al., 2004	Perceptions of left-handed surgeons with regard to both surgery training and practice. Left-handed (pure left-handed and ambidextrous) surgeons, who served either general surgery or other surgical specialties.	Contact information for left-handed surgeons were obtained from colleagues. A web-based survey (www.geocities.com/ lefthandsurgeon).	Results and conclusions presented in detail are of great and particular significance for the surgeon-world, both the administration and the personnel.
Pipraiya & Chowdhary, 2006	Handedness. A section of pilots of the Indian Air Force.	An adapted from the Edinburgh Handedness Inventory (E.H.I.) questionnaire.	Left-handedness incidence (7.39%) found was as the one of the general population. Mixed-handedness incidence observed: 26.848%. Relative mixed-handedness incidence: 84.2%: left-handed pilots, 21.9%: right-handed pilots.
Preti & Vellante, 2007	Unusual subjective experiences' relation to non-right handedness in creative artists taking into account psychological distress as well as psychoactive substance use. Along with other two professional groups of creative artists, painters and writers - musicians.	The Annett Hand Preference Questionnaire (H.P.Q.).	**Musicians**: 2 ambidextral (6.666%), 3 fully sinistral (10%) subjects. Conditional greater indirect effect (t=2.30, p=.021) of the mixed-handed. Handedness does not interact with psychoactive substance use so as to explain unusual subjective experiences.

Many more handedness studies have been contacted throughout research history and at this point as far as we can catalogue them they are merely presented: Raczkowski et al. (1974), Bryden (1977), Klukowski et al. (2007), Puterman et al. (2010).

Tracking handedness research the next, in brief given, points are underscored: (a) familial history of sinistrality has a unique role in one's life, (b) the percentage of either right-handedness or left-handedness is approximately the same in global scale, (c) research presupposes a substantial amount of handedness data to exist, which does not seem to be a given reality for many professions˙ tennis and cricket are very well recorded, aviation industry has started officially recording handedness the last decades, left-handed surgeons' databases have not always been available.

[1.3]. Handedness and Professions

[1.3.1]. Introduction

Handedness in professions emerged in research as a topic decades ago and since then it has been systematically studied, as literature shows (see Table 1).

Attention of researchers has been drawn to the existence of possible relationship between handedness patterns and performance at work.

Accountants (Schachter & Ransil, 1996), architects (Schachter & Ransil, 1996), aviators (Crowley, 1989), professional/first class (county) cricketers (Wood & Aggleton, 1989; Aggleton, Bland, Kentridge, & Neave, 1994), dentists (Schachter & Ransil, 1996), professional football (soccer) goalkeepers (Wood & Aggleton, 1989), elite ice hockey players/expert hockey players/skating players (Puterman, Baker, & Schorer, 2010), lawyers (Schachter & Ransil, 1996), librarians (Schachter & Ransil, 1996), mathematicians (Schachter & Ransil, 1996), musicians (Preti & Vellante, 2007), orthodontists (Schachter & Ransil, 1996), painters (Preti & Vellante, 2007), psychiatrists (Schachter & Ransil, 1996), surgeons (Adusumilli et al., 2004), orthop(a)edic surgeons (Schachter & Ransil, 1996), professional (singles) tennis players (Wood & Aggleton, 1989; Holtzen, 2000), writers (Preti & Vellante, 2007) are among the professions that have been examined.

We should at this point take into serious consideration the fact that in relevant research the term “handedness” has been deemed to be closely related or of analogous quality (e.g., a “manifestation” of, a “marker” of) to the terms “cerebral lateralisation of functions” (Cosenza & Mingoti, 1993), “hemispheric predominance”, “hemispheric laterality”, “cerebral asymmetry”, “cerebral laterality” (Crowley, 1989) and additional others. Much criticism has been made on this (Crowley, 1989). According to my opinion, findings must always be separately and clearly presented, as follows:

a. as far as it concerns strictly “handedness and profession(s)/occupation(s)” association:

(i). Crowley (1989) refers to as in several studies shown “an elevated rate of non-right-handedness in certain occupations, several of which require an increased use of spatial talents.” (p. 43).

b. as far as it concerns “hemisphericity/hemispheric predominance/cerebral asymmetry/cerebral lateralisation of functions, etc. and profession(s)/occupation(s)” association:

(i). as Crowley (1989) writes “bank employees in supervisory positions or with complex clerical duties performed better on tests of visuospatial skills.” (p. 44).

(ii). as Crowley (1989) writes “in managers of a health care facility, job ratings correlated with visuospatial performance and job complexity.” (p. 44-45).

(iii). as Crowley (1989) writes “managers in a major airline with higher verbosequential skills who were controlling greater numbers of people and services, received higher performance ratings from their supervisors.” (p. 45).

In “Handedness in professions” topic the centre and lion’s share of attention has steadily been the left-handedness part of it˙ on some circumstances, co-examined with footedness [e.g., in surgeons (Adusumilli et al., 2004)] and/or eyedness of professionals, according to Augustyn & Peters (as cited in Adusumilli et al., 2004).

Essentiality in parallel with practicality lie underneath the topic.

[1.3.2]. Left-Handedness in Professions

Left-handedness, according to literature, in the nine target professions of this work is presented below. Namely:

[1.3.2.1]. Architectural Engineers

“Architects have been particularly well-studied” (p. 52) as Schachter and Ransil (1996) underline. A higher incidence - either in comparison with the “normally” expected one or among a number of co-studied professions - of left-handedness has been found[5] in professionals in architecture (Peterson & Lansky, 1974; Schachter & Ransil, 1996).

A number of hypotheses, on that basis, has long before arisen (e.g., developed spatial or visuospatial skills in left-handers, harmonically influenced cerebral hemispheres’ relative growth and talents). In terms of statistical significance, Wood and Aggleton (1991)[6] “found no evidence of an abnormal proportion of left-handers among either qualified architects…” (p. 398).

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[5] 29.4% (17 full-time male faculty members/architects) (Peterson & Lansky, 1974).

Weighted average total mean laterality score [modified 10-item E.H.I. inventory]: 41.82% (min.: 41.82, max.: 45.13) and relative frequency f(r) [Self-reported global handedness question]: .1757 (min.: .379, max.: .1757). (148 architects from regional or national directories) (Schachter & Ransil, 1996).

[6] 10.2% [236 male fully qualified architects from thirty one (31) architectural firms] (Wood & Aggleton, 1991).

[1.3.2.2]. Fencing Athletes

An astonishing excess of left-handedness incidence in the sport of fencing is documented in detail[7a] in literature - the more advanced the level of competition, the higher[7b] the incidence [Clermont-Ferrand (as cited in Bisiacchi, Ripoll, Stein, Simonet, and Azémar, 1985); Azémar, Ripoll, Simonet, and Stein (as cited in Wood & Aggleton, 1989); Hécaen (as cited in Flor-Henry, 1990)/Chapter 14, In S. Coren (Ed.); Azémar et al. (as cited in Raymond, Pontier, Dufour, and Møller, 1996); Azémar and Stein (as cited in Raymond, Pontier, Dufour, and Møller, 1996); Grouios, Tsorbatzoudis, Alexandris, and Barkoukis, 2000; Azémar, Stein, and Boulinguez (as cited in Grouios, 2004); Azémar, Ripoll, Simonet et al. (as cited in Roi & Bianchedi, 2008); Rossi and Salmaso (as cited in Roi & Bianchedi, 2008); Roi and Bianchedi, 2008; Azémar (as cited in Harris, 2010)].

Two hypotheses have for long been thoroughly analysed with regard to the extraordinary rates of left-handedness in the sport of "Gentlemen": (a) the hypothesis of innate superiority [Azémar et al. (as cited in Grouios, 2004); Taddei, Viggiano, and Mecacci (as cited in Grouios, 2004); Azémar et al. (as cited in Grouios, 2004)] (e.g., superior right-hemispheric abilities, including superior spatiomotor skills, difference of neural correlates of visuospatial functions between left-handed and right-handed athletes, functional cerebral asymmetries affect sensorimotor processing and performance in opposition sports), (b) the hypothesis of strategic advantage [Grouios et al. (as cited in Grouios, 2004)] (tactical or strategic nature of the sporting activity, e.g., bowling style).

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[7a, 7b]Quarter finalists: 100% (4 male) and 50% (2 female) [fencers], 25% (1) [sword], 25% (1) [sabre] {World Fencing Championship (W.F.C.), 1981} [Clermont-Ferrand (as cited in Bisiacchi, Ripoll, Stein, Simonet, & Azémar, 1985]. All Competitors [sabre]: (12) 12.5%. For a complete picture of "All Competitors" and "Entrants to Finals" percentages data ([fencers], [sword], [sabre]), please, see same reference, Table 1 (p. 507).

35% (127 male entrants) and 32.3% (102 female entrants) [foil competition], 24.2% (130 male) [épée events], 12.5% (n=95) [sabre] {World Championships, 1981} [Azémar, Ripoll, Simonet, & Stein (as cited in Wood & Aggleton, 1989)].

100% (top 8 places) {Mexico games, 1979}, 100% (top 8 places) {Moscow Olympics, 1980. Increase proportionally with ranking: 48% (in first 25), 80% (in first 10), 100% (in first 4) {1980} as well as similar trends {World Championships, 1981} [Hécaen (as cited in Flor-Henry, 1990)/Chapter 14, In S. Coren (Ed.)].

55% (20 male) {French National Team, 1965} [Azémar et al. (as cited in Raymond, Pontier, Dufour, & Møller, 1996)].

23.9% (879 registered male champions) and 37.5% (56 male, last 8) and 21.4% (145 registered female champions) and 37.5% (8 female, last 8) [sword] as well as 33.3% (807 registered male champions) and 50% (56 male, last 8) and 27% (659 registered female champions) and 33.9% (56 female, last 8) [foil] as well as 13.6% (550 registered male champions) and 12.5% (56 male, last 8) [sabre] {1979-1993 Champions} [Azémar & Stein (as cited in Raymond, Pontier, Dufour, & Møller, 1996)].

[1.3.2.3]. Librarians

"…, and librarians had the most righthanded average laterality scores." (p. 51) among nine professions co-examined in a statistical, comparative[8] study by Schachter and Ransil (1996). What is enthralling is that over half [*f*(50)=52.5] of the professionals were found to be for the inventory items "completely right-handed" (Schachter & Ransil, 1996). In addition, librarians were found to be the most right-handed of all in the items relating to (a) scissors, (b) knife, and (c) broom (Schachter & Ransil, 1996). Finally, they showed the lowest ambilateral relative frequency (.0125) as well as the lowest ambilateral laterality index (.41) of all in the self-reported global handedness question (Schachter & Ransil, 1996).

Hypotheses, in the case of librarians, concern left-hemisphere's dominance (Schachter & Ransil, 1996), and thus, verbal proficiency, according to Lau (as cited in Schachter & Ransil, 1996).

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(continues from page 35)

37.7% (23, 61 total sample), 42.9% (12 men) and 33.3% (11 women) (Grouios, Tsorbatzoudis, Alexandris, & Barkoukis, 2000). Comparison groups: non sporting undergraduate A.U.TH. students, non interactive sports athletes, indirect interactive sports athletes.

Regular increase from 30% (qualified) to 60% (winners) [épée and foil] {World Championships from 1979 to 1998} [Azémar, Stein, & Boulinguez (as cited in Grouios, 2004)].

41% (13 among 32 finalists) {World Championships, 1981}, 44% (14 among 32 finalists) {World Championships, 1982}, 50% (12 among 24 medalists) and 17% (1 among 6 winners) {World Championships, 2006} [Azémar, Ripoll, Simonet et al. (as cited in Roi & Bianchedi, 2008); Rossi & Salmaso (as cited in Roi & Bianchedi, 2008); Roi & Bianchedi, 2008].

Increasing % as the competition advanced: 25.8% (opening round), 30.2% (round of 32), 44.4% (round of 8), 47.2% (medallist round), 66.7% (championship round) [épée] {Olympics, 1996} [Azémar (as cited in Harris, 2010)].

[8]Weighted average total mean laterality score [modified 10-item E.H.I. inventory]: 44.98 (min.: 41.82, max.: 45.13) and laterality score [Self-reported global handedness question]: 48.49 (min.: 46.93, max.: 48.49). Researchers calculated laterality following additional statistical approaches (Schachter & Ransil, 1996).

[1.3.2.4]. Musicians

It is firmly stated in literature that professional instrumentalists, professional instrument playing musicians, present higher degree[9] of ambidexterity and/or sinistrality when by instrument category formed musicians' subgroups are compared with each other or when musicians are compared with nonartists, viz., subjects practiced noncreative professions (Christman, 1993; Preti & Vellante, 2007).

Representative hypotheses for professional musicians relate to: (a) both hemispheres' lesions and consequent disruption of musical skills [Alajouanine; Basso & Capitani; Beatty, Winn, Adams, Allen, Wilson, Prince, Olson, Dean, & Littleford; Miller, Boone, Cummings, Read, & Mishkin (as cited in Preti & Vellante, 2007)], (b) overrepresentation of left-handed and/or mixed-handed instrumentalists of the integrated family-type of instruments, and greater bihemispheric control as well as bimanual, coordinated activity (Christman, 1993).

[1.3.2.5]. Opticians-Optometrists

No literature exists investigating left-handedness for the professional group of opticians-optometrists.

Hypotheses been examined by handedness group in related research thus far [e.g., comparison of occupational fields in terms of experts (among which opticians) and novices] relate to: (a) work-related expertise in fine motor skills and touch (tactile and haptic) perception (Reuter, Voelcker-Rehage, Vieluf, & Godde, 2012), (b) left-right confusion in optometrist consultation room or any similar clinical settings (McMonnies, 1990).

[1.3.2.6]. Pharmacists

No literature exists investigating left-handedness for the professional group of pharmacists.

A hypothesis that has been examined in Chermak (2009) relates in essence to language skill behind accurate discrimination of orthographically similar drug names.

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[9] 10-item E.H.I. scores [average score/average of absolute values]: 61.3/77.6 [bimanual, integrated instrument musicians], 69.4/84.6 [bimanual, independent instrument musicians], 67.0/84.9 [unimanual instrument musicians] (Christman, 1993).

"Artists'" higher percentages in comparison with "nonartists'", esp. for musicians: (6.666%) (2 ambidextrals), 10% (3 fully sinistrals) (Preti & Vellante, 2007).

[1.3.2.7]. Pilots

Literature provides evidence[10] that professional aviators are basically right-handed (Crowley, 1989; Pipraiya & Chowdhary, 2006). The more advanced the level of pilot proficiency, the lower the incidence of inconsistent left-handedness and the higher the level of consistent, also, right-handed professionals, according to Gedye (as cited in Crowley, 1989).

Associated hypotheses up to the present time tested relate to: (a) functional cerebral asymmetry (or handedness) patterns and aviator performance (Crowley, 1989), (b) left-handedness incidence in aviators and general population's one (Pipraiya & Chowdhary, 2006), (c) mixed-handedness' relative incidence in the left-handed and the right-handed professionals (Pipraiya & Chowdhary, 2006), (d) stimulus-response compatibility and response competition (Sandry & Wickens, 1982).

[1.3.2.8]. Surgeons

High incidences of right-handedness are stated in literature for the professional group of surgeons when compared with physicians or other professions[11a] (Schott & Puttick, 1995; Schachter & Ransil, 1996). What is worthy of attention is that orthop(a)edic surgeons were proved[11b] to be the most right-handed of all (Schachter & Ransil, 1996). Furthermore, they proved to be quite a lot more right-handed than dentists and orthodontists, the additional two professions of the bimanual fine motor skills category of professions in research (Schachter & Ransil, 1996). In addition, orthop(a)edic surgeons were found to be the most right-handed of all in all items besides (a) scissors, (b) knife, (c) match, and (d) broom (Schachter & Ransil, 1996). Finally, they showed the lowest left laterality score (12.40), the lowest left relative frequency (.0379) as well as the lowest left laterality index (.47) of all in the self-reported global handedness question (Schachter & Ransil, 1996).

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[10] 92.2% (237 right-handed pilots), 7.*392*% (19 left-handed), ≅0.4% (1 ambidextral) (Pipraiya & Chowdhary, 2006).

[11a, 11b] 100% (36 surgeons) (Schott & Puttick, 1995).

Weighted average total mean laterality score [modified 10-item E.H.I. inventory]: 45.13 (min.: 41.82, max.: 45.13) and relative frequency f(r) [Self-reported global handedness question]: .9166 (min.: .7770, max.: .9166). In this case, subjects are specifically "Orthop(a)edic surgeons". Researchers calculated laterality following additional statistical approaches. (Schachter & Ransil, 1996).

Among hypotheses examined so far by researchers as far as it concerns the profession of surgeons relate to: (a) handedness influence on doctor's choice of career (Schott & Puttick, 1995), (b) laparoscopic psychomotor performance in left-handed and right-handed surgical residents (Grantcharov, Bardram, Funch-Jensen, & Rosenberg, 2003).

[1.3.2.9]. Tennis Athletes

Left-handedness literature provides no consistent results for the professional group of tennis players (Wood and Aggleton, 1989; Holtzen, 2000)˙ reasons vary (Holtzen, 2000). Statistically significant excess of left-handedness has been found among top 25 and top 4 1980 world rankings male professional players, according to Azemar et al. (as cited in Wood and Aggleton, 1989), among top half of 1982 ATP world rankings male players, according to Annett (as cited in Wood and Aggleton, 1989) and among 1968-1999 both male and female top ranking players and Grand Slam singles finalists (champions and runners-up included), in all but two cases, as well as among 1999 Grand Slam male singles players in all tournaments (Holtzen, 2000) while Wood and Aggleton (1989) for comparisons made found no differences for any of the years examined. Furthermore, whereas Holtzen (2000) found no statistically significant difference in left-handedness incidence between professional tennis players of either sex separately and general population, Wood and Aggleton (1989) found a slight - neither strong, nor consistent - statistically significant advantage in two cases for male professional tennis players and in one case for female professional tennis players when compared with general population.

Hypotheses that have been tested by researchers concern superior visuospatial-visuomotor skill of left-handed professional tennis players comparatively to right-handed ones due to brain organization, ongoing/professional experience's/practice's role as activator of biological prenatal substrate, biological postnatal (level of hormones in adolescence) influence on performance, according to Holtzen (2000) and strategic advantages in sport of tennis (e.g., advantage for left-handed players due to different style of playing of theirs, to which right-handed ones are unaccustomed) (Wood and Aggleton, 1989).

Existing literature for architects, fencing athletes, librarians, musicians, pilots, surgeons and tennis athletes as well as greater accessibility of pharmacists at their pharmacies and opticians-optometrists at their optical stores in labour market resulted in studying in this work the specific, as previously presented, nine target professions.

CHAPTER 2nd - THEORETICAL BACKGROUND

[2.1]. Literature Review

[2.1.1]. Handedness-focused Research

[2.1.1.1]. Architectural Engineers

Peterson and Lansky (1974) conducted a simple survey studying both full-time male faculty architects of the Department of Architecture the University of Cincinnati (N=17) and full-time male architecture students of it, too (N=484). The aim of the study was to examine whether left-handedness incidence was higher than the one in the "normal" population, defined to range between 8% and 10%. They used three statements [totally left-handed, either hand equally, totally right-handed] to examine handedness as well as they gathered data as far as it concerns the name, the year of studying and the major field. According to the results, (a) 29.4% of the male faculty architects were left-handed˙ two right-handed were left-handers as children, (b) architecture students' percentages of left-handedness ranged between 10.8% (min., 1st y.) to 23.9% (max., 4th y.). The freshmen's percentage did not differ a lot from the maximum one of the "normal" population and in each of all years later it was higher enough than in the first year.

Schachter and Ransil (1996) examined in the frame of a large, nine professions, comparative handedness research the professional group of architects (N=148). Architects' profession was considered and so classified as a profession of visuospatial skills' demands˙ three more skill-based categories of professions were also included in research. They measured handedness both with a modified version of the 10-item Edinburgh Handedness Inventory (E.H.I.) - a five-point scale one [5 responds: always left, usually left, no preference, usually right, always right] - and a self-report global handedness question, containing three statements [righthanded, ambidextrous, lefthanded]. Additionally, they gathered information regarding original hair colour and history of learning disabilities. According to the relevant analyses, (a) architects were the most left-handed among the nine professions: E.H.I. laterality score (weighted average total mean): 41.82 (min.: 41.82, max.: 45.13)˙ highest left relative frequency (.1757) as well as highest left laterality index (3.46) of all in the self-reported global handedness question, (b) architects were found to be the most right-handed of all in the item related to scissors, (c) architects were found to be the most left-handed of all in the items related to (a) draw, (b) throw, (c) toothbrush, (d) match, (e) box/lid, (d) architects showed the lowest right relative frequency (.7770) and the lowest right laterality index (36.89) of all in the self-reported global handedness question.

Other research attempts

Peterson and Lansky (1974) conducted a study, focusing on (a) a group of first year architecture students (N_1=73), and (b) two groups of the fourth year ($N_{4/total}$=28+25=53), so as to examine whether the left-handed architecture students had more spatial flexibility than the right-handed ones. Subjects' handedness had already been examined by researchers in the simple survey they themselves conducted at the University of Cincinnati (as described above). Students were asked to execute a design task, namely to design a space maze˙ strict - oral or written - instructions were given in parallel. According to the results, (a) left-handed students did not solve the space mazes more frequently than right-handed ones˙ no differences were observed, (b) more than 50% of the freshmen made errors and the fourth year architecture students made more errors than expected, (c) fourth year architecture students performed better than freshmen, (d) written instructions did not lead to fewer incorrect designed space mazes than oral ones, (e) left-handed architecture students did better than right-handed ones in terms of correctness of design (χ_2=12.95, df=1, p<.001). The hypothesis was confirmed.

Cosenza and Mingoti (1993) examined handedness patterns, among all professional courses of the Federal University of Minas Gerais (State of Minas Gerais, Brazil), who had been asked to participate in the questionnaire-based research, applicants ($N_{appl.\_total}$=30.646), in (a) the respondents ($N_{appl.\_respond.}$=16.590, N_m=7.266, N_f=9.324), and (b) the finally admitted respondents ($N_{appl.\_admit.}$=1.961, N_m=1.040, N_f=921). They used the 10-question short version of the Edinburgh Handedness Inventory (E.H.I.) to measure handedness. They aimed to investigate whether there were differences in laterality among university professional courses' applicants. Researchers treated data for the university all professional courses' applicants as well as the finally admitted ones in many different ways˙ one of the ways of analysis was based on grouping criteria such as: (a) university professional courses offered, (b) three areas of knowledge, (c) five blocks of (related) occupations. According to the results, (i) for the university all professional courses' applicants: (a) 7.91% were left-handed [L.Q.=<0], (b) 8.89% of males and 7.14% of females were left-handed˙ the difference was statistically significant, (c) statistical significant difference was observed in left-handedness incidence in laterality quotient distributions in university professional courses offered grouping [3 clusters]˙ excess of left-handedness was observed for the Statistics course (20.29%) as well as for the Music course (20.00%), (d) statistical significant difference was observed in left-handedness incidence in laterality quotient distributions in three areas of knowledge grouping [4 classes]˙ the highest percentage of left-handers was observed in the Mathematical Sciences area of knowledge (6.26%) and the lowest in the Humanities area of knowledge (4.80%), (e) statistical significant difference was observed in left-handedness incidence in laterality quotient distributions in five blocks of (related) occupations grouping [4 classes]˙ the Mathematical

block of (related) occupations and the Verbal block of (related) occupations were the ones being responsible for statistical difference. They, also, conducted analyses for each sex separately., (ii) for the finally admitted applicants: (a) more left-handers [L.Q.=≤0] were observed in each of the three areas of knowledge in comparison with the right-handers, (b) more left-handers [L.Q.=≤0] were observed in each of the five blocks of (related) occupations in comparison with the right-handers, (c) no statistically significant difference was observed in left-handedness incidence in laterality quotient distributions in three areas of knowledge grouping [4 classes], (d) no statistically significant difference was observed in left-handedness incidence in laterality quotient distributions in five blocks of (related) occupations grouping [4 classes], (iii) for the comparison between the university all professional courses' applicants and the finally admitted ones: (a) statistical significant difference was observed in left-handedness incidence in laterality quotient distributions [20 classes]˙ no statistically significant differences were observed when same comparisons were made for each sex separately, (b) higher proportion of left-handers was observed in the finally admitted applicants (9.43%) in comparison with the university all professional courses' applicants (7.91%)˙ analogous observation was made for each of the two sexes separately.

Götestam (1990) studied left-handedness - along with reading problems, dyslexia and stuttering - in a group of the School of Architecture at Trondheim Institute of Technology at the University of Trondheim architecture students ($N_{Arch.Stud.}$=60, N_m=23, N_f=37), a group of both the Trondheim Music Conservatory and the Department of Music at the University of Trondheim students of music ($N_{Mus.Stud.}$=88, N_m=44, N_f=44), and in - as the control/comparison group - a general student group, which was recruited from the Ringve High School, Grades 10-12 ($N_{Gen.Stud.}$=87, N_m=43, N_f=44). He used a four-question [writing, throwing a ball, threading a needle, kicking a ball], 3-point scale [3 responds: always right, either right or left, always left] measure to assess handedness˙ left-handedness index was calculated based on a 1-2-3 scoring system. He, also, classified subjects in four - defined by Lansky, Feinstein, and Peterson, 1988 - handedness categories (lefts, left mixeds, right mixeds, rights). The aim of the study was twofold: (a) to make a comparison between each of the students groups' left-handedness frequency and the comparison's group one, and (b) to examine reading problems, dyslexia, stuttering and twinning. According to the results, (a) the highest frequency of "Lefts" among the three groups was observed in students of architecture (5%), (b) the highest frequency of "always left" writing among the three groups was observed in students of architecture (13.3%), (c) statistical significant values were observed between left-handedness and stuttering, (d) statistical significant values were observed between left-handedness and reading problems, (e) statistical significant values were observed between left-handedness and dyslexia.

[2.1.1.2]. Fencing Athletes

Grouios et al. (2000) examined in the frame of a large - sporting competitors ($N_{Sport.Compet.}$=1.112), nonsporting university students ($N_{Non\_Sport.Univ.Stud.}$=1.187), N_{total}=2.299 -, primarily sports-focused, comparative handedness research athletes of the sport of fencing ($N_{Fencing.Athl.}$=61). Sporting competitors were of class A (very good) athletes in northern Greece as well as they represented both interactive and non interactive sports˙ further, as far as it concerns the first both direct and indirect sports. Nonsporting university students were studying social sciences, economics and law at undergraduate level at the Aristotle University of Thessaloniki (A.U.TH.) and they volunteered to be research subjects. Fencing was treated as a direct, interactive sport in research. The purpose of the study was to investigate whether there were any statistical significant differences in left-handedness incidence between (a) sporting competitors and nonsporting university students, (b) interactive sporting competitors and non interactive sporting competitors, (c) direct interactive sporting competitors and indirect interactive sporting competitors. Researchers used the Briggs and Nebes' (1975) 12-item Handedness Inventory, a 5-point scale one [5 responds: always left, usually left, no preference, usually right, always right] to assess hand preference. According to the results (a) there was statistically significant difference in left-handedness incidence between sporting competitors and nonsporting university students˙ higher incidence was observed in the first group (14.8%), (b) there was statistically significant difference in left-handedness incidence between interactive sporting competitors and non interactive sporting competitors˙ higher incidence was observed in the first group (19.6%), (c) there was statistically significant difference in left-handedness incidence between direct interactive sporting competitors and indirect interactive sporting competitors˙ higher incidence was observed in the first group (25.1%). Especially, for fencers/fencing athletes, left-handedness incidence was found to be as high as 37.7% [male: 42.9%, female: 33.3%].

[2.1.1.3]. Librarians

Schachter and Ransil (1996) examined in the frame of a large, nine professions, comparative handedness research the professional group of librarians ($N_{Libr.}$=80). Librarians' profession was considered and so classified along with psychiatrists and lawyers' ones as a profession of verbal skills' demands˙ three more skill-based categories of professions were also included in research. They measured handedness both with a modified version of the 10-item Edinburgh Handedness Inventory (E.H.I.) - a five-point scale one [5 responds: always left, usually left, no preference, usually right, always right] - and a self-report global handedness question, containing three statements [righthanded, ambidextrous, lefthanded]. Additionally, they gathered information regarding original hair colour and history of learning

disabilities. According to the relevant analyses, (a) librarians were of the most right-handed (2nd in turn) professions among the nine professions: E.H.I. laterality score (weighted average total mean): 44.98 (min.: 41.82, max.: 45.13), (b) librarians were the most right-handed in comparison with the co-classified professions in the verbal skills category of professions, (c) librarians were the first among the nine professions to be "completely right-handed" (L.Q.=50) [*f*(50)=52.5] (min.: 27.6, max.: 52.5), (d) librarians were the only profession of all in which over half [*f*(50)=52.5] of the professionals were found to be "completely right-handed", (e) librarians were found to be the most right-handed of all in the items related to (a) scissors, (b) knife, and (c) broom, and (f) librarians showed the highest right laterality score (48.49) and the lowest ambilateral relative frequency (.0125) as well as the lowest ambilateral laterality index (.41) of all in the self-reported global handedness question.

[2.1.1.4]. Musicians

Christman (1993) studied musicians ($N_{Mus.}$=196) - recruited from[12] the performance faculty of Departments and Schools of Music of many institutions and from a local symphony orchestra -, more precisely instrumentalists, who played (i) bimanual[13] musical instruments either integrated (string and woodwind ones) ($N_{integr.}$=82) or independent (keyboard ones) ($N_{indep.}$=81), (ii) unimanual musical instruments of the brass family ($N_{unim.}$=33). He used the 10-item Edinburgh Handedness Inventory (E.H.I.) and he, additionally, received information regarding principal musical instrument and familial sinistrality. The aim of the study was to investigate whether two hands' role as far as it concerns the fine motor movements needed in playing bimanual musical instruments was related to direction and/or degree of handedness. The theoretical basis of the research is laid on the possibility of the left-handed to have greater bihemispheric control of fine motor movements as well as the possibility of greater interhemispheric transfer and integration of information of the left and mixed handed. According to the results (a) there was no statistically significant difference between the integrated instruments musicians group and the independent instruments one in handedness direction, (b) there was statistically significant difference between the integrated instruments musicians group and the independent instruments one in handedness degree˙ weaker degree for the first group. The hypothesis that left and/or mixed handed musicians were overrepresented in the integrated instruments category was supported. The expectation that

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[12]"1. Professors … of musical performance at the schools listed in the acknowledgments. 2. Members of the Toledo Symphony, a (semi-)professional organization …" (S. Christman, personal communication (email), August 11, 2017, 19.22).

[13]In bimanual musical instruments contrary to the unimanual ones both hands perform.

mixed-handed musicians would have been overrepresented in the woodwind instruments category in comparison with the string instrument one was not supported.

Other research attempts

Preti and Vellante (2007) studied - along with other two professional groups of creative artists, painters and writers - musicians ($N_{Mus.}$=30). They applied a specialised set of inclusion criteria for each of the two samples under comparison, the experimental group ($N_{creat.prof.}$=80) and the control group ($N_{non\_creat.prof.}$=80, noncreative professionals). They used the Annett Hand Preference Questionnaire (H.P.Q.) to collect handedness data from the two samples. Among musicians, two subjects (6.666%) were ambidextral and three subjects (10%) were fully sinistral. The aim of the study was to investigate whether unusual subjective experiences were related to non-right handedness in creative artists taking into account psychological distress as well as psychoactive substance use. Specifically for handedness, they examined the hypothesis that handedness moderated the impact of psychoactive substance use on unusual subjective experiences. Results showed conditional greater indirect effect (*t*=2.30, p=.021) of the mixed-handed (N=160). According to the results, handedness did not interact with psychoactive substance use so as to explain unusual subjective experiences.

Götestam (1990) studied left-handedness - along with reading problems, dyslexia and stuttering - in a group of the School of Architecture at Trondheim Institute of Technology at the University of Trondheim architecture students ($N_{Arch.Stud.}$=60, N_m=23, N_f=37), a group of both the Trondheim Music Conservatory and the Department of Music at the University of Trondheim students of music ($N_{Mus.Stud.}$=88, N_m=44, N_f=44), and in - as the control/comparison group - a general student group, which was recruited from the Ringve High School, Grades 10-12 ($N_{Gen.Stud.}$=87, N_m=43, N_f=44). He used a four-question [writing, throwing a ball, threading a needle, kicking a ball], 3-point scale [3 responds: always right, either right or left, always left] measure to assess handedness˙ left-handedness index was calculated based on a 1-2-3 scoring system. He, also, classified subjects in four - defined by Lansky et al., 1988 - handedness categories (lefts, left mixeds, right mixeds, rights). The aim of the study was twofold: (a) to make a comparison between each of the students groups' left-handedness frequency and the comparison's group one, and (b) to examine reading problems, dyslexia, stuttering and twinning. According to the results (a) the highest frequency of choir members among the three groups was observed in students of music (64.3%)˙ statistical significant difference was observed in choir membership between students of music and control group, (b) the highest frequency of "always right" writing among the three groups was observed in students of music (89.8%), (c) the highest frequency of "Rights" among the three groups was observed in students of music (21.7%), (d) statistical significant values were observed

between left-handedness and stuttering, (e) statistical significant values were observed between left-handedness and reading problems, (f) statistical significant values were observed between left-handedness and dyslexia.

Oldfield (1969) conducted a comparative study in musicians on the basis of a previous research's partial questionnaire data of a group of students ($N_{Mus.Stud.}$=129) and a group of staff ($N_{Staff\_of\_Mus.}$=129, N_m=57, N_f=72) of Schools of Music of the University of Edinburgh as well as the University of Reading. The section of the questionnaire used in the initial research, from which the above data were obtained, included a 22-item "handedness inventory" and a number of additional questions [see Appendix B, (c)]. Comparison was made with a group of psychology undergraduates ($N_{Psych.Undergrad.}$=1.128), who, also, filled in the question 1.4. and the above - with 20 items - "handedness inventory". The aim of the study was to investigate whether left-handedness was prevalent in musicians and whether the left-handed musicians faced any possible difficulty in acquiring executant skills, especially when an instrument could not be played in a reverse mode. According to the results (a) left-handedness incidence in musicians was not statistically significantly different from that in the control group and (b) no special difficulty had been faced in learning and execution by left-handed musicians.

[2.1.1.5]. Opticians-Optometrists

No literature exists investigating left-handedness for the professional group of opticians-optometrists.

[2.1.1.6]. Pharmacists

No literature exists investigating left-handedness for the professional group of pharmacists.

[2.1.1.7]. Pilots

Pipraiya and Chowdhary (2006) studied handedness in a section of pilots of the Indian Air Force. Among 257 subjects, who filled in and returned completed an adapted from the Edinburgh Handedness Inventory (E.H.I.) questionnaire, 7.39% (N=19) were left-handed, 0.389% (N=1) were ambidextrous and 92.2% (N=237) were right-handed. In addition, 15.789% (N=3) of the left-handed and 78.059% (N=185) of the right-handed were highly lateralized. Finally, mixed-handedness [laterality quotient range: -74 to +74] was observed in the 26.85% (N=69) of the total sample, percentage consisted of the 84.2% of the left-handed and the 21.9% of the right-handed. Left-handedness incidence found was as the one of the general population, which led to the conclusion that there was not any bias in the flying

selection process or pilot training against the sinistral professionals. Mixed-handedness incidence found led to the double interpretation that mixed-handedness might be learned and acquired by the left-handers due to de facto living in "a world constructed and functioning for the right-handers" as well as it might be a matter of natural endowment for them comparatively to the right-handers.

Other research attempts

Sandry and Wickens (1982) studied a group of ten male pilots, employed at the Naval Air Test Centre (N.A.T.C.), Patuxent, River, Maryland. The subjects, all right-handed, were classified in terms of handedness on the basis of both (a) the Bryden (1977) inventory and (b) the Crovitz and Zener (1962) inventory, too. Authors tried to examine in an F-18 flight simulator a model for stimulus-response compatibility as well as resource competition, especially as far as it concerned verbal and spatial tasks. A matrix of conditions (e.g., i/o combinations, verbal/spatial task, difficulty of task, single/dual task performance) made up the whole experiment. Their model was upheld.

[2.1.1.8]. Surgeons

Schott and Puttick (1995) studied a group of physicians and surgeons ($N_{Phys.\_\&\_Surg.}$=103) among which 36 - 27 of them men - were surgeons. Handedness measurement tool used was the questionnaire. The aim of the study was to investigate whether left-handedness influenced a doctor's career choice. According to their analysis and results, there was no left-handedness incidence observed at all, that is none of the 36 surgeons was left-handed. This, as authors write, "… might suggest that left handers are less capable than right handers at manual skills pertinent to surgery." (p. 739). Furthermore, it may partly occurred because of the state of affairs in surgical training as it "… usually requires trainees to assist right handed surgeons." (p. 739).

Schachter and Ransil (1996) examined in the frame of a large, nine professions, comparative handedness research the professional group of orthop(a)edic surgeons ($N_{Orth.Surg.}$=132). Orthop(a)edic surgeons' profession was considered and so classified along with dentists and orthodontists' ones as a profession of bimanual fine motor skills' demands˙ three more skill-based categories of professions were also included in research. They measured handedness both with a modified version of the 10-item Edinburgh Handedness Inventory (E.H.I.) - a five-point scale one [5 responds: always left, usually left, no preference, usually right, always right] - and a self-report global handedness question, containing three statements [righthanded, ambidextrous, lefthanded]. Additionally, they gathered information

regarding original hair colour and history of learning disabilities. According to the relevant analyses, (a) orthop(a)edic surgeons were the most right-handed among the nine professions: E.H.I. laterality score (weighted average total mean): 45.13 (min.: 41.82, max.: 45.13), (b) orthop(a)edic surgeons were the most right-handed among the co-classified professions in the bimanual fine motor skills category of professions, (c) orthop(a)edic surgeons were found to be the most right-handed of all in items related to (a) draw, (b) write, (c) throw, (d) toothbrush, (e) spoon, (f) box/lid, and (d) orthop(a)edic surgeons showed the highest ambilateral laterality score (36.17), the lowest right laterality score (46.93), the lowest left laterality score (12.40) as well as the highest right relative frequency (.9166), the lowest left relative frequency (.0379) and, the lowest left laterality index (.47) of all in the self-reported global handedness question.

Other research attempts

Adusumilli et al. (2004) on their study focused on the perceptions of the left-handed (69%: pure left-handed, 31%: ambidextrous) surgeons ($N_{Surg.}$=68), who served either general surgery or other surgical specialties, with regard to both surgery training and practice. More precisely, they tried to elicit answers with respect to, indicatively, the following issues: laterality related mentoring existence in the two settings, left-handed instruments provision in the two settings, surgeons' voluntary advice seeking from senior left-handed ones in training period, patients' notice and concern expression in regard to surgeon's left-handedness, surgeons' foot preference. Results and conclusions presented in detail are of great and particular significance for the surgeon-world, both the administration and the personnel.

Grantcharov, Bardram, Funch-Jensen, and Rosenberg (2003) studied a sample of surgical residents (surgeons in training) ($N_{Surg.Resid.}$=25) aiming to test whether gender, hand dominance and experience with computer games affected a surgeon's operative psychomotor performance. They used the Minimally Invasive Surgical Trainer - Virtual Reality (M.I.S.T.-V.R.), Mentice Medical Simulator - the scoring system of which had been validated in a number of studies earlier and thus was considered be an objective and reliable method of assessment of surgical laparoscopic skill -, to expose subjects to six, specific in nature tasks. Measures of surgical laparoscopic skill were: (a) time, (b) errors, and (c) number of unnecessary movements. Results are eloquent of the statistical significant difference between left-handed surgeons and right-handed ones in favour of the latter.

[2.1.1.9]. Tennis Athletes

Holtzen (2000) studied a group of professional tennis players ($N_{Tennis.Players}$=2.437), both sexes, with comparison to general population as well as a group of professional tennis players ($N_{Tennis.Players}$=4.173), both sexes, defined as highly classified. He worked on a compiled from different sources data set covering the 1981-1999 period in the first case and a 32 years (1968-1999) time period in the second. He examined left-handedness incidence thoroughly analysing various subsets (e.g., by sex, by ranking range, by tournament) of sample in each case˙ for high classification athletes subset's analyses he used various left-handedness base rates. According to the results, (a) neither male nor female professional tennis players showed statistically significant difference in incidence of left-handedness with comparison to the general population, and, (b) high classification left-handed professional tennis players showed, as presented in *[1.3.2.9].*, a statistically significant over-representation with comparison to the respective right-handed ones.

Wood and Aggleton (1989) analysed specific yearbooks' handedness data for professional tennis players, both male [ys: 1981, 1986, 1987] and female [ys: 1981, 1986] after filtering initial data so as to include each player only once [pooled analysis] (N_m=500, N_f=252). The aim of the study was to examine whether there was a higher proportion than normal of left-handed players in professional tennis. For statistical comparisons the above data as well as, combined (control group), the responses of the Annett (1970) and the Bryden (1977) handedness surveys were used. According to the sex comparison results in all cases examined [1. all professionals by year, 2. top 100 professionals by year, 3. N_m & N_f], both males and females showed higher percentages in left-handedness than the control group˙ among all sex comparisons two were statistically significant for males and one for females. In additional analyses, no differences were found (a) between the two halves of the rankings, (b) between the top 25 of the rankings, and, (c) between the top four of the rankings, for any of the above years.

[2.1.2]. Critical Analysis

Reviewing literature a number of critical issues arise. Below, a list of such issues are pictured:

[a]. "wording of the phenomenon": "handedness" and "hand preference" have been used in literature as of equal meaning wording to introduce the phenomenon of functional dominance of one hand (preferred hand) over the other (non-preferred hand) and thus the most frequent and effective usage of the first in tasks by an individual (see [1.2.1].). According to Papadatou-Pastou et al. (2008), "handedness" is a broader meaning having been assessed either as

“hand preference” (via a self-report preference statement/answer) or as a factual “hand usage” (via a performance measure).

[b]. “plenty of measurement tools and research conclusions”: researchers have used a variety of different handedness measurement tools (see [1.2.3].) and have come to conclusions about handedness patterns. Further, statements are made regarding studies being in accordance or in contradiction with previous ones (e.g., for architecture: see Peterson & Lansky, 1974 vs Schachter & Ransil, 1996 as well as both studies vs Wood & Aggleton, 1991). For instance:

(a) the Edinburgh Handedness Inventory (E.H.I.) was used by (i) Byrne (1974) [short form], (ii) Cosenza and Mingoti (1993) [10-question short version], (iii) Wood and Aggleton (1989) [10-item one, 22-item original version], (iv) Schachter and Ransil (1996) [modified 10-item version], (vi) Christman (1993) [10-item one].

(b) the Hand-Preference Questionnaire (H.P.Q.) was used by Preti and Vellante (2007).

(c) a self-report statement was used by (i) Peterson and Lansky (1974) [three (3) statements] or either a self-report single question was used by Schachter and Ransil (1996) [a question about self-described global handedness].

(d) subject’s hand was used by Wood and Aggleton (1989) (as existed in bibliographic tennis yearbooks/guides) [hand holding the racket].

Doubt is cast on the conclusions reached due to fundamental differences in measurement tools’ design and application: (a) number of answers in an inventory˙ it produces a broader or more subtle handedness distribution, (b) actions included in an inventory˙ an action is proved unanswerable in some cases [see [1.2.3].], (c) number of actions included in an inventory as well as percentage of same actions among inventories˙ a range of diversity is observed along with validity implications, (d) exact nature of a required performance task˙ unknown/not co-examined factor(s) might affect performance.

[c]. “sampling and research conclusions”: it is obvious in literature that different populations have been investigated regarding a domain (e.g., architecture, piloting, surgery, music) and, in addition, that investigations have been conducted on the basis of different sample sizes. Indicatively, samples already examined included:

(a) applicants in a range of a university professional courses (architecture, library science, music, pharmacy, etc.) (Cosenza & Mingoti, 1993).

(b) admitted by a university students in a range of professional courses (architecture, library science, music, pharmacy, etc.) (Cosenza & Mingoti, 1993) as well as full-time male architecture students in a University Department of Architecture (Peterson & Lansky, 1974).

(c) full-time male faculty architects of a University Department of Architecture (Peterson & Lansky, 1974) as well as performance faculty (professors) of Departments and Schools of Music of many institutions (see Footnote 12) (Christman, 1993).

(d) members, more precisely instrumentalists, from a local symphony orchestra, a (semi-) professional organization (see Footnote 12) (Christman, 1993) as well as architects (professional group) from national or regional directories (Schachter & Ransil, 1996) or fully qualified architects from architectural firms (Wood & Aggleton, 1991).

With such differentiation in the nature (moreover, in age, in expertise, etc.) of samples conclusions reached about a domain's handedness patterns are of questionable value (e.g., for architecture: see, same as above study cases, Peterson & Lansky, 1974, Wood & Aggleton, 1991 and Schachter & Ransil, 1996). Further, so are statements made regarding studies being in accordance or in contradiction with previous ones.

As far as it concerns sample size it seems to influence handedness results. For instance, research when largest sample size obtained has shown opposite handedness results in comparison to previous studies that used smaller samples [e.g., for the sport of tennis: see Wood & Aggleton, 1989 vs Annett as well as Azémar et al. (as cited in Wood & Aggleton, 1989)]. On that basis excluding any other limitations in research methodology each time conclusions about handedness patterns and statements made regarding studies being in accordance or in contradiction with previous ones are in question.

[d]. "numerous left-handedness comparison base rates and research conclusions": many different comparative base rates for left-handedness have been used. Specifically:

(a) 6.98% was used by Holtzen [male professional tennis players] (Holtzen, 2000).

(b) 7.69% was used by Holtzen [female professional tennis players] (Holtzen, 2000).

(c) 8.0% [created by combination of two previous studies' data, racket use, female] was used by Wood and Aggleton (Wood & Aggleton, 1989).

(d) 8.1% [Annett's, racket use, both sexes] was used by Holtzen (Holtzen, 2000).

(e) 8.9% [created by combination of two previous studies' data, male] was used by Wood and Aggleton (Wood & Aggleton, 1989).

(f) 10% was used [Bryden's, both sexes] by Holtzen (Holtzen, 2000).

(g) 10.7% was used [Wood and Aggleton's, racket use, female] by Holtzen (Holtzen, 2000).

(h) 12.2% was used [Wood and Aggleton's, racket use, male] by Holtzen (Holtzen, 2000).

Cautiousness is needed when conclusions about a domain's handedness patterns as well as consequent statements about studies' alignment or contradiction are made. Issues as a technically constructed figure, as the figure 8.9% in (e) case above, or a, lower or higher,

base rate each time used might affect comparison results. For the latter, see in Wood & Aggleton (1989) researchers' critical reference about the base rate of 6% that Azemar et al. used (p. 228). However, quantities of base rates has its advantages, too.

Finally, many a issue is identified as reviewing critically handedness literature such as formation of handedness groups and type of statistical analysis.

[2.2]. Present Research

[2.2.1]. Problem Setting

Studying handedness literature the following scheme seems to emerge:

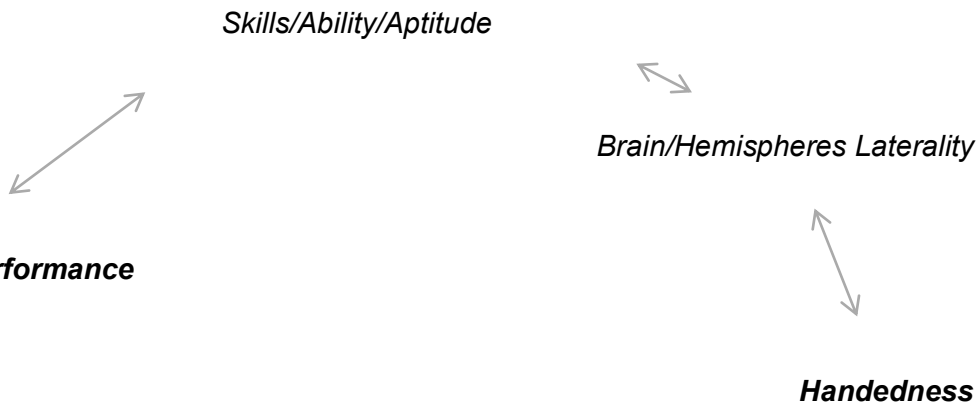

Figure 1: The chain of interactions from handedness to professional performance and visa versa.

The above scheme depicts the general problem setting in research in regard with handedness and professions. It is deemed that skills required by professionals at workplace derive from brain, of which manifestation of organisation and function is handedness. As a consequence, handedness relates to professional performance.

This notion of chain of interactions can be applied on any profession [e.g., right-handedness of librarians and expected verbal proficiency (see *[1.3.2.3].*)].

We participate to the general problem setting framework with the Briggs and Nebes' (1975) inventory distributed to a population of professionals so as to investigate handedness in professions.

[2.2.2]. Purpose

The purpose of the study is to investigate handedness, particularly left-handedness, in professions.

The aim of the study is to investigate whether a statistically significant different incidence of left-handedness is observed in nine professions (see [1.3.2].) by comparison to general population's one.

[2.2.3]. Significance

Significance of present study is documented by the use of the Briggs and Nebes' (1975) inventory on already with alternative measures examined professions as the professions of architects, fencers, librarians, musicians, pilots, surgeons and tennis players, the investigation of two additional, never examined up to now, professions, the profession of opticians-optometrists and the profession of pharmacists and, finally, the fact that research addressed exclusively to working population, viz., population being employed as well as to competitive sports population, viz., population participating in official competitive sports events.

[2.2.4]. Functional Definitions

"Professionals": working population, viz., population being employed as well as competitive sports population, viz., population participating in official competitive sports events.

[2.2.5]. Delimitation: Limitations

The study has a number of limitations a part of which are:

[1]. questionnaire completion took place at workplaces: professionals' available time was limited in some cases and interruptions of the process occurred sometimes due to their duties as for example in the cases of pharmacists and optician-optometrists.

[2]. questionnaire wording and verbal biases: a few of the 12 inventory items (e.g., item No [12].) as well as in part the wording (e.g., term "relatives") of the additional questionnaire questions were not clearly enough understood by some of the participants.

[3]. e-mail mode vs face-to-face (f2f) mode of questionnaire completion: more verbal biases could be observed in f2f mode as well as additional information could be received in f2f mode˙ both can be confirmed by student-researcher. F2f mode proved more flexible and more loose than e-mail mode.

[4]. questionnaire is a self-report measurement tool˙ answers can be subjective enough.

[5]. convenience and snowball sampling˙ not representative of general professional respective populations.

[6]. unequal sample sizes: not all workplaces and/or professionals were in the same manner approachable/accessible.

[7]. males-females proportion in samples: unequal proportion is observed in a number of samples and even zero proportion is observed in pilots' sample.

[8]. small sample sizes: not all workplaces and/or professionals were in the same manner approachable/accessible, exclusion of subjects from final samples due to many reasons (see [3.1].).

[9]. possible subjects' participation bias: research concept was explicitly (enough) explained to potential research participants from beginning when approaching them, and hence the left-handed ones might have felt more engaged with the topic and thus have been more interested in it, participating as a consequence in a higher degree than the right-handed ones due to personal, positive or negative, previous or ongoing life experience.

[10]. inexperience of student-researcher in conducting research.

[11]. labour market sad and sorry state of affairs: international and national occupational classifications' coding differences as well as obsolete occupational databases [e.g., Architectural Engineers' database at the Technical Chamber of Greece (TEE-TCG)] were two of the observed and/or encountered difficulties.

[2.2.6]. Stated H_0 & H_1 Hypotheses

The study states the following hypotheses:

Architectural Engineers:

H_0 : Architectural Engineers do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Architectural Engineers show a different incidence of left-handedness in comparison to general population's one.

Fencing Athletes:

H_0 : Fencing Athletes do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Fencing Athletes show a different incidence of left-handedness in comparison to general population's one.

Librarians:

H_0 : Librarians do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Librarians show a different incidence of left-handedness in comparison to general population's one.

Musicians:

H_0 : Musicians do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Musicians show a different incidence of left-handedness in comparison to general population's one.

Opticians-Optometrists:

H_0 : Opticians-Optometrists do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Opticians-Optometrists show a different incidence of left-handedness in comparison to general population's one.

Pharmacists:

H_0 : Pharmacists do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Pharmacists show a different incidence of left-handedness in comparison to general population's one.

Pilots:

H_0 : Pilots do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Pilots show a different incidence of left-handedness in comparison to general population's one.

Surgeons:

H_0 : Surgeons do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Surgeons show a different incidence of left-handedness in comparison to general population's one.

Tennis Athletes:

H_0 : Tennis Athletes do not show a different incidence of left-handedness in comparison to general population's one.

H_1 : Tennis Athletes show a different incidence of left-handedness in comparison to general population's one.

CHAPTER 3rd - METHODOLOGICAL APPROACH

[3.1]. Sampling

Research subjects of the nine target professions of this work were recruited mostly by convenience and less by snowball sampling.

Initial contact with each potential research participant, either directly with them or after obtaining permission by one's affiliation contact person in charge, from a technical point of view was made by f2f mode, phone call mode or e-mail mode (see Appendix C).

Research concept and methodology were explicitly (enough) explained to everybody from beginning when approaching potential research participants. As it has already been stated in [2.2.5]. the specific research strategy might have functioned as a limitation of it, too.

All subjects were a priori fully informed as far as it concerned their consent or not to participate in the research. No motives at all were given to them.

Anonymity was a target of this research˙ it was not always possible to obtain anonymity due to professional environments visited and the consequent welcomeness of the professionals, which led them to introduce themselves or colleagues of theirs.

Not all subjects' nationality was Greek, not all subjects' mother tongue was Greek, not all had received relevant to their profession education/training in Greece. This research material is a piece of the orally stated by the subjects additional information received in the f2f mode (see [2.2.5].).

All the participants completed the printed questionnaire in the f2f mode except from, as it was designed, the Architectural Engineers, who, submitted via e-mail completed the e-tool.

Final samples, hopefully, consist of exclusively working population, viz., population being employed as well as competitive sports population, viz., population participating in official competitive sports events (see [2.2.3]. and catalogues in Acknowledgements).

Final samples do not include subjects with serious head injury [see Appendix D: Questionnaire [Printed, f2f mode], question 3rd, page 2nd & Appendix E: Questionnaire [Google Form, e-mail mode], question 3rd, page 7th]. Some subjects have, also, been excluded from final samples for many other reasons, such as the questionnaire completion procedure followed was not the proper, viz., the subject desired to answer orally the questions and the student-researcher to write them down on the paper.

Control sample or control group, fulfilling general population's distribution requirements, consists of nonsporting university students ($N_{Non\_Sport.Univ.Stud.}$=1.187) of social

sciences, economics and law at undergraduate level at the Aristotle University of Thessaloniki (A.U.TH.), who volunteered to be research subjects in the Grouios et al. (2000) research study.

[3.2]. Measurement

The 2-page self-report questionnaire used in this research is presented in the Appendices D and E.

The Briggs and Nebes' (1975) inventory is a 12-item handedness measure (see Appendix D: Questionnaire [Printed, f2f mode], page 1st & Appendix E: Questionnaire [Google Form, e-mail mode], section 4th).

The Briggs and Nebes' (1975) inventory provides a 5-point scale [5 responds: always left, usually left, no preference, usually right, always right] for handedness assessment producing in consequence a more subtle and more powerful distribution of values. Scoring system followed the model "1-2-3-4-5", with each value corresponding to responds above, which was transformed into the model "(-2)-(-1)-0-1-2" so as the received data set to be comparable with the control group's data set. Scores ranged from -24 (complete/extreme left-handedness) to 24 (complete/extreme right-handedness). Subjects were categorised in three handedness groups on the basis of two cut off points application: (a) left-handed [(-24)-(-9)], (b) mixed handed [(-8)-8], and (c) right-handed [9-24].

In a few cases the 12-item inventory was returned incomplete as answers in 1 to 3 items' are missing and in other cases, some specific items (e.g., item [3].). of its were answered on a hypothetical basis.

The Briggs and Nebes' (1975) inventory has been used in many studies supervised by the Professor of Motor Behaviour at the Department of Physical Education and Sports Sciences at the A.U.TH., Mr Grouios George.

[3.3]. Procedure

An extensive search for papers was conducted using the Google Scholar search engine (URL: https://scholar.google.com).

For the profession of librarians the keyword used was "handedness AND librarian".

For the profession of opticians-optometrists the keywords used were "handedness AND optician", "handedness AND opticist", "handedness AND oculist" and "handedness AND optometrist".

For the profession of pharmacists the keywords used were "handedness AND pharmacist", "handedness AND chemist", "handedness AND apothecary", "handedness AND

druggist", "handedness AND pharmaceutist", "handedness AND pharmacian", "handedness AND pharmacologist", "handedness AND "pharmaceutical chemist"" and "handedness AND "chemist and druggist"".

For the profession of pilots the keywords used were "handedness AND pilot", "handedness AND airman", "handedness AND airwoman", "handedness AND flyer", "handedness AND flier", "handedness AND aeronaut", "handedness AND aviator", "handedness AND copilot", "handedness AND wingman", "handedness AND controller", "handedness AND navigator", "handedness AND aviation", "handedness AND "aviation safety"", "handedness AND "aviation personnel"" and "handedness AND "aviation performer"".

Research mainly started in September of the year 2016 [1st questionnaire's completion date, f2f mode] and ended in February of the year 2018 [last submitted via e-mail questionnaire].

Subjects from different areas of Greece (capital city of Athens and suburbs of it, city of Thessaloniki and suburbs of it, city of Trikala in the prefecture of Thessaly) participated in the f2f mode completion of the printed questionnaire.

All geographical locations were visited by student-researcher. All professionals were met personally either during working hours or during the hours that an official competitive tennis or fencing event or tennis or fencing training session lasted.

Completion time exceeded the pre-estimated time of 5-7 minutes only when subjects either narrated a personal handedness-related story (e.g., familial sinistrality, bad behavioring of society towards left-handers in the past) or asked for further detailed information regarding the meaning of a question and/or an item.

In the latter case explanations and/or instructions were given.

During completion of the inventory a considerable number of subjects acted with joy the required by an item action before checking the answer of their choice.

Immediately after completion of the printed questionnaire the student-researcher took notes on the additional each time received information on either a paper-and-pencil mode or a mobile text mode.

Details of all research procedures have been saved in e- or paper-and-pencil files.

CHAPTER 4th - RESULTS

[4.1]. Statistical Analysis

As far as it concerned statistical analysis in the present study we applied both descriptive and inferential statistics for the total sample of professionals (N_{total_sample}=561) as well as for each of the nine professions sample separately.

More specifically, we calculated - where appropriate - descriptive measures (the mean, the median, the mode, the standard deviation, the skewness and the kurtosis indices, the range, the minimum, the maximum, the percentiles and the percentages) of a variable of interest, viz., the handedness index, the left-handedness, the sex or the age (recoded as the "age group" variable, alternatively) and present the relevant each time tables of results.

Furthermore, we performed the non-parametric statistical χ^2 test (chi-square test for independence) so as to test each of the nine left-handedness hypotheses separately. In all statistical tests conducted the level of statistical significance was set to 5% (α=.05). In all statistical tests in [4.2.2.3]., viz., for the professions vs general population comparisons we used the Fisher's exact test.

In order to perform the statistical comparisons with the general population we calculated the Non_Left-Handedness percentage of the control group based on the Grouios et al. (2000) published percentage of 9.1% of Left-Handedness of this group. We transformed the initial Handedness Group Variable into the Left-Handedness Index variable (Left-Handedness and Non_Left-Handedness) and calculated the relevant percentages for each profession.

Histograms, bar charts and pie charts were created so as the results to be presented graphically.

Statistics were performed using the I.B.M. Statistical Package for the Social Sciences (I.B.M.® S.P.S.S.®), Version 25 [via the Aristotle University of Thessaloniki Students' License].

Missing Values:

Responds to 12-item inventory not given by subjects (see [3.2].) were not analysed. A few responds in item [12]. (see [2.2.5]., [2].) were considered missing values, too.

Cronbach's Alpha Coefficient of Reliability (Cronbach's α):

Subjects' in the 12-item Briggs and Nebes' (1975) inventory responding reliability is, as shown in Table 2, .965, which indicates rather high internal consistency.

Table 2: Reliability Statistics

Reliability Statistics	
Cronbach's Alpha	N of Items
.965	12

[4.2]. Statistics

[4.2.1]. Descriptive Statistics

[4.2.1.1]. Total Sample

(i) Handedness Index

Handedness Index Mean Value of 16.092 indicates right-handedness prevalence. 50% of the sample (N_{valid}=522) gathered at the higher range of right-handedness values on the handedness continuum as the handedness index of theirs was ≥21. Skewness negative index of -2.146 shows negative asymmetry in Handedness Index distribution, which shows that values gathered on the right part of the handedness continuum and the sample was mostly right-handed. Both skewness Index and Kurtosis Index of 3.795 show that distribution declined from normality. Both the right and the left extremes of the handedness condition existed in the sample as both the ±24 indexes were observed on the handedness continuum˙ extreme right-handedness was observed in at least 1/4 of 522. Additional statistics are presented in Table 3.

Table 3: Total sample Handedness Index statistics

Statistics

Handedness Index

N	Valid	522
	Missing	39
Mean		16.0920
Median		21.0000
Mode		24.00
Std. Deviation		12.02633
Skewness		-2.146
Std. Error of Skewness		.107
Kurtosis		3.795
Std. Error of Kurtosis		.213
Range		48.00
Minimum		-24.00
Maximum		24.00
Percentiles	25	14.7500
	50	21.0000
	75	24.0000

Histogram, as shown in Figure 2, depicts Handedness Index distribution.

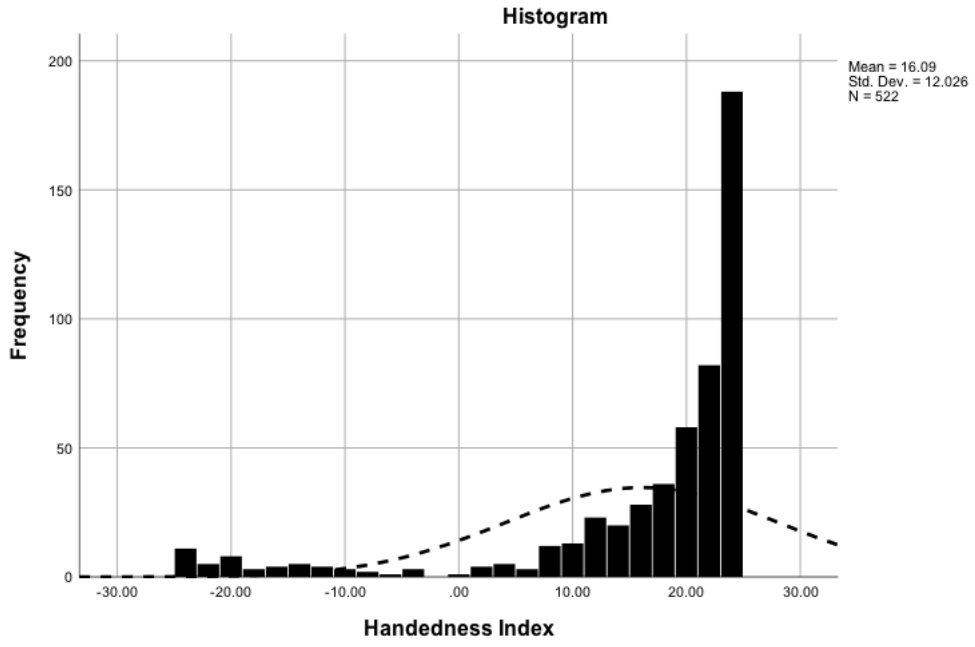

Figure 2: Total sample Handedness Index distribution

(ii) Left-Handedness

8.6% of professionals (N_{valid}=522) were left-handed so long as 85.8% of them were right-handed. The sum of left-handedness and mixed handedness was 14.2%, as, also, shown in Table 4.

Table 4: Total sample Handedness Groups' statistics

Handedness Group					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Left-Handedness	45	8.0	8.6	8.6
	Mixed Handedness	29	5.2	5.6	14.2
	Right-Handedness	448	79.9	85.8	100.0
	Total	522	93.0	100.0	
Missing	System	39	7.0		
Total		561	100.0		

Left-Handedness percentage is depicted graphically in the Bar Chart in Figure 3.

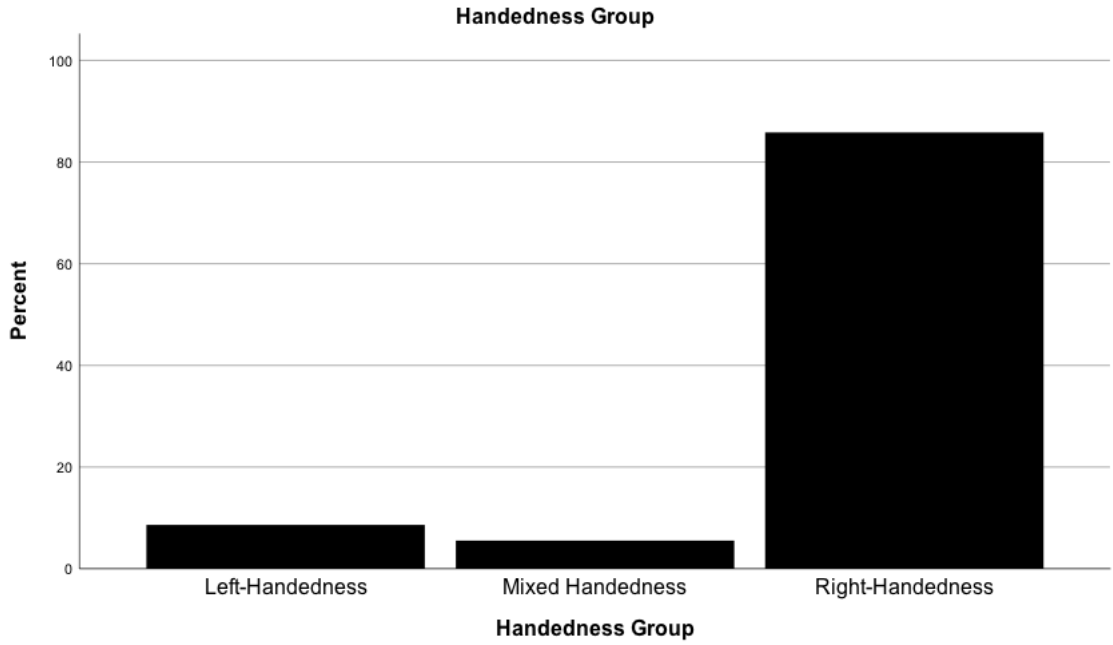

Figure 3: Total sample Handedness Groups' distribution

(iii) Sex

316 male subjects and 233 female subjects constituted the total sample of professionals (N_{valid}=549)˙ and in other words, they constituted the 57.6% and the 42.4% of it respectively, as shown in Table 5.

Table 5: Total sample Sex statistics

Sex: (Male, Female)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	316	56.3	57.6	57.6
	Female	233	41.5	42.4	100.0
	Total	549	97.9	100.0	
Missing	System	12	2.1		
Total		561	100.0		

Pie in Figure 4 depicts Sex results.

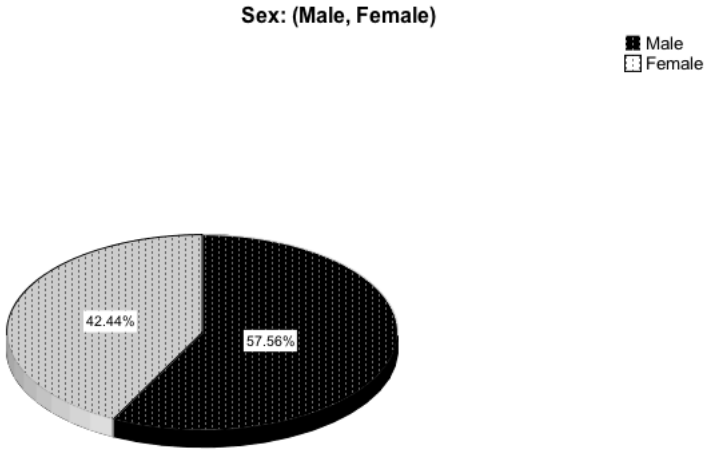

Figure 4: Total sample Sex distribution

(iv) Age

Age Mean Value of 40.154 indicates prevalence of professionals being in the middle adulthood - based on the developmental stages by Erik Homburger Erikson. 50% of the sample (N_{valid}=551) was up to 40 years old as the age of theirs was ≤40 years old while 50% of the sample's age values gathered ±9 years around the age value of 40. Skewness index of .097 shows a positive asymmetry in Age distribution, which means that more of the younger ages values occurred in the sample˙ no problem of asymmetry is ascertained. Kurtosis Index of -.683 shows a platykurtic Age distribution. Range of values of 54 years shows a really broad representation of decades of life. Maximum as well as unique observed age of 72 is rather noteworthy, especially taking into account the male pharmacist's 45 years of work experience (statistics on "Work_Experience_or_Sport_Training" variable will probably be presented in future). Additional statistics are presented in Table 6.

Table 6: Total sample Age statistics

Statistics

Age		
N	Valid	551
	Missing	10
Mean		40.15426
Median		40.00000
Mode		45.000
Std. Deviation		11.895751
Skewness		.097
Std. Error of Skewness		.104
Kurtosis		-.683
Std. Error of Kurtosis		.208
Range		54.000
Minimum		18.000
Maximum		72.000
Percentiles	25	31.00000
	50	40.00000
	75	49.00000

Histogram, as shown in Figure 5, depicts Age normal distribution.

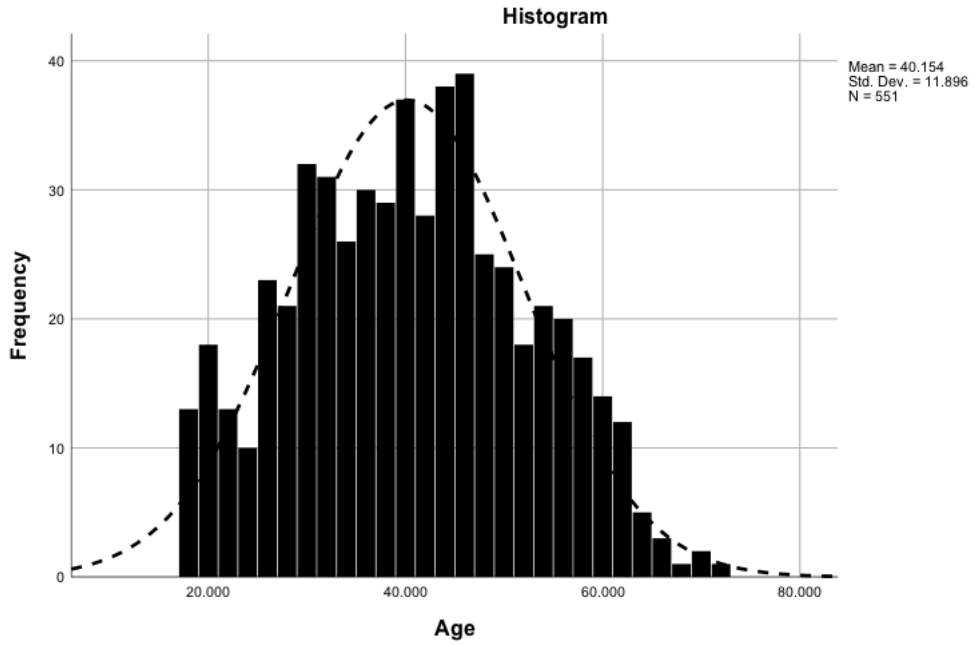

Figure 5: Total sample Age distribution

Age Group analysis organises observed age values from a different point of view providing details by decades. Last age group's - a group which includes the most decades with comparison to each one of all age groups separately - participants percentage (20.7%) was lower than every single percentage of the other age groups. Participation in research seems almost evenly proportioned among the specific age groups, though. A detailed presentation of the analysis is provided in Table 7.

Table 7: Total sample Age Group statistics

Age Group					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	... - 30	130	23.2	23.6	23.6
	31 - 40	153	27.3	27.8	51.4
	41 - 50	154	27.5	27.9	79.3
	51 - ...	114	20.3	20.7	100.0
	Total	551	98.2	100.0	
Missing	System	10	1.8		
Total		561	100.0		

Pie in Figure 6 depicts Age Group results.

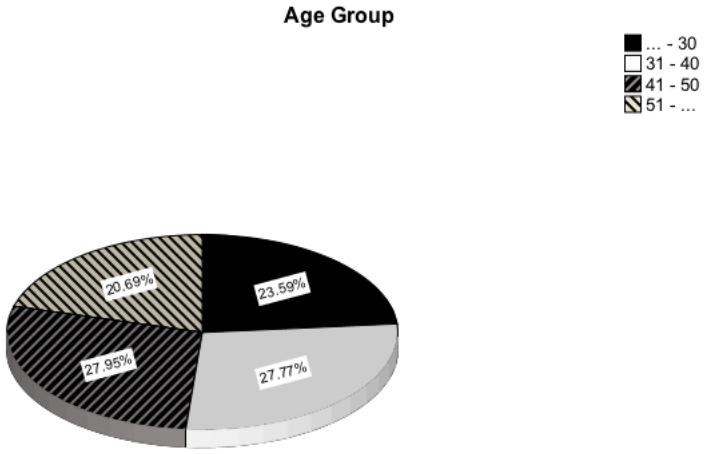

Figure 6: Total sample Age Group distribution

(v) Professions

Nine professions ($N_{total\_sample}=N_{valid}=561$) distribution is comprehensibly presented in Table 8. Most of the participants were Pharmacists ($N_{Pharm.}=110$, 19.6%), following them Musicians ($N_{Mus.}=94$, 16.8%). The least of all were Tennis Athletes ($N_{Tennis.Athl.}=27$, 4.8%) and Architectural Engineers ($N_{Arch.Eng.}=28$, 5.0%), preceding.

Table 8: Total sample professions' statistics

Profession_or_Sport

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Architectural Engineers	28	5.0	5.0	5.0
	Fencing Athletes	68	12.1	12.1	17.1
	Librarians	76	13.5	13.5	30.7
	Musicians	94	16.8	16.8	47.4
	Opticians-Optometrists	71	12.7	12.7	60.1
	Pharmacists	110	19.6	19.6	79.7
	Pilots	50	8.9	8.9	88.6
	Surgeons	37	6.6	6.6	95.2
	Tennis Athletes	27	4.8	4.8	100.0
	Total	561	100.0	100.0	

Professions participation percentages are depicted graphically in the Bar Chart in Figure 7.

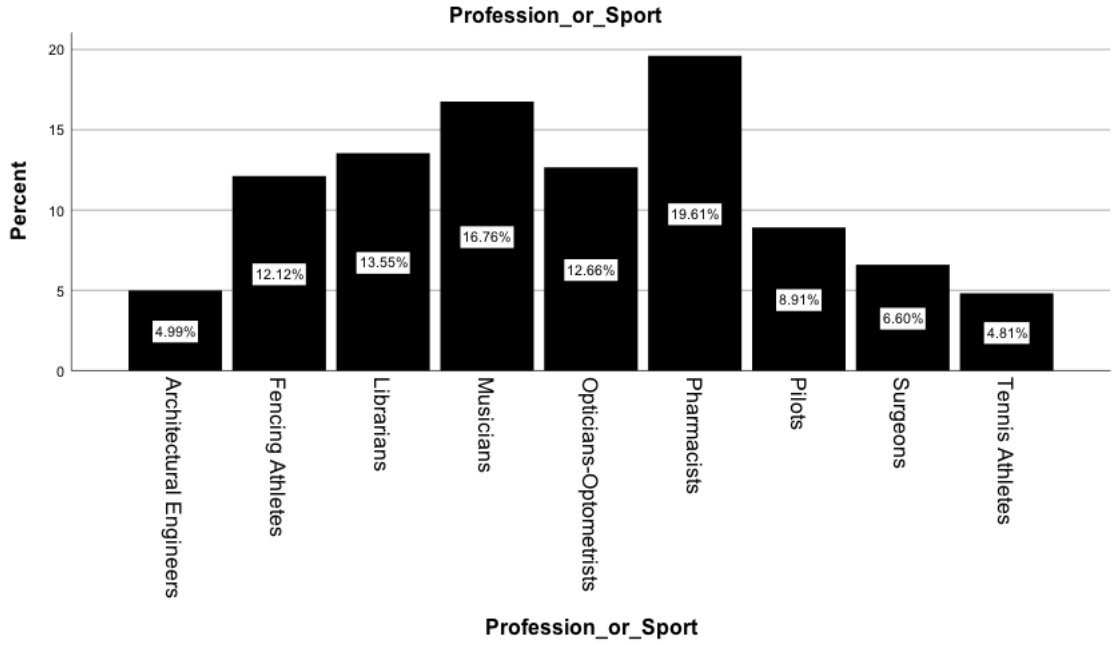

Figure 7: Total sample professions' distribution

[4.2.1.2]. Within Profession

(i) Left-Handedness

13.9% of Librarians and 13.6% of Fencing Athletes were left-handed while 3.7% of Tennis Athletes and 3.1% of Surgeons were left-handed. A high enough percentage (10.7%) occurred for Architectural Engineers, too. The most left-handed in the total sample were encountered in the professions of: (a) Librarians (22.2%), (b) Fencing Athletes (20%), and (c) Pharmacists (17.8%). The sum of left-handedness and mixed-handedness in the following professions is noticeable: (a) Surgeons (25%), (b) Fencing Athletes (19.7%), (c) Librarians (19.5%), (d) Architectural Engineers (17.8%), (e) Optician-Optometrists (12.5%), (f) Pharmacists (12.5%), and (g) Musicians (10.1%).

Worthy of notice, as illustrated in Table 9, too, are Surgeons and Tennis Athletes' Mixed-Handedness percentages, viz., 21.9% and .0% respectively as well as Tennis Athletes and Pilots' Right-Handedness ones, viz., 96.3% and 91.7% respectively˙ the highest percentages of all.

Table 9: Within profession Handedness Groups' statistics

		Handedness Group								
		Left-Handedness			Mixed Handedness			Right-Handedness		
		Count	Row Valid N %	Column Valid N %	Count	Row Valid N %	Column Valid N %	Count	Row Valid N %	Column Valid N %
Profession_or_Sport	Architectural Engineers	3	10.7%	6.7%	2	7.1%	6.9%	23	82.1%	5.1%
	Fencing Athletes	9	13.6%	20.0%	4	6.1%	13.8%	53	80.3%	11.8%
	Librarians	10	13.9%	22.2%	4	5.6%	13.8%	58	80.6%	12.9%
	Musicians	5	5.6%	11.1%	4	4.5%	13.8%	80	89.9%	17.9%
	Opticians-Optometrists	6	9.4%	13.3%	2	3.1%	6.9%	56	87.5%	12.5%
	Pharmacists	8	8.3%	17.8%	4	4.2%	13.8%	84	87.5%	18.8%
	Pilots	2	4.2%	4.4%	2	4.2%	6.9%	44	91.7%	9.8%
	Surgeons	1	3.1%	2.2%	7	21.9%	24.1%	24	75.0%	5.4%
	Tennis Athletes	1	3.7%	2.2%	0	0.0%	0.0%	26	96.3%	5.8%

(ii) Sex

In six out of nine professions males were more than females. Pilots were only males (100%), fact that creates the greatest - the greatest possible that could occur, too - difference (100.0% vs 0.0%) in sexes' representation within a profession in the total sample. The smallest difference, as, also, shown in Table 10, in sexes' representation within a profession exists in the profession of Pharmacists (52.7% vs 47.3%). Both situations described in statistical terms right above can be easily noticed at a glance in labour market in everyday life.

Table 10: Within profession Sex statistics

		Sex: (Male, Female)					
		Male			Female		
		Count	Row Valid N %	Column Valid N %	Count	Row Valid N %	Column Valid N %
Profession_or_Sport	Architectural Engineers	6	21.4%	1.9%	22	78.6%	9.4%
	Fencing Athletes	38	58.5%	12.0%	27	41.5%	11.6%
	Librarians	19	25.3%	6.0%	56	74.7%	24.0%
	Musicians	62	68.1%	19.6%	29	31.9%	12.4%
	Opticians-Optometrists	41	58.6%	13.0%	29	41.4%	12.4%
	Pharmacists	52	47.3%	16.5%	58	52.7%	24.9%
	Pilots	47	100.0%	14.9%	0	0.0%	0.0%
	Surgeons	31	86.1%	9.8%	5	13.9%	2.1%
	Tennis Athletes	20	74.1%	6.3%	7	25.9%	3.0%

(iii) Age

Age Mean of each of the nine professions is given in Table 11. Both Fencing Athletes and Tennis Athletes had the lowest Age Mean Values, of 27.687 years old (±8.271) and 21.000 years old (±3.419) respectively, in the total sample as well as Musicians and Surgeons had the highest Age Mean Values, of 45.130 years old (±8.901) and 49.972 years old (±8.557) respectively, of all professionals. Additional information, the median age value and both the minimum and the maximum age values of each and every profession, cast light on every single age distribution of the nine.

Table 11: Within profession Age statistics

		Age						
		Mean	Row Valid N %	Column Valid N %	Median	Minimum	Maximum	Standard Deviation
Profession_or_Sport	Architectural Engineers	35.286	100.0%	5.1%	35.000	24.000	50.000	6.324
	Fencing Athletes	27.687	100.0%	11.6%	25.000	18.000	50.000	8.271
	Librarians	43.627	100.0%	13.6%	45.000	22.000	56.000	6.596
	Musicians	45.130	100.0%	16.7%	44.000	26.000	70.000	8.901
	Opticians-Optometrists	40.629	100.0%	12.7%	39.000	24.000	67.000	10.927
	Pharmacists	42.009	100.0%	19.8%	36.000	23.000	72.000	12.727
	Pilots	43.040	100.0%	9.1%	43.000	21.000	61.000	10.533
	Surgeons	49.972	100.0%	6.5%	51.000	34.000	63.000	8.557
	Tennis Athletes	21.000	100.0%	4.9%	20.000	18.000	30.000	3.419

Age Group analysis is much more informative, as shown in Table 12: 67.2% of Fencing Athletes and all (100%) Tennis Athletes were up to 30 years old whereas 50% of Surgeons were at least 51 years old. Three professions (Architectural Engineers, Fencing Athletes, Tennis Athletes) showed zero percentage for the older age group while one (Surgeons) showed zero percentage for the younger age group. “Why do the two sports have such a difference in age groups representation?” is a fairly reasonable question arising from it.

In the total sample the most oldest professionals were encountered in the professions of Pharmacists (28.1%) and Musicians (21.1%) since the most youngest were encountered in the professions of Fencing (33.1%) and Tennis (20.8%). The least youngest were met in the professions of Architectural Engineers, Musicians and Pilots (4.6% for all) and the profession of Librarians (3.1%) while the least oldest were met in the profession of Librarians (8.8%).

Results quite likely bring into question issues of entrepreneurship and employment in Greek labour market.

Table 12: Within profession Age Group statistics

		Age Group											
		... - 30			31 - 40			41 - 50			51 - ...		
		Count	Row Valid N %	Column Valid N %	Count	Row Valid N %	Column Valid N %	Count	Row Valid N %	Column Valid N %	Count	Row Valid N %	Column Valid N %
Profession_or_Sport	Architectural Engineers	6	21.4%	4.6%	17	60.7%	11.1%	5	17.9%	3.2%	0	0.0%	0.0%
	Fencing Athletes	43	67.2%	33.1%	17	26.6%	11.1%	4	6.3%	2.6%	0	0.0%	0.0%
	Librarians	4	5.3%	3.1%	13	17.3%	8.5%	48	64.0%	31.2%	10	13.3%	8.8%
	Musicians	6	6.5%	4.6%	24	26.1%	15.7%	38	41.3%	24.7%	24	26.1%	21.1%
	Opticians-Optometrists	15	21.4%	11.5%	23	32.9%	15.0%	18	25.7%	11.7%	14	20.0%	12.3%
	Pharmacists	23	21.1%	17.7%	37	33.9%	24.2%	17	15.6%	11.0%	32	29.4%	28.1%
	Pilots	6	12.0%	4.6%	18	36.0%	11.8%	10	20.0%	6.5%	16	32.0%	14.0%
	Surgeons	0	0.0%	0.0%	4	11.1%	2.6%	14	38.9%	9.1%	18	50.0%	15.8%
	Tennis Athletes	27	100.0%	20.8%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%

[4.2.2]. Inferential Statistics

[4.2.2.1]. Total Sample

(i) Left-Handedness by Profession

Results as depicted in Tables 13 and 14 show that there was statistically significant difference in left-handedness incidence among professions [$\chi_2(16)=28.418$, $p=.028<.05$].

Percentages are presented in [4.2.1.2] (i).

Table 13: Relationship between Handedness Group and Profession in total sample

Handedness Group * Profession_or_Sport Crosstabulation

% within Profession_or_Sport

		Profession_or_Sport									Total
		Architectural Engineers	Fencing Athletes	Librarians	Musicians	Opticians-Optometrists	Pharmacists	Pilots	Surgeons	Tennis Athletes	
Handedness Group	Left-Handedness	10.7%	13.6%	13.9%	5.6%	9.4%	8.3%	4.2%	3.1%	3.7%	8.6%
	Mixed Handedness	7.1%	6.1%	5.6%	4.5%	3.1%	4.2%	4.2%	21.9%		5.6%
	Right-Handedness	82.1%	80.3%	80.6%	89.9%	87.5%	87.5%	91.7%	75.0%	96.3%	85.8%
Total		100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 14: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	28.418[a]	16	.028
Likelihood Ratio	23.810	16	.094
Linear-by-Linear Association	4.250	1	.039
N of Valid Cases	522		

a. 12 cells (44.4%) have expected count less than 5. The minimum expected count is 1.50.

(ii) Left-Handedness by Sex

Results as depicted in Tables 15 and 16 show that there was no statistically significant difference in left-handedness incidence between sexes [$\chi^2(2)=0.99$, $p=.61>.05$].

Table 15: Relationship between Handedness Group and Sex in total sample

Handedness Group * Sex: (Male, Female) Crosstabulation

% within Sex: (Male, Female)

		Sex: (Male, Female)		Total
		Male	Female	
Handedness Group	Left-Handedness	8.5%	9.3%	8.8%
	Mixed Handedness	6.1%	4.2%	5.3%
	Right-Handedness	85.4%	86.6%	85.9%
Total		100.0%	100.0%	100.0%

Table 16: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.990[a]	2	.610
Likelihood Ratio	1.012	2	.603
Linear-by-Linear Association	.005	1	.945
N of Valid Cases	511		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 11.41.

(iii) Left-Handedness by Age Group

Results as depicted in Tables 17 and 18 show that there was no statistically significant difference in left-handedness incidence among age groups [$\chi_2(6)=6.036$, $p=.419>.05$].

Table 17: Relationship between Handedness Group and Age Group in total sample

Handedness Group * Age Group Crosstabulation

% within Age Group

		Age Group				
		... - 30	31 - 40	41 - 50	51 - ...	Total
Handedness Group	Left-Handedness	11.2%	6.1%	9.3%	7.9%	8.6%
	Mixed Handedness	2.4%	6.8%	5.0%	7.9%	5.5%
	Right-Handedness	86.4%	87.1%	85.7%	84.2%	86.0%
Total		100.0%	100.0%	100.0%	100.0%	100.0%

Table 18: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.036[a]	6	.419
Likelihood Ratio	6.463	6	.373
Linear-by-Linear Association	.004	1	.948
N of Valid Cases	513		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.51.

[4.2.2.2]. Within Profession

(i) Left-Handedness by Sex

Results as depicted in Tables 19 and 20 show that there was no statistically significant difference in left-handedness incidence between sexes [$\chi^2_{Arch.Eng.}(2)=1.789$, $p=.409>.05$, $\chi^2_{Fencing.Athl.}(2)=2.38$, $p=.304>.05$, $\chi^2_{Libr.}(2)=2.557$, $p=.278>.05$, $\chi^2_{Mus.}(2)=3.988$, $p=.136>.05$, $\chi^2_{Optic.-Optom.}(2)=1.791$, $p=.408>.05$, $\chi^2_{Pharm.}(2)=2.827$, $p=.243>.05$, $\chi^2_{Surg.}(2)=1.597$, $p=.450>.05$, $\chi^2_{Tennis.Athl.}(1)=.363$, $p=.741>.05$]. Pilots profession due to $N_f=0$ could not be tested.

Table 19: Relationship between Handedness Group and Sex by profession

Handedness Group * Sex: (Male, Female) Crosstabulation

% within Sex: (Male, Female)

Profession_or_Sport			Sex: (Male, Female)		Total
			Male	Female	
Architectural Engineers	Handedness Group	Left-Handedness		13.6%	10.7%
		Mixed Handedness	16.7%	4.5%	7.1%
		Right-Handedness	83.3%	81.8%	82.1%
	Total		100.0%	100.0%	100.0%
Fencing Athletes	Handedness Group	Left-Handedness	15.8%	12.0%	14.3%
		Mixed Handedness	7.9%		4.8%
		Right-Handedness	76.3%	88.0%	81.0%
	Total		100.0%	100.0%	100.0%
Librarians	Handedness Group	Left-Handedness	5.6%	17.0%	14.1%
		Mixed Handedness	11.1%	3.8%	5.6%
		Right-Handedness	83.3%	79.2%	80.3%
	Total		100.0%	100.0%	100.0%
Musicians	Handedness Group	Left-Handedness	5.1%	7.4%	5.8%
		Mixed Handedness	1.7%	11.1%	4.7%
		Right-Handedness	93.2%	81.5%	89.5%
	Total		100.0%	100.0%	100.0%
Opticians-Optometrists	Handedness Group	Left-Handedness	13.5%	3.7%	9.4%
		Mixed Handedness	2.7%	3.7%	3.1%
		Right-Handedness	83.8%	92.6%	87.5%
	Total		100.0%	100.0%	100.0%
Pharmacists	Handedness Group	Left-Handedness	13.3%	3.9%	8.3%
		Mixed Handedness	4.4%	3.9%	4.2%
		Right-Handedness	82.2%	92.2%	87.5%
	Total		100.0%	100.0%	100.0%
Pilots	Handedness Group	Left-Handedness	4.4%		4.4%
		Mixed Handedness	2.2%		2.2%
		Right-Handedness	93.3%		93.3%
	Total		100.0%		100.0%
Surgeons	Handedness Group	Left-Handedness	3.7%		3.2%
		Mixed Handedness	25.9%		22.6%
		Right-Handedness	70.4%	100.0%	74.2%
	Total		100.0%	100.0%	100.0%
Tennis Athletes	Handedness Group	Left-Handedness	5.0%		3.7%
		Right-Handedness	95.0%	100.0%	96.3%
	Total		100.0%	100.0%	100.0%

Table 20: Chi-square test

Chi-Square Tests

Profession_or_Sport		Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Architectural Engineers	Pearson Chi-Square	1.789[a]	2	.409		
	Likelihood Ratio	2.239	2	.326		
	Linear-by-Linear Association	.249	1	.617		
	N of Valid Cases	28				
Fencing Athletes	Pearson Chi-Square	2.380[b]	2	.304		
	Likelihood Ratio	3.440	2	.179		
	Linear-by-Linear Association	.700	1	.403		
	N of Valid Cases	63				
Librarians	Pearson Chi-Square	2.557[c]	2	.278		
	Likelihood Ratio	2.647	2	.266		
	Linear-by-Linear Association	.631	1	.427		
	N of Valid Cases	71				
Musicians	Pearson Chi-Square	3.988[d]	2	.136		
	Likelihood Ratio	3.661	2	.160		
	Linear-by-Linear Association	1.433	1	.231		
	N of Valid Cases	86				
Opticians-Optometrists	Pearson Chi-Square	1.791[e]	2	.408		
	Likelihood Ratio	1.986	2	.370		
	Linear-by-Linear Association	1.486	1	.223		
	N of Valid Cases	64				
Pharmacists	Pearson Chi-Square	2.827[f]	2	.243		
	Likelihood Ratio	2.911	2	.233		
	Linear-by-Linear Association	2.670	1	.102		
	N of Valid Cases	96				
Pilots	Pearson Chi-Square	.[g]				
	N of Valid Cases	45				
Surgeons	Pearson Chi-Square	1.597[h]	2	.450		
	Likelihood Ratio	2.588	2	.274		
	Linear-by-Linear Association	1.385	1	.239		

	N of Valid Cases	31				
Tennis Athletes	Pearson Chi-Square	.363[i]	1	.547		
	Continuity Correction[j]	.000	1	1.000		
	Likelihood Ratio	.614	1	.433		
	Fisher's Exact Test				1.000	.741
	Linear-by-Linear Association	.350	1	.554		
	N of Valid Cases	27				

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .43.

b. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.19.

c. 3 cells (50.0%) have expected count less than 5. The minimum expected count is 1.01.

d. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.26.

e. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .84.

f. 4 cells (66.7%) have expected count less than 5. The minimum expected count is 1.88.

g. No statistics are computed because Sex: (Male, Female) is a constant.

h. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .13.

i. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .26.

j. Computed only for a 2x2 table

(ii) Left-Handedness by Age Group

Results as depicted in Tables 21 and 22 show that there was no statistically significant difference in left-handedness incidence among age groups [$\chi^2_{Arch.Eng.}(4)=2.278$, $p=.685>.05$, $\chi^2_{Fencing.Athl.}(4)=4.796$, $p=.309>.05$, $\chi^2_{Libr.}(6)=8.579$, $p=.199>.05$, $\chi^2_{Mus.}(6)=3.36$, $p=.762>.05$, $\chi^2_{Optic.-Optom.}(6)=3.238$, $p=.778>.05$, $\chi^2_{Pharm.}(6)=5.435$, $p=.489>.05$, $\chi^2_{Pilots}(6)=4.521$, $p=.607>.05$, $\chi^2_{Surg.}(4)=1.624$, $p=.805>.05$]. Tennis Athletes profession due to the fact that all athletes belonged to one age group, the youngests', could not be tested.

Table 21: Relationship between Handedness Group and Age Group by profession

Handedness Group * Age Group Crosstabulation

% within Age Group

Profession_or_Sport			Age Group				Total
			... - 30	31 - 40	41 - 50	51 - ...	
Architectural Engineers	Handedness Group	Left-Handedness	16.7%	11.8%			10.7%
		Mixed Handedness	16.7%	5.9%			7.1%
		Right-Handedness	66.7%	82.4%	100.0%		82.1%
	Total		100.0%	100.0%	100.0%		100.0%
Fencing Athletes	Handedness Group	Left-Handedness	19.0%	6.3%			14.5%
		Mixed Handedness	2.4%	12.5%			4.8%
		Right-Handedness	78.6%	81.3%	100.0%		80.6%
	Total		100.0%	100.0%	100.0%		100.0%
Librarians	Handedness Group	Left-Handedness			19.6%		12.7%
		Mixed Handedness		15.4%	4.3%		5.6%
		Right-Handedness	100.0%	84.6%	76.1%	100.0%	81.7%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Musicians	Handedness Group	Left-Handedness	16.7%	8.7%	5.4%		5.7%
		Mixed Handedness		4.3%	5.4%	4.5%	4.5%
		Right-Handedness	83.3%	87.0%	89.2%	95.5%	89.8%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Opticians-Optometrists	Handedness Group	Left-Handedness	7.1%	9.1%	6.7%	16.7%	9.5%
		Mixed Handedness		4.5%		8.3%	3.2%
		Right-Handedness	92.9%	86.4%	93.3%	75.0%	87.3%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Pharmacists	Handedness Group	Left-Handedness	9.5%	2.9%	9.1%	13.8%	8.4%
		Mixed Handedness	4.8%		9.1%	6.9%	4.2%
		Right-Handedness	85.7%	97.1%	81.8%	79.3%	87.4%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Pilots	Handedness Group	Left-Handedness		5.6%		6.7%	4.2%
		Mixed Handedness		11.1%			4.2%
		Right-Handedness	100.0%	83.3%	100.0%	93.3%	91.7%
	Total		100.0%	100.0%	100.0%	100.0%	100.0%
Surgeons	Handedness Group	Left-Handedness				6.7%	3.2%
		Mixed Handedness		25.0%	16.7%	26.7%	22.6%
		Right-Handedness		75.0%	83.3%	66.7%	74.2%
	Total			100.0%	100.0%	100.0%	100.0%
Tennis Athletes	Handedness Group	Left-Handedness	3.7%				3.7%
		Right-Handedness	96.3%				96.3%
	Total		100.0%				100.0%

Table 22: Chi-square test

Chi-Square Tests

Profession_or_Sport		Value	df	Asymptotic Significance (2-sided)
Architectural Engineers	Pearson Chi-Square	2.278[a]	4	.685
	Likelihood Ratio	2.933	4	.569
	Linear-by-Linear Association	1.549	1	.213
	N of Valid Cases	28		
Fencing Athletes	Pearson Chi-Square	4.796[b]	4	.309
	Likelihood Ratio	5.235	4	.264
	Linear-by-Linear Association	1.436	1	.231
	N of Valid Cases	62		
Librarians	Pearson Chi-Square	8.579[c]	6	.199
	Likelihood Ratio	11.448	6	.075
	Linear-by-Linear Association	.251	1	.617
	N of Valid Cases	71		
Musicians	Pearson Chi-Square	3.360[d]	6	.762
	Likelihood Ratio	4.387	6	.624
	Linear-by-Linear Association	2.096	1	.148
	N of Valid Cases	88		
Opticians-Optometrists	Pearson Chi-Square	3.238[e]	6	.778
	Likelihood Ratio	3.742	6	.712
	Linear-by-Linear Association	.798	1	.372
	N of Valid Cases	63		
Pharmacists	Pearson Chi-Square	5.435[f]	6	.489
	Likelihood Ratio	6.870	6	.333
	Linear-by-Linear Association	1.489	1	.222
	N of Valid Cases	95		
Pilots	Pearson Chi-Square	4.521[g]	6	.607
	Likelihood Ratio	5.694	6	.458
	Linear-by-Linear Association	.014	1	.904
	N of Valid Cases	48		
Surgeons	Pearson Chi-Square	1.624[h]	4	.805
	Likelihood Ratio	2.020	4	.732
	Linear-by-Linear Association	.773	1	.379
	N of Valid Cases	31		
Tennis Athletes	Pearson Chi-Square	.[i]		
	N of Valid Cases	27		

a. 8 cells (88.9%) have expected count less than 5. The minimum expected count is .36.

b. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .19.

c. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .23.

d. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .27.

e. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .38.

f. 8 cells (66.7%) have expected count less than 5. The minimum expected count is .46.

g. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .21.

h. 7 cells (77.8%) have expected count less than 5. The minimum expected count is .13.

i. No statistics are computed because Age Group is a constant.

[4.2.2.3]. Profession vs General Population

(i) Architectural Engineers

Results as depicted in Tables 23 and 24 show that there was no statistically significant difference in left-handedness incidence between Architectural Engineers and General Population [$\chi_2(1)=.086$, $p=.737>.05$].

Table 23: Relationship between Handedness and Architectural Engineers vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		Total
			Architectural Engineers	General Population	
Left-Handedness Index	Left-Handedness	Count	3	108	111
		% within Profession or Sport vs General Population	10.7%	9.1%	9.1%
	Non_ Left-Handedness	Count	25	1079	1104
		% within Profession or Sport vs General Population	89.3%	90.9%	90.9%
Total		Count	28	1187	1215
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 24: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.086[a]	1	.769		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.082	1	.775		
Fisher's Exact Test				.737	.479
Linear-by-Linear Association	.086	1	.769		
N of Valid Cases	1215				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.56.

b. Computed only for a 2x2 table

(ii) Fencing Athletes

Results as depicted in Tables 25 and 26 show that there was no statistically significant difference in left-handedness incidence between Fencing Athletes and General Population [$\chi_2(1)=1.521$, $p=.198>.05$].

Table 25: Relationship between Handedness and Fencing Athletes vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Fencing Athletes	General Population	Total
Left-Handedness Index	Left-Handedness	Count	9	108	117
		% within Profession or Sport vs General Population	13.6%	9.1%	9.3%
	Non_ Left-Handedness	Count	57	1079	1136
		% within Profession or Sport vs General Population	86.4%	90.9%	90.7%
Total		Count	66	1187	1253
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 26: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.521[a]	1	.217		
Continuity Correction[b]	1.032	1	.310		
Likelihood Ratio	1.360	1	.244		
Fisher's Exact Test				.198	.154
Linear-by-Linear Association	1.520	1	.218		
N of Valid Cases	1253				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 6.16.

b. Computed only for a 2x2 table

(iii) Librarians

Results as depicted in Tables 27 and 28 show that there was no statistically significant difference in left-handedness incidence between Librarians and General Population [$\chi_2(1)=1.834$, $p=.207>.05$].

Table 27: Relationship between Handedness and Librarians vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Librarians	General Population	Total
Left-Handedness Index	Left-Handedness	Count	10	108	118
		% within Profession or Sport vs General Population	13.9%	9.1%	9.4%
	Non_ Left-Handedness	Count	62	1079	1141
		% within Profession or Sport vs General Population	86.1%	90.9%	90.6%
Total		Count	72	1187	1259
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 28: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.834[a]	1	.176		
Continuity Correction[b]	1.313	1	.252		
Likelihood Ratio	1.633	1	.201		
Fisher's Exact Test				.207	.128
Linear-by-Linear Association	1.832	1	.176		
N of Valid Cases	1259				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.75.

b. Computed only for a 2x2 table

(iv) Musicians

Results as depicted in Tables 29 and 30 show that there was no statistically significant difference in left-handedness incidence between Musicians and General Population [$\chi_2(1)=1.243$, $p=.335>.05$].

Table 29: Relationship between Handedness and Musicians vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Musicians	General Population	Total
Left-Handedness Index	Left-Handedness	Count	5	108	113
		% within Profession or Sport vs General Population	5.6%	9.1%	8.9%
	Non_ Left-Handedness	Count	84	1079	1163
		% within Profession or Sport vs General Population	94.4%	90.9%	91.1%
Total		Count	89	1187	1276
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 30: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.243[a]	1	.265		
Continuity Correction[b]	.849	1	.357		
Likelihood Ratio	1.399	1	.237		
Fisher's Exact Test				.335	.180
Linear-by-Linear Association	1.242	1	.265		
N of Valid Cases	1276				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.88.

b. Computed only for a 2x2 table

(v) Opticians-Optometrists

Results as depicted in Tables 31 and 32 show that there was no statistically significant difference in left-handedness incidence between Opticians-Optometrists and General Population [$\chi_2(1)=.006$, $p=.826>.05$].

Table 31: Relationship between Handedness and Opticians-Optometrists vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Opticians-Optometrists	General Population	Total
Left-Handedness Index	Left-Handedness	Count	6	108	114
		% within Profession or Sport vs General Population	9.4%	9.1%	9.1%
	Non_ Left-Handedness	Count	58	1079	1137
		% within Profession or Sport vs General Population	90.6%	90.9%	90.9%
Total		Count	64	1187	1251
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 32: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.006[a]	1	.940		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.006	1	.941		
Fisher's Exact Test				.826	.537
Linear-by-Linear Association	.006	1	.940		
N of Valid Cases	1251				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.83.

b. Computed only for a 2x2 table

(vi) Pharmacists

Results as depicted in Tables 33 and 34 show that there was no statistically significant difference in left-handedness incidence between Pharmacists and General Population [$\chi_2(1)=.063$, $p=1.000>.05$].

Table 33: Relationship between Handedness and Pharmacists vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Pharmacists	General Population	Total
Left-Handedness Index	Left-Handedness	Count	8	108	116
		% within Profession or Sport vs General Population	8.3%	9.1%	9.0%
	Non_ Left-Handedness	Count	88	1079	1167
		% within Profession or Sport vs General Population	91.7%	90.9%	91.0%
Total		Count	96	1187	1283
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 34: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.063[a]	1	.801		
Continuity Correction[b]	.004	1	.947		
Likelihood Ratio	.065	1	.799		
Fisher's Exact Test				1.000	.491
Linear-by-Linear Association	.063	1	.802		
N of Valid Cases	1283				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 8.68.

b. Computed only for a 2x2 table

(vii) Pilots

Results as depicted in Tables 35 and 36 show that there was no statistically significant difference in left-handedness incidence between Pilots and General Population [$\chi_2(1)=1.383$, p=.309>.05].

Table 35: Relationship between Handedness and Pilots vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Pilots	General Population	Total
Left-Handedness Index	Left-Handedness	Count	2	108	110
		% within Profession or Sport vs General Population	4.2%	9.1%	8.9%
	Non_ Left-Handedness	Count	46	1079	1125
		% within Profession or Sport vs General Population	95.8%	90.9%	91.1%
Total		Count	48	1187	1235
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 36: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.383[a]	1	.240		
Continuity Correction[b]	.842	1	.359		
Likelihood Ratio	1.682	1	.195		
Fisher's Exact Test				.309	.182
Linear-by-Linear Association	1.382	1	.240		
N of Valid Cases	1235				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 4.28.

b. Computed only for a 2x2 table

(viii) Surgeons

Results as depicted in Tables 37 and 38 show that there was no statistically significant difference in left-handedness incidence between Surgeons and General Population [$\chi_2(1)=1.366$, $p=.353>.05$].

Table 37: Relationship between Handedness and Surgeons vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		
			Surgeons	General Population	Total
Left-Handedness Index	Left-Handedness	Count	1	108	109
		% within Profession or Sport vs General Population	3.1%	9.1%	8.9%
	Non_ Left-Handedness	Count	31	1079	1110
		% within Profession or Sport vs General Population	96.9%	90.9%	91.1%
Total		Count	32	1187	1219
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 38: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.366[a]	1	.243		
Continuity Correction[b]	.730	1	.393		
Likelihood Ratio	1.772	1	.183		
Fisher's Exact Test				.353	.203
Linear-by-Linear Association	1.364	1	.243		
N of Valid Cases	1219				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.86.

b. Computed only for a 2x2 table

(ix) Tennis Athletes

Results as depicted in Tables 39 and 40 show that there was no statistically significant difference in left-handedness incidence between Tennis Athletes and General Population [$\chi_2(1)=.940$, $p=.504>.05$].

Table 39: Relationship between Handedness and Tennis Athletes vs General Population

Left-Handedness Index * Profession or Sport vs General Population Crosstabulation

			Profession or Sport vs General Population		Total
			Tennis Athletes	General Population	
Left-Handedness Index	Left-Handedness	Count	1	108	109
		% within Profession or Sport vs General Population	3.7%	9.1%	9.0%
	Non_ Left-Handedness	Count	26	1079	1105
		% within Profession or Sport vs General Population	96.3%	90.9%	91.0%
Total		Count	27	1187	1214
		% within Profession or Sport vs General Population	100.0%	100.0%	100.0%

Table 40: Chi-square test

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.940[a]	1	.332		
Continuity Correction[b]	.396	1	.529		
Likelihood Ratio	1.179	1	.278		
Fisher's Exact Test				.504	.286
Linear-by-Linear Association	.939	1	.332		
N of Valid Cases	1214				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.42.

b. Computed only for a 2x2 table

CHAPTER 5th - DISCUSSION

[5.1]. Conclusions-Interpretation

The present research tried to investigate left-handedness incidence in nine professions (see [1.3.2].) by comparison to general population's one. The non-parametric statistical χ_2 test (chi-square test for independence) was used so as to test the respective nine left-handedness hypotheses.

According to the χ_2 test results - for some of which greater scepticism and cautiousness is suggested to the reader before adopting them - all nine stated null hypotheses (H_0) in [2.2.6]. are deemed to be proved and in all nine profession cases the two categorical variables are independent. Conclusions and interpretation are presented below.

(i) Architectural Engineers

The null hypothesis that Architectural Engineers do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

Our study is not consistent with the Peterson and Lansky (1974) study percentage results. No comparison between neither our study and the Schachter and Ransil (1996) study results nor our study and the Wood and Aggleton (1991) study statistical comparison results is possible as of their different point of reference.

In the Peterson and Lansky (1974) survey 29.4% of the male faculty architects were left-handed˙ two right-handed were left-handers as children. The above percentage was higher than the one in the "normal" population, defined to range between 8% and 10%. In the Schachter and Ransil (1996) study architects were the most left-handed among the nine professions: E.H.I. laterality score (weighted average total mean): 41.82 (min.: 41.82, max.: 45.13)˙ highest left relative frequency (.1757) as well as highest left laterality index (3.46) of all in the self-reported global handedness question. In our study left-handedness incidence observed in the profession of Architectural Engineers was 10.7%, as shown in Tables 9, 13, 19, 21 and 23 and the one observed in the male Architectural Engineers was 0.0%, as shown in Table 19. The first percentage is higher than the 9.1% and the second one is lower than the respective in the Grouios et al. (2000) study of male control group, which was 10.1% (see Table 1, p. 1277). In addition, the above mentioned percentage of 10.7% with comparison to the other eight professions' percentages is high enough in the relevant percents sequence (third in turn, in the upper one third), indicating that Architectural Engineers are of the most left-handed professionals among the examined ones [see [4.2.1.2]. (i)].

In terms of statistical significance, in the Wood and Aggleton (1991) study researchers "found no evidence of an abnormal proportion of left-handers among either qualified architects…" (p. 398) and more specifically the 10.2% of the 236 male professionals' left-handedness was not different from the male control group's one of 10%, according to Oldfield (as cited in Wood and Aggleton, 1991). In our study it was found that there was no statistically significant difference in left-handedness incidence between Architectural Engineers and General Population [$\chi_2(1)=.086$, $p=.737>.05$] [see [4.2.2.3]. (i)]. No further by sex analysis is available thus far (statistics on it will probably be presented in future).

The specific statistical result does not provide support for the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b, 1986) as architectural engineers, although spatial skills, which, as deemed, derive from the right hemisphere of the human brain, are prerequisite in the specific profession (Wood & Aggleton, 1991; ISCO-08), do not differ from the general population in terms of left-handedness.

(ii) Fencing Athletes

The null hypothesis that Fencing Athletes do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

Our study is consistent with the Grouios et al. (2000) study percentage results. No comparison of our study and the Grouios et al. (2000) study statistical comparison results is possible as of their different point of reference.

In the Grouios et al. (2000) study left-handedness incidence, especially, for fencing athletes, was found to be as high as 37.7% [male: 42.9%, female: 33.3%]. The above percentage was higher than the one in the nonsporting university students (9.1%). Furthermore, the above mentioned male and female fencing athletes' left-handedness incidences were higher than the respective ones in the Grouios et al. (2000) study of male and female control groups, which were 10.1% and 8.0% (see Table 1, p. 1277). In our study left-handedness incidence observed in the profession of Fencing Athletes was 13.6%, as shown in Tables 9, 13 and 25 and the ones observed in the male and female Fencing Athletes were 15.8% and 12.0%, respectively, as shown in Table 19. The first is higher than the 9.1% and the second and third ones are higher than the respective ones in the Grouios et al. (2000) study of male and female control groups, which were 10.1% and 8.0% (see Table 1, p. 1277). Finally, in both studies the profession proves to be of the most left-handed due to incidences

of 37.7% (first in turn) and 13.6% (second in turn) with comparison to the co-examined interactive and non-interactive sports and eight professions, respectively.

In terms of statistical significance, in the Grouios et al. (2000) study there was difference in left-handedness incidence between sporting competitors and nonsporting university students˙ higher incidence was observed in the first group (14.8%). No further by sport statistical analysis is available in the specific published paper. In our study it was found that there was no statistically significant difference in left-handedness incidence between Fencing Athletes and General Population [$\chi_2(1)=1.521$, $p=.198>.05$] (see [4.2.2.3]. (ii)]. No further by sex analysis is available thus far (statistics on it will probably be presented in future).

The specific statistical result does not provide support for the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b, 1986) as fencing athletes, although spatial attention skills, which, as deemed, derive from the right hemisphere of the human brain, are prerequisite in the specific sport (Bisiacchi et al., 1985), do not differ from the general population in terms of left-handedness.

(iii) Librarians

The null hypothesis that Librarians do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

No comparison between our study and the Schachter and Ransil (1996) study results is possible as of their different point of reference.

In the Schachter and Ransil (1996) study librarians were of the most right-handed among the nine professions: E.H.I. laterality score (weighted average total mean): 44.98 (2_{nd} in turn) (min.: 41.82, max.: 45.13)˙ highest right laterality score (48.49) of all in the self-reported global handedness question. In our study left-handedness incidence observed in the profession of Librarians was 13.9%, as shown in Tables 9, 13 and 27 and with comparison to the other eight professions' percentages it is the highest of all in the relevant percents sequence, indicating that Librarians are the most left-handed professionals among the examined ones [see [4.2.1.2]. (i)].

The specific statistical result does not provide support for the Levy's (1969) contention (as cited in Crowley, 1989) as librarians, although verbal proficiency skills, which, as deemed, derive as well from the right hemisphere of the human brain in left-handed people, are prerequisite in the specific profession, according to Lau (as cited in Schachter & Ransil, 1996), do not differ from the general population in terms of left-handedness.

(iv) Musicians

The null hypothesis that Musicians do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

In both our study and the Preti & Vellante (2007) study the left-handedness, the mixed-handedness and the right-handedness groups for the musicians are observed.

The profession of Musicians demands relative fine motor hand movement skills (Christman, 1993).

(v) Opticians-Optometrists

The null hypothesis that Opticians-Optometrists do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

(vi) Pharmacists

The null hypothesis that Pharmacists do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

The specific statistical result does not provide support for the Levy's theory (as cited in Gilbert, 1977) as pharmacists, although language skills, which, as deemed, derive as well from the right hemisphere of the human brain in left-handed people, are prerequisite for similar drug name discrimination in the specific profession, according to Chermak (2009), do not differ from the general population in terms of left-handedness.

(vii) Pilots

The null hypothesis that Pilots do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

Our study is both consistent and not with the Pipraiya and Chowdhary (2006) survey percentage results depending on the stated each time in literature comparison base range.

We use at this point as such a base the 1% to 29.3% range of left-handedness incidence, as stated in Perelle & Ehrman (1994).

In the Pipraiya and Chowdhary (2006) survey 7.39% of a section of pilots of the Indian Air Force were left-handed. The above percentage was as the one of the general population, or as the author writes “within the stated incidence for left-handed individuals in general population.” (p. 30). In our study left-handedness incidence observed in the profession of Pilots was 4.2%, as shown in Tables 9, 13, 21 and 35. The percentage is within the above stated in literature broadest range.

(viii) Surgeons

The null hypothesis that Surgeons do not show a different incidence of left-handedness in comparison to general population’s one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

Our study is consistent with the Schott and Puttick (1995) study percentage results. No comparison between our study and the Schachter and Ransil (1996) study results is possible as of their different point of reference.

In the Schott and Puttick (1995) study none of the 36 surgeons was left-handed. The respective percentage result, the zero one (0.0%), is de facto the lowest possible with comparison to either the one of the one and only co-examined group of physicians (12%), or any comparison base rate used for the general population (see [2.1.2]., [d].). In our study left-handedness incidence observed in the profession of Surgeons was 3.1%, as shown in Tables 9, 13 and 37. The percentage is the lowest of all the co-examined professions’ respective ones, as shown in Tables 9 and 13, and, also, lower than even the lowest of the used, according to previously mentioned literature, base rates, the one of 6%.

In the Schachter and Ransil (1996) study orthop(a)edic surgeons were the most right-handed among the nine professions by the following measures: E.H.I. laterality score (weighted average total mean): 45.13 (min.: 41.82, max.: 45.13)˙ highest right relative frequency (.9166) of all in the self-reported global handedness question. In our study right-handedness incidence observed in the profession of Surgeons was 75.0%, as shown in Tables 9 and 13 and with comparison to the other eight professions’ percentages it is the lowest of all in the relevant percents sequence indicating that Surgeons are the least right-handed professionals among the examined ones [see [4.2.1.2]. (i)].

(ix) Tennis Athletes

The null hypothesis that Tennis Athletes do not show a different incidence of left-handedness in comparison to general population's one is deemed to be proved. There is no relationship between left-handedness and the specific profession or, more precisely, the demanded skills and professional performance (see [2.2.1].).

Our study is not consistent neither with the Grouios et al. (2000) study percentage results nor with the Wood and Aggleton (1989) study percentage results. No comparison between neither our study and the Grouios et al. (2000) study statistical results nor our study and the Wood and Aggleton (1989) as well as the Holtzen (2000) studies statistical results is possible as of their different point of reference.

In the Grouios et al. (2000) study left-handedness incidence, especially, for tennis athletes, was found to be as high as 17.3% [male: 18.2%, female: 16.6%]. The above percentage was higher than the one in the nonsporting university students (9.1%). Furthermore, the above mentioned male and female tennis athletes' left-handedness incidences were higher than the respective ones in the Grouios et al. (2000) study of male and female control groups, which were 10.1% and 8.0% (see Table 1, p. 1277). In the Wood and Aggleton (1989) study left-handedness incidence was found to range between 11.6% and 16.5% for the male professional tennis players and between 10.7% and 12.6% for the female professional tennis players, included for both sexes all cases examined (see Table 1, p. 231). The above mentioned male and female tennis players' left-handedness incidences were higher than the respective ones in the same study of male and female control groups, which were 8.9% and 8.0% (see Table 1, p. 231). In our study left-handedness incidence observed in the profession of Tennis Athletes is 3.7%, as shown in Tables 9, 13, 19, 21 and 39 and the ones observed in the male and female Tennis Athletes are 5.0% and 0.0%, respectively, as shown in Table 19. The first is lower than the 9.1% and the second as well as the third, the zero one, de facto the lowest possible, are lower than the respective ones in the Grouios et al. (2000) study of male and female control groups, which were 10.1% and 8.0% (see Table 1, p. 1277).

In terms of statistical significance, in the Grouios et al. (2000) study there was difference in left-handedness incidence between sporting competitors and nonsporting university students˙ higher incidence was observed in the first group (14.8%). No further by sport statistical analysis is available in the specific published paper. In the Wood and Aggleton (1989) as well as in the Holtzen (2000) studies only by sex statistical comparisons are available. In our study it was found that there was no statistically significant difference in left-handedness incidence between Tennis Athletes and General Population [$\chi_2(1)=.940$,

p=.504>.05] (see [4.2.2.3]. (ix)]. No further by sex analysis is available thus far (statistics on it will probably be presented in future).

The specific statistical result does not provide support for the Geschwind and Galaburda's cerebral lateralization theory (1985a, 1985b, 1986) as tennis athletes, although spatial skills, which, as deemed, derive from the right hemisphere of the human brain, are prerequisite in the specific sport (Holtzen, 2000), do not differ from the general population in terms of left-handedness.

Studies' results considerable inconsistency is a well-known reality in handedness research literature (Cosenza & Mingoti, 1993). It is generally attributed to a number of factors, some of which have been briefly outlined in Critical Analysis (see [2.1.2].). As far as it concerns our research results' differentiation with previous studies' ones, measurement tools, sample size and left-handedness comparison base rates can be thought to have been of the factors having exerted influence on˙ all populations in studies compared are professionals.

As technological advancements directly affect professions (Imhoff & Levine, 1981), namely the required tasks and duties, and so the demanded skills, handedness research literature to date should be taken into account with cautiousness in our information society era. Pilots as well as surgeons' professions are referred to be of the most illustrative examples of it.

[5.2]. Future Work: Labour Market Applications and Research

The study results could be taken into account by professionals in labour market both the ones of the respective nine examined professions as well as the personnel and careers professionals (Schachter & Ransil, 1996; ISCO-08) in employees' recruitment process, in career counseling provision or else human resource development service such as education, vocational training or promotion. Contrasting literature should be seriously considered complementarily in parallel by them.

The study results could be taken into account by researchers so as to delve deeper into the topic investigating further points and/or questions logically arisen. Research on the topic could be replicated using larger and of equal size samples of professionals, if possible˙ investigation could, also, be extended to other professions of analogous as of the ones examined in our research skills requirements. In addition, we could further investigate handedness in professions by item of the twelve in the Briggs and Nebes' (1975) inventory and make comparisons with the Schachter and Ransil (1996) respective results. What is more,

we could classify the nine professions in categories by required skill and examine left-handedness among professions within each category as well as make comparisons with the Schachter and Ransil (1996) respective results. Furthermore, patterns of combination of handedness with eyedness, earedness or footedness in professionals could be investigated as such combinations prove to be/might be of critical importance for professional performance, as for example, in the case of opticians or for appropriate instruments' design and construction, as in the case of surgeons (Adusumilli et al., 2004). An interesting, more detailed investigation within profession would be the analysis of subjects' handedness by professional sub-specialties or other categorization, as for instance, surgical sub-specialties in the profession of surgeons or categories based on type of aircraft piloted in the profession of pilots or ones generated by musical instrument category, as in the case of Christman's (1993) study, in the profession of musicians, purposing to highlight career choice or sampling bias. Finally, the Briggs and Nebes (1975) questionnaire itself could be further evaluated and developed based on total response material, both written or typed and oral one, of the 561 participants.

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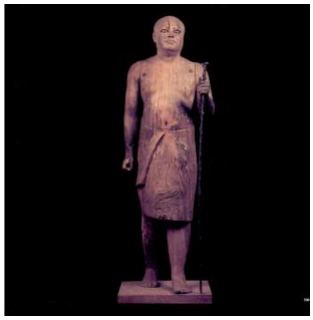
APPENDICES

Appendix A

"ArtWORK"

(a) Sculpture:



The wooden statue of Ka-aper, called Sheikh el-Balad.
Photograph by Atiya Farid.
Source: El-Shahawy, Abeer (2005).

Appendix B

Inventories - Questionnaires

(a) The Jasper's Handedness Inventory (Jasper, 1932; Annett, 1970).

Appendix

Date.....

HANDEDNESS INDEX

Name..... Age..... Sex..... Race..... Nationality .... .

Are you right handed or left handed *now?*

Were you ever changed from left to right handedness?

Did you ever stutter? At what age? For how long?

Did you ever have the right arm or hand injured for any length of time?

For how long? At what age?

In using tools with long handles, the hands may be used in one of two ways:

A. Right hand near outer end of handle, left hand nearer the "business end" of the instrument—such as hoe, rake, etc.

B. Leht hand near outer end of handle, right hand nearer the "business end" of the instrument.

If in using the following tools, you almost always use your hands as in "A", draw a circle around "A".

If you almost always use your hands as in "B", draw a circle around "B". If you have no particular choice, draw a circle around "X".

1. Hoe	A B X	4. Shovel	A B X	7. Axe	A B X
2. Rake	A B X	5. Broom	A B X	8. Ball bat	A B X
3. Pitchfork	A B X	6. Spade	A B X	9. Golf club	A B X

10. In which direction do you ordinarily sweep: (1) Toward the right, (2) Toward the left, (3) No particular choice.

11. From which shoulder do you ordinarily swing a baseball bat: (1) Right, (2) Left, (3) No particular choice.

In doing the following acts, one hand does all or almost all of the work. If you almost always use the right hand, draw a circle around "R". If you almost always use the left hand, draw a circle around "L". If you have no particular choice, or if you use both hands (as, for example, shaving one side of your face with one hand, and the other side with the other hand), draw a circle around "X" Answer only for those acts which you have actually done.

1. Which hand drives billiard cue?	R L X
2. Which hand swings tennis racket?	R L X
3. Which hand throws a ball?	R L X
4. With which foot do you kick?	R L X

5. Which foot steps on a spade? R L X
6. Which hand does most in shuffling cards? R L X
7. Which hand deals the cards? R L X
8. Which hand works lever in filling your pen? R L X
9. Which hand turns the pages as you read? R L X
10. Which hand puts the letter in the envelope? R L X
11. Which hand puts the stamp on the envelope? R L X
12. Which hand tears open envelope? R L X
13. Which eye stays open when you aim a gun? R L X
14. Against which shoulder do you hold butt of gun? R L X
15. Which hand holds knife when you whittle? R L X
16. Which hand cuts with the knife in eating? R L X
17. Which hand holds the fork in eating? R L X
18. Which hand uses the salt shaker? R L X
19. (You hold a dish in one hand and wash or wipe it with the other.) Which hand washes the dish? R L X
20. Which hand wipes the dish? R L X
21. Which hand combs your hair? R L X
22. Which hand strops your razor? R L X
23. Which hand shaves your face? R L X
24. Which hand uses the powder puff? R L X
25. Which hand uses the tooth brush? R L X
26. Which hand winds your watch? R L X
27. Which hand scratches matches? R L X
28. Which hand holds your cigarette? R L X
29. Which hand uses the dust cloth? R L X
30. Which hand uses the needle in sewing? R L X
31. Which hand holds the thread in threading the needle? R L X
32. Which hand uses the scissors? R L X
33 When you wash your hands, which hand rubs the soap on the other? R L X
34. Which hand wraps the tie around when you tie your tie? R L X
35. Which hand would you use for lifting and carrying a cup level full of water? R L X
36. Which hand uses a saw? R L X
37. Which hand uses a hammer? R L X
38. Which hand uses a screw driver? R L X
39. Which hand uses wrenches? R L X
40. Which hand cranks a car? R L X
41. Which hand uses a key in a lock? R L X
42. Which hand turns nuts on bolts? R L X
43. Which hand handles the money which you pay for something? R L X
44. Which side do you sleep on? R L X
45. Which hand holds a paper cup for drinking? R L X
46. In jumping which foot gives the last push? R L X
47. Which hand goes in coat sleeve first? R L X
48. Under which arm do you usually carry books? R L X
49. Which hand turns a door knob? R L X
50. Which hand holds the receiver when telephoning? R L X
51. Which hand usually pulls out a drawer? R L X
52. Which hand hangs up your hat? R L X
53. Which hand stirs when mixing things? R L X
54. Which hand picks up right shoe when dressing? R L X
55. Which hand picks up left shoe when dressing? R L X

56. Which shoe do you take off first?	R L X
57. Which shoe is put on first?	R L X
58. Which stocking do you put on first?	R L X
59. Which stocking do you take off first?	R L X
60. Which glove is put on first?	R L X
61. Which hand turns key when locking a door?	R L X
62. Which hand reaches to pick up small object on floor in front of you?	R L X
63. Which hand writes letters?	R L X
64. Which hand draws pictures?	R L X
65. Which hand does figuring?	R L X
66. Which hand erases on paper?	R L X
67. Which hand does the most manipulating when tying shoe string?	R L X
68. Which hand leads in reaching to a high shelf?	R L X
69. Which hand uses the can opener?	R L X
70. Which hand turns egg beater?	R L X
71. Which hand turns on water tap?	R L X
72. Which hand takes mail out of box?	R L X
73. Which hand pulls corks from bottles?	R L X
74. Which hand supports you in rising from sitting position on floor?	R L X
75. When standing with both feet together which foot goes forward first to catch yourself when you start to fall?	R L X
76. Which ear do you turn towards a sound that is hard to hear?	R L X

(b) The Test for Handedness (Crovitz & Zener, 1962).

TEST FOR HANDEDNESS

Answer the following questions carefuly. Imagine yourself performing the activity described before answering each question. Answer by drawing a circle around the

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Psychol., 57, 1958, 292-298; Seymour Fisher and Joseph Abercrombie, The relationship of body image distortions to body reactivity gradients, *J. Pers.*, 26, 1958, 320-329.

[7] Julius Wishner and Thomas Shipley, Jr., Direction of autokinetic movement as a test of the "Sensory-Tonic-Field" theory of perception, *J. Pers.*, 23, 1954, 99-106.

[8] Crovitz, *op. cit.*, 19.

[9] In the Wishner and Shipley study, it is possible that this might have occurred, since the criterion of left-handedness was similar to Items 1, 2, 3, 8 and 9 in the test described below, with only half the 'left-handed' *Ss* giving results on all of these in a left-handed direction.

[10] Our thanks are due Donald Freedheim, William Groman, and George Greenberg for assisting in the collection of the data and also to Elaine K. Crovitz for assisting in scoring and tabulating the results.

appropriate set of letters appearing to the left of each question whose meanings is:[11]

Ra = right hand always.
Rm = right hand most of the time.
E = both hands equally often.
Lm = left hand most of the time.
La = left hand always.
X = do not know which hand.

(1) Ra Rm E Lm La X: is used to write with.
(2) Ra Rm E Lm La X: to hold nail when hammering.
(3) Ra Rm E Lm La X: to throw a ball.
(4) Ra Rm E Lm La X: to hold bottle when removing top.
(5) Ra Rm E Lm La X: is used to draw with.
(6) Ra Rm E Lm La X: to hold potato when peeling.
(7) Ra Rm E Lm La X: to hold pitcher when pouring out of it.
(8) Ra Rm E Lm La X: to hold scissors when cutting.
(9) Ra Rm E Lm La X: to hold knife when cutting food.
(10) Ra Rm E Lm La X: to hold needle when threading.
(11) Ra Rm E Lm La X: to hold drinking glass when drinking.
(12) Ra Rm E Lm La X: to hold tooth brush when brushing teeth.
(13) Ra Rm E Lm La X: to hold dish when wiping.
(14) Ra Rm E Lm La X: holds tennis racket when playing.

Every item is scored on a 5-point scale. On Items 1, 3, 5, 7, 8, 9, 11, 12 and 14, Ra is scored '1'; Rm, '2'; E, '3'; Lm, '4'; and La, '5.' All other items (2, 4, 6, 10, 13) are scored in the reverse fashion. Items marked X are prorated. The highest possible right-handed score is 14, and the highest left-handed score is 70.

(c) The Questionnaire including “handedness inventory” used by Oldfield in musicians (Oldfield, 1969).

APPENDIX A

1.4	Have you ever had any tendency to left-handedness?	Yes	No

2. Please indicate your preference in the use of hands in the following activities *by putting + in the appropriate column*. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put* + +. If in any case you are really indifferent, put + *in both columns*. Some of the activities require both hands. In these cases the part of the task, or object, for which the hand-preference is wanted is indicated in brackets.

		R	L
2.1	Writing		
2.2	Drawing		
2.3	Throwing		
2.4	Scissors		
2.5	Razor		
2.6	Comb		
2.7	Toothbrush		
2.8	Knife (without fork)		
2.9	Spoon		
2.10	Hammer		
2.11	Screwdriver		
2.12	Tennis racket		
2.13	Fishing rod		
2.14	Knife (with fork)		
2.15	Cricket bat (lower hand)		
2.16	Golf club (lower hand)		
2.17	Broom (upper hand)		
2.18	Rake (upper hand)		
2.19	Striking match (match)		
2.20	Opening box (lid)		
2.21	Dealing cards (card being dealt)		
2.22	Threading needle (needle or thread according to which is *moved*)		
2.40	Which foot do you prefer to kick with?		
2.41	Which eye do you use when using only one?		
2.50	Were efforts ever made to get you to use the hand opposite to the one you preferred to use, in musical, or any other, activity?	Yes	No
	2.501 If Yes, in what activities?		
	2.503 Did the change become established?	Yes	No

4. If you think you ever had any tendency to left-handedness, please answer the following questions:

4.1	Were you ever told that this tendency would be a handicap or difficulty to you in pursuing your musical interests?	Yes	No
4.2	Did you ever think this yourself?	Yes	No
4.3	Has it in fact been a difficulty?	Yes	No
4.31	If Yes, please enlarge briefly.		
4.32	If Yes, have you had to make a conscious effort to overcome such difficulties?	Yes	No
4.4	If you have made such an adaptation in relation to musical activities, has this altered your left-handed tendencies in other connexions?	Yes	No
4.41	If Yes, say in which.		
4.5	In any musical activity do you now use the hand opposite to that used by the majority of your colleagues?	Yes	No
4.51	If Yes, give details.		

(d) The Hand-Preference Questionnaire (Annett, 1970).

APPENDIX I

QUESTIONNAIRE 2

Handedness research

NAME_____ AGE_____ SEX_____

Were you one of twins, triplets at birth or were you single born?

*Please indicate which hand you habitually use for each of the following activities by writing R (for right), L (for left), E (for either).

Which hand do you use:

1. To write a letter legibly? .....
2. To throw a ball to hit a target? .....
3. To hold a racket in tennis, squash or badminton? .....
4. To hold a match whilst striking it? .....
5. To cut with scissors? .....
6. To guide a thread through the eye of a needle (or guide needle on to thread)? .....
7. At the top of a broom while sweeping? .....
8. At the top of a shovel when moving sand? .....
9. To deal playing cards? .....
10. To hammer a nail into wood? .....
11. To hold a toothbrush while cleaning your teeth? .....
12. To unscrew the lid of a jar? .....

If you use the RIGHT HAND FOR ALL OF THESE ACTIONS, are there any one-handed actions for which you use the LEFT HAND? Please record them here .....

.....

If you use the LEFT HAND FOR ALL OF THESE ACTIONS, are there any one-handed actions for which you use the RIGHT HAND? Please record them here.....

.....

QUESTIONNAIRE 3

* This sentence was omitted.

(e) The Handedness Inventory (Oldfield, 1971).

APPENDIX 1

M.R.C. Speech and Communication Research Unit

HANDEDNESS INVENTORY

NAME .....

DATE OF BIRTH .....

SEX .....

Have you ever had any tendency to left-handedness?

YES NO

Please indicate your preferences in the use of hands in the following activities *by putting + in the appropriate column*. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put ++*. If in any case you are really indifferent *put + in both columns*.

Some of the activities require both hands. In these cases the part of the task, or object, for which hand-preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		R	L
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Comb		
6	Toothbrush		
7	Knife (without fork)		
8	Spoon		
9	Hammer		
10	Screwdriver		
11	Tennis Racket		
12	Knife (with fork)		
13	Cricket bat (lower hand)		
14	Golf Club (lower hand)		
15	Broom (upper hand)		
16	Rake (upper hand)		
17	Striking Match (match)		
18	Opening box (lid)		
19	Dealing cards (card being dealt)		
20	Threading needle (needle or thread according to which is moved)		
40	Which foot do you prefer to kick with?		
41	Which eye do you use when using only one?		

(f) The Edinburgh Handedness Inventory (Oldfield, 1971).

APPENDIX II

Medical Research Council Speech & Communication Unit

EDINBURGH HANDEDNESS INVENTORY

Surname..... Given Names.....

Date of Birth..... Sex.....

Please indicate your preferences in the use of hands in the following activities *by putting + in the appropriate column.* Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, *put ++.* If in any case you are really indifferent *put + in both columns.*

Some of the activities require both hands. In these cases the part of the task, or object, for which hand preference is wanted is indicated in brackets.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		LEFT	RIGHT
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Toothbrush		
6	Knife (without fork)		
7	Spoon		
8	Broom (upper hand)		
9	Striking Match (match)		
10	Opening box (lid)		
i	Which foot do you prefer to kick with?		
ii	Which eye do you use when using only one?		

L.Q.		Leave these spaces blank	DECILE	

(g) The Handedness Questionnaire used by Raczkowski et al. in undergraduates, Duke University (Raczkowski et al., 1974).

Table 1. Instructions and questions of the handedness questionnaire. The order of the questions has been changed to facilitate discussion of results.

Name.....

This is a survey to discover which hand you use in the following manual tasks. Circle L if you perform the task with your left hand; circle R if you perform the task with your right hand; circle B if you perform the task equally well with both hands. Assume that your hands are empty (except as indicated) before attempting each task. If you have no experience with a given task, do not mark a preference.

With which hand do you:

1. draw?	L	R	B
2. write?	L	R	B
3. remove the top card of a deck of cards (i.e. dealing?)	L	R	B
4. use a bottle opener?	L	R	B
5. throw a baseball to hit a target?	L	R	B
6. use a hammer?	L	R	B
7. use a toothbrush?	L	R	B
8. use a screwdriver?	L	R	B
9. use an eraser on paper?	L	R	B
10. use a tennis racket?	L	R	B
11. use scissors?	L	R	B
12. hold a match when striking it?	L	R	B
13. stir a liquid or semi-solid?	L	R	B
14. on which shoulder do you rest a bat before swinging?	L	R	B
15. with which foot do you kick a ball?	L	R	B
16. carry your books or book bag?	L	R	B
17. pick up the salt or pepper shaker?	L	R	B
18. guide a string through the eye of a needle (needle stationary)?	L	R	B
19. which foot do you put a shoe on first?	L	R	B
20. pour a large volume of liquid from a pitcher?	L	R	B
21. hold a filled cup or glass when drinking?	L	R	B
22. which arm do you place in a coat sleeve first?	L	R	B
23. which hand is on top of the handle when you sweep the floor with a straight broom?	L	R	B

(h) The Handedness Inventory developed by Bryden in 1977 (as cited in Sandry & Wickens, 1982).

APPENDIX A

Assessment of Handedness (Bryden, 1977)

NAME: _____

Have you ever had any tendency to left handedness?

YES NO

Please indicate your preferences in the use of hands in the following activities by putting "+" in the appropriate column. Where the preference is so strong that you would never try to use the other hand unless absolutely forced to, put "++". If in any case you are really indifferent, put "+" in both columns.

Please try to answer all the questions, and only leave a blank if you have no experience at all of the object or task.

		R	L
1	Writing		
2	Drawing		
3	Throwing		
4	Scissors		
5	Comb		
6	Toothbrush		

APPENDIX A (cont.)

1. Do you consider yourself right-handed, left-handed, or ambi-dexterous?

_____ _____

2. Is there anyone in your family (blood relations) who is left-handed or ambidexterous? If so, who?

_____

3. Were you ever considered left-handed and then for some reason changed? If so, why and when?

_____

4. Is there any activity or set of activities not on this list for which you consistently use your non-dominant hand?

_____

(i) Handedness Questionnaire used by Pipraiya and Chowdhary in 2006 [R. Pipraiya, personal communication (e-mail), January 26, 2018, 15.49].

Appendix 'A'

Institute of Aerospace Medicine

THE EDINBURH HANDEDNESS INVENTORY

Handedness Questionnaire

NAME- RANK- SERVICE-

No.- UNIT- AGE-

FLYING EXPERIENCE-

Instructions
For each of the ten activities below, please tell us:

1. **Which hand do you prefer for that activity?**
2. **Do you *ever* use the other hand for the activity?**

Which hand do you prefer when:	Right/Left/Either
Writing:	
Drawing:	
Throwing:	
Using Scissors:	
Using a Toothbrush:	
Using a Knife (without fork):	
Using a Spoon:	
Using a Broom (upper hand):	
Striking a Match:	
Opening a Box (lid):	

Thank you for your responses

This handedness questionnaire was adapted from:

Oldfield, R.C. The assessment and analysis of handedness: the Edinburgh inventory. Neuropsychologia; 9(1): 97-113. 1971.

(j) The Fazio Laterality Inventory (F.L.I.) (Fazio et al., 2013).

APPENDIX

Fazio Laterality Inventory

Instructions

Please indicate the percentage of time (0% to 100%) that you use your **RIGHT** hand for the following tasks. Please answer each question; however, if you have no experience with an object or task, then leave it blank.

For example, if you almost always use your right hand to throw a ball, then enter "98" in the blank. However, if you always use your left hand for that task, then enter a "0."

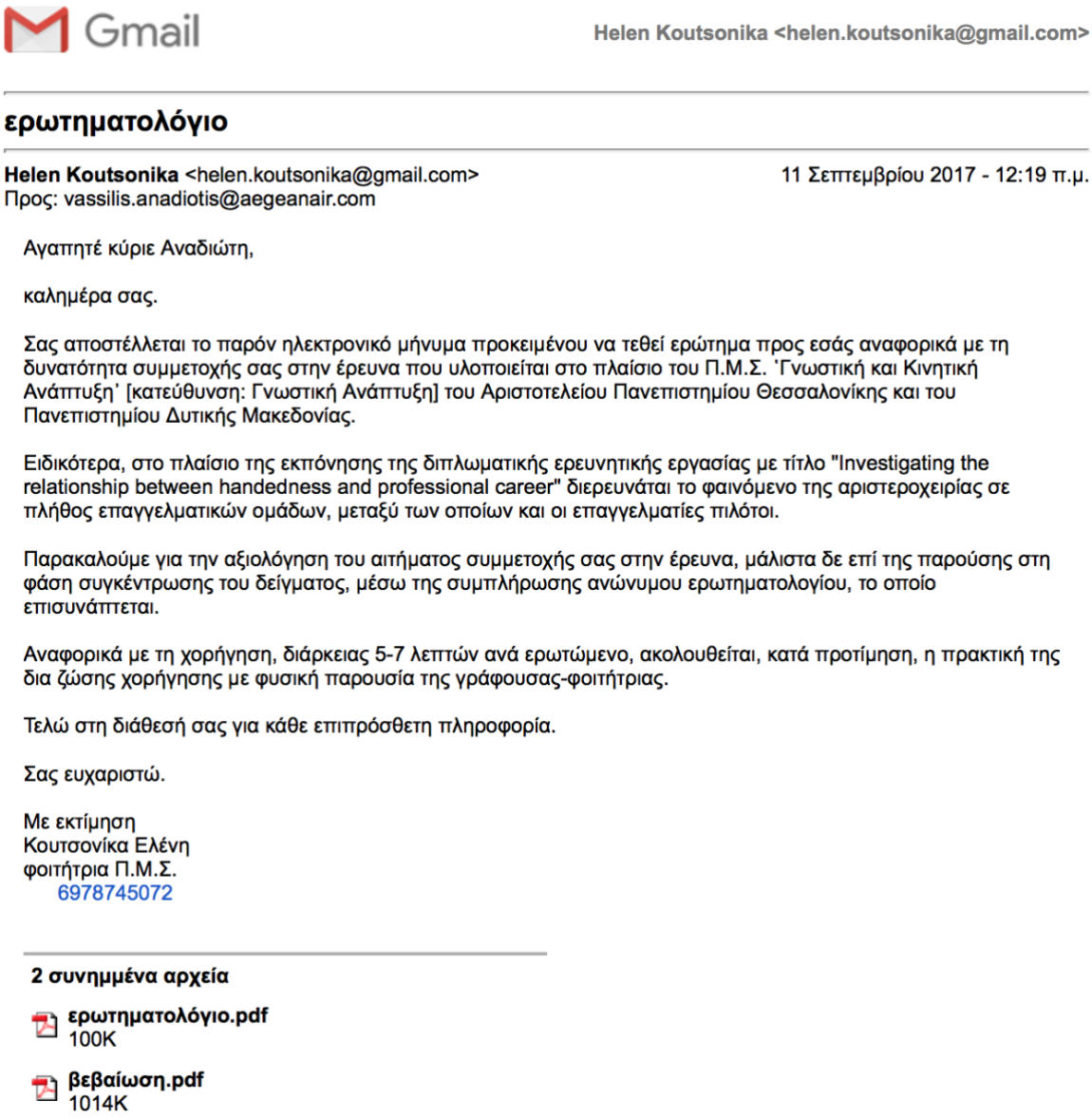
Task	%
Writing	
Drawing	
Waving hello or goodbye	
Using a TV remote	
Snapping your fingers	
Scratching an itchy nose	
Pointing at something in the distance	
Throwing an object	
Reaching to pick up an object	
Using a hammer	

I believe myself to be: ☐ Right-handed ☐ Left-handed
☐ Ambidextrous (use both hands equally)

Are your answers influenced by impairment to your shoulder, arm, or hand (e.g., amputation, injury, arthritis, paralysis, palsy, etc.)?
☐ Yes ☐ No.

Appendix C

Official contact e-mail (contact case: Profession of Pilots)



Gmail — Helen Koutsonika <helen.koutsonika@gmail.com>

ερωτηματολόγιο

Helen Koutsonika <helen.koutsonika@gmail.com> 11 Σεπτεμβρίου 2017 - 12:19 π.μ.
Προς: vassilis.anadiotis@aegeanair.com

Αγαπητέ κύριε Αναδιώτη,

καλημέρα σας.

Σας αποστέλλεται το παρόν ηλεκτρονικό μήνυμα προκειμένου να τεθεί ερώτημα προς εσάς αναφορικά με τη δυνατότητα συμμετοχής σας στην έρευνα που υλοποιείται στο πλαίσιο του Π.Μ.Σ. 'Γνωστική και Κινητική Ανάπτυξη' [κατεύθυνση: Γνωστική Ανάπτυξη] του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης και του Πανεπιστημίου Δυτικής Μακεδονίας.

Ειδικότερα, στο πλαίσιο της εκπόνησης της διπλωματικής ερευνητικής εργασίας με τίτλο "Investigating the relationship between handedness and professional career" διερευνάται το φαινόμενο της αριστεροχειρίας σε πλήθος επαγγελματικών ομάδων, μεταξύ των οποίων και οι επαγγελματίες πιλότοι.

Παρακαλούμε για την αξιολόγηση του αιτήματος συμμετοχής σας στην έρευνα, μάλιστα δε επί της παρούσης στη φάση συγκέντρωσης του δείγματος, μέσω της συμπλήρωσης ανώνυμου ερωτηματολογίου, το οποίο επισυνάπτεται.

Αναφορικά με τη χορήγηση, διάρκειας 5-7 λεπτών ανά ερωτώμενο, ακολουθείται, κατά προτίμηση, η πρακτική της δια ζώσης χορήγησης με φυσική παρουσία της γράφουσας-φοιτήτριας.

Τελώ στη διάθεσή σας για κάθε επιπρόσθετη πληροφορία.

Σας ευχαριστώ.

Με εκτίμηση
Κουτσονίκα Ελένη
φοιτήτρια Π.Μ.Σ.
6978745072

2 συνημμένα αρχεία

ερωτηματολόγιο.pdf
100K

βεβαίωση.pdf
1014K

Appendix D

Questionnaire [Printed, f2f mode]

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΠΡΟΤΙΜΩΜΕΝΟΥ ΆΝΩ ΆΚΡΟΥ [ΧΕΙΡΟΣ]

A/A: .....
Ημερομηνία: ...../..../2016

Φύλο: Άνδρας ☐ Γυναίκα ☐
Ηλικία: .....
Επάγγελμα: .....
Έτη προϋπηρεσίας: .....

Ερωτηματολόγιο Προτιμώμενου Άνω Άκρου [Χειρός]

Ποιο από τα δύο χέρια χρησιμοποιείς προκειμένου να:	Πάντα το αριστερό	Συνήθως το αριστερό	Και τα δύο / Δεν υπάρχει προτίμηση / Αδιάφορο	Συνήθως το δεξί	Πάντα το δεξί
[1]. γράφεις ένα καλλιγραφικό γράμμα					
[2]. ρίζεις μια μπάλα σ' ένα στόχο					
[3]. παίζεις τέννις					
[4]. ανάφεις ένα σπίρτο					
[5]. κόφεις ένα χαρτί με το φαλίδι					
[6]. περάσεις την κλωστή στη βελόνα					
[7]. μοιράσεις τα χαρτιά					
[8]. καρφώσεις ένα καρφί					
[9]. βουρτσίσεις τα δόντια σου					
[10]. ξεβιδώσεις μια βίδα					
[11]. καθαρίσεις μια επιφάνεια μ' ένα σκουπάκι					
[12]. μαζέφεις τα χώματα από μια επιφάνεια μ' ένα φτυαράκι					

***Πηγή*:**
Briggs, G. G., & Nebes, R. D. (1975). Patterns of Hand Preference in a Student Population. *Cortex, 11* (3), 230-238. doi:10.1016/S0010-9452(75)80005-0

Είναι κάποιος ή κάποιοι από τους συγγενείς σου αριστερόχειρας, -ες; *ΝΑΙ* ☐ *ΟΧΙ* ☐

Εάν ΝΑΙ, ποιος ή ποιοι;

…… …… ……
…… …… ……
…… …… ……

Έκανες κάποια ειδική εξάσκηση **ή δέχθηκες** κάποιου είδους ενθάρρυνση προκειμένου να χρησιμοποιήσεις το ένα από τα δύο σου χέρια σε μία ή και περισσότερες από τις αριθμημένες από το [1] έως το [12] ενέργειες του ως άνω πίνακα;

ΝΑΙ ☐ *ΟΧΙ* ☐

Εάν ΝΑΙ, σε ποια ή ποιες, και γιατί;

……, διότι ……
……, διότι ……
……, διότι ……
……, διότι ……
……, διότι ……

Είχες τραυματιστεί ποτέ σοβαρά στο κεφάλι κατά τη διάρκεια της βρεφικής ή νηπιακής σου ηλικίας, έτσι ώστε να χρειαστεί να νοσηλευτείς για το λόγο αυτό σε ιδιωτικό ή/και κρατικό νοσοκομείο;

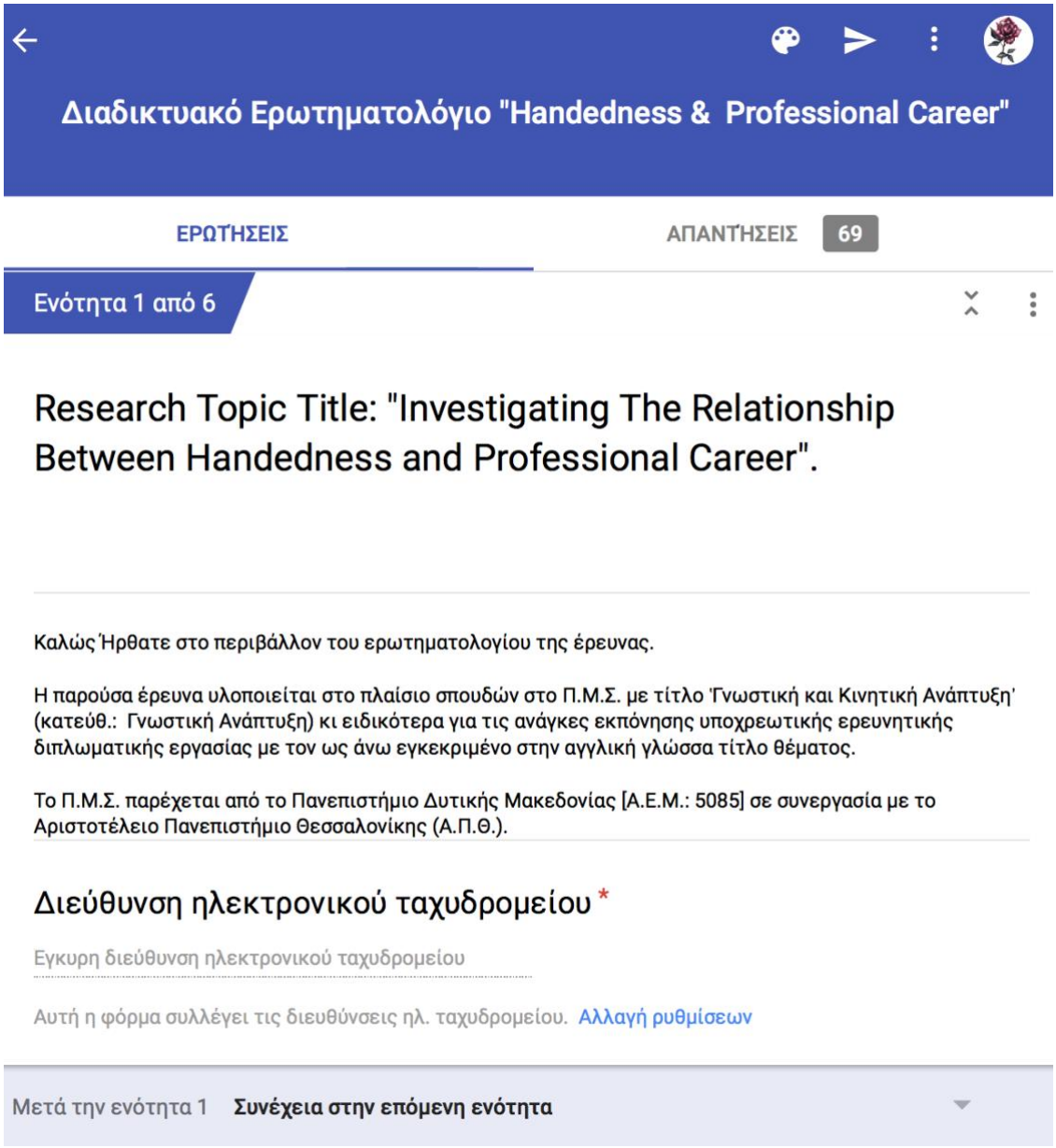
ΝΑΙ ☐ *ΟΧΙ* ☐

Εάν ΝΑΙ, **πότε** και **πόσο σοβαρά**;

……
……
……
……

Appendix E

Questionnaire [Google Form, e-mail mode]



Ενότητα 2 από 6

Εισαγωγή - Ενημέρωση

Περιγραφή (προαιρετικό)

Τα δύο Ημισφαίρια του Ανθρώπινου Εγκεφάλου κι η μεταξύ τους σύνδεση "Corpus Callosum".

Πηγή απεικόνισης: Wikipedia, 2017 (https://en.wikipedia.org/wiki/Corpus_callosum, 16.4.2017, 12.39) [Life Science Databases (LSDB) - Anatomography Website, Άδεια: CC-BY-SA-2.1-jp].

Σκοποί-στόχοι & Σχετική Βιβλιο/Αρθρο-γραφία:

Στην παρούσα έρευνα προτίμησης χεριού (handedness) πρόκειται ειδικά να διερευνηθεί ο δείκτης αριστεροχειρίας σε έναν αριθμό δειγμάτων επαγγελματικών ομάδων (π.χ. Αρχιτέκτονες Μηχανικοί, Βιβλιοθηκονόμοι, Μουσικοί, Οπτικοί, Φαρμακοποιοί, Πιλότοι, Ιατροί Χειρουργοί) κι ομάδων αθλητών αγωνιστικού επιπέδου (π.χ. Αθλητές Ξιφασκίας, Αθλητές Αντισφαίρισης).

Ο δείκτης αυτός δύναται να συγκριθεί με τον αντίστοιχο δείκτη του γενικού πληθυσμού. Δύναται δε να μελετηθεί περαιτέρω η ισχύς εξειδικευμένων ανά επάγγελμα κι άθλημα ερευνητικών υποθέσεων [π.χ. υψηλό ποσοστό αριστεροχειρίας σε συγκεκριμένο τύπο μουσικών οργάνων (Christman, 1993)].

Η προτίμηση χεριού συνδέεται με τη λειτουργία των ημισφαιρίων του εγκεφάλου, ακριβέστερα δε με την κυρίαρχη λειτουργία του ενός εκ των δύο και - σε γενική θεώρηση - κατά τρόπο αντίστροφο (δεξί/αριστερό χέρι - αριστερό/δεξί ημισφαίριο), αποτελώντας ουσιαστικά την ορατή έκφανση αυτής.

Σε ορισμένα επαγγέλματα (π.χ. Αρχιτέκτονες Μηχανικοί, Μουσικοί) κι αθλήματα (π.χ. Αθλητές Ξιφασκίας) καταγράφονται υψηλά ποσοστά αριστεροχειρίας (Peterson & Lansky, 1974; Schachter & Ransil, 1996; Preti & Vellante, 2007; Christman, 1993; Grouios, Tsorbatzoudis, Alexandris, and Barkoukis, 2000)˙ μάλιστα δε όσο πιο υψηλό το επίπεδο των απαιτήσεων μιας θέσης ή ενός αγώνα τόσο πιο υψηλά τα ποσοστά αριστεροχειρίας.

Στη βιβλιο/αρθρο-γραφία απαντώνται αντιφατικά αποτελέσματα σε ορισμένες από τις ως άνω περιπτώσεις ομάδων ενώ σε άλλες δεν υπάρχουν έρευνες καθόλου.

Συμμετοχή κατά προαίρεση

Παρακαλείσθε, εφόσον είστε επαγγελματίας και μόνον, για τη συμπλήρωση των ερωτήσεων ως πρέπει. Η συμβολή σας αυτή υποστηρίζει την ορθή διεξαγωγή της έρευνας και τη βέλτιστη δυνατή παραγωγή ουσιαστικών αποτελεσμάτων.

Σε κάθε περίπτωση που επιθυμείτε να επικοινωνήσετε με την φοιτήτρια-ερευνήτρια για ενδεχόμενες ερωτήσεις επί του ερωτηματολογίου προ της συμπλήρωσης κι υποβολής του, αυτό είναι εφικτό μέσω ηλεκτρονικής επικοινωνίας, και στους λογαριασμούς ηλεκτρονικού ταχυδρομείου: helen.koutsonika AT gmail DOT com, ekoutson AT phed DOT auth DOT gr, κι, ekoutson AT gapps DOT auth DOT gr (κατά προτίμηση).

Κάθε λήψη και συγκέντρωση στοιχείων υποκειμένων της παρούσης έρευνας τελείται εμπιστευτικά και στο μέγιστο δυνατό βαθμό ασφάλειας. Τα έν λόγω στοιχεία αποτελούν υλικό υποστήριξης της ερευνητικής προσπάθειας κι ως εκ τούτου αντικείμενο επεξεργασίας μόνον στο πλαίσιο αυτής.

Παρακαλείσθε να είστε διαθέσιμοι με το πέρας της χορήγησης του παρόντος προκειμένου για ενδεχόμενες διευκρινίσεις επί των απαντήσεων χάριν βελτίωσης της ποιότητας των ερευνητικών δεδομένων.

Η υποβολή του παρόντος ερωτηματολογίου από κάθε υποκείμενο της έρευνας συνεπάγεται πως αυτή αποτελεί τη μοναδική κι αποκλειστική συμμετοχή του και για μια και μόνη αποκλειστικά επαγγελματική ομάδα ή ομάδα αθλητών αγωνιστικού επιπέδου.

Η κατάθεση διακριτικού της επαγγελματικής ιδιότητας (π.χ. ενός επαγγελματικού email) κρίνεται σημαίνουσα για την έρευνα˙ αποτελεί δε κατά βούληση ενέργεια των υποκειμένων της έρευνας.

Μετά την ενότητα 2 **Συνέχεια στην επόμενη ενότητα**

Ενότητα 3 από 6

Δημογραφικές ερωτήσεις

Περιγραφή (προαιρετικό)

Φύλο: *

- Άνδρας
- Γυναίκα

Ηλικία: *

Κείμενο σύντομης απάντησης

Επάγγελμα: *

Κείμενο μακροσκελούς απάντησης

Έτη προϋπηρεσίας: *

Κείμενο σύντομης απάντησης

Μετά την ενότητα 3 **Συνέχεια στην επόμενη ενότητα**

Ενότητα 4 από 6

Ερωτηματολόγιο Προτιμώμενου Άνω Άκρου [Χειρός]

Πηγή ερωτηματολογίου: Briggs, G. G., & Nebes, R. D. (1975). Patterns of Hand Preference in a Student Population. Cortex, 11(3), 230-238. doi:10.1016/S0010-9452(75)80005-0

Ποιο από τα δύο χέρια χρησιμοποιείς προκειμένου να: *

	Πάντα το αριστ...	Συνήθως το αρι...	Και τα δύο / Δε...	Συνήθως το δεξί	Πάντα το δεξί
[1]. γράψεις ένα...	○	○	○	○	○
[2]. ρίξεις μια μ...	○	○	○	○	○
[3]. παίξεις τένις	○	○	○	○	○
[4]. ανάψεις ένα...	○	○	○	○	○
[5]. κόψεις ένα ...	○	○	○	○	○
[6]. περάσεις τη...	○	○	○	○	○
[7]. μοιράσεις τ...	○	○	○	○	○
[8]. καρφώσεις ...	○	○	○	○	○
[9]. βουρτσίσεις...	○	○	○	○	○
[10]. ξεβιδώσει...	○	○	○	○	○
[11]. καθαρίσει...	○	○	○	○	○
[12]. μαζέψεις τ...	○	○	○	○	○

Μετά την ενότητα 4 **Συνέχεια στην επόμενη ενότητα**

Ενότητα 5 από 6

Ερωτήσεις σε συγκεκριμένα κρίσιμα ζητήματα [συγγένεια, εξάσκηση/ενθάρρυνση, τραυματισμός]

Περιγραφή (προαιρετικό)

Είναι κάποιος ή κάποιοι από τους συγγενείς σου αριστερόχειρας, - *

- ΝΑΙ
- ΌΧΙ

Εάν ΝΑΙ, ποιος ή ποιοι;

Κείμενο μακροσκελούς απάντησης

Έκανες κάποια ειδική εξάσκηση ή δέχθηκες κάποιου είδους *

ενθάρρυνση προκειμένου να χρησιμοποιήσεις το ένα από τα δύο σου χέρια σε μία ή και περισσότερες από τις αριθμημένες από το [1]. έως το [12]. ενέργειες του ως άνω πίνακα (στην Ενότητα 4);

- ΝΑΙ
- ΌΧΙ

Εάν ΝΑΙ, σε ποια ή ποιες, και γιατί;

Κείμενο μακροσκελούς απάντησης

Είχες τραυματιστεί ποτέ σοβαρά στο κεφάλι κατά τη διάρκεια της βρεφικής ή νηπιακής σου ηλικίας, έτσι ώστε να νοσηλευτείς για το λόγο αυτό σε ιδιωτικό ή/και κρατικό νοσοκομείο; *

- ΝΑΙ
- ΌΧΙ

Εάν ΝΑΙ, πότε και πόσο σοβαρά;

Κείμενο μακροσκελούς απάντησης

Μετά την ενότητα 5 **Συνέχεια στην επόμενη ενότητα**

Ενότητα 6 από 6

Ολοκλήρωση

Σας ευχαριστούμε ιδιαίτερα για την συμπλήρωση του διαδικτυακού ερωτηματολογίου της έρευνας.

Τελώ στη διάθεσή σας για κάθε επιπρόσθετη πληροφορία ή/και διευκρίνιση μελλοντικά στους ως άνω λογαριασμούς ηλεκτρονικού ταχυδρομείου [Ενότητα: 'Εισαγωγή - Ενημέρωση'].

Appendix F

Abbreviations

A.U.TH.	Aristotle University of Thessaloniki
B.V.	Besloten vennootschap
.co.uk	commercial United Kingdom
doi	digital object identifier
EEG	Electroencephalogram, Electroencephalograph(y)
e.g.	exempli gratia
E.H.I.	Edinburgh Handedness Inventory
e-mail	electronic mail
et al.	et alii
etc.	et cetera
F.L.I.	Fazio Laterality Inventory
f2f	face-to-face
html	hypertext markup language
https	hypertext transport(transfer) protocol secure
IL	Illinois
Inc.	Incorporated
i/o	input/output
the Annett H.P.Q.	the Annett Hand Preference Questionnaire
I.N.S.E.P.	Institut National du Sport et de l' Éducation Physique
M.I.S.T.-V.R.	Minimally Invasive Surgical Trainer - Virtual Reality
N.A.T.C.	Naval Air Test Centre
.pdf	portable document format
pp.	pages
Rh	Rhesus
R.S. Theory	Right Shift Theory
R.T.	Reaction Time
U.S.A.	United States of America
U.S.A.F.S.A.M.	United States Air Force School of Aerospace Medicine
viz.	videlicet
vs	versus
W.F.C.	World Fencing Championship
yr	year