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RESEARCH ARTICLE

LINGUISTIC REHABILITATION AND SINGING POTENTIAL: CORRELATING PERFORMANCE SHAPES WITH SONIC CONTOURS

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ABSTRACT

In most cases Cochlear Implant users are subject to post-surgical treatment that not only calibrates and adjusts via mapping functions the acoustic characteristics of the recipient's hearing, but also applies linguistic course treatments designed to reverse the physical or mental debilitating effects of severe hearing loss. Usually Cochlear Implant users attend stringent Special Education courses to regain normal schooling access. During this process, distinguishing features of oral and aural communication are promoted. This research extrapolates the learning aptitude tests, like storytelling, to the sphere of singing and music comprehension in general. It aims to evince how neurophysiological processes in oral and aural communication are affected by mental representations and how the observation of meaningful signals can reveal musical contours that link social or musical intelligence attributes with performance shapes.

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INTRODUCTION

Not all cars produce the same sonic impression as they soar across the streets. The idiosynchratic potential of their engines along with other crucial characteristics of their make, like their cubic capacity, their chassis, their suspensions, their gear box, even their tyres or the quality of fuel they use, shape more or less their physiognomy in terms of vehicular attributes. Some of these attributes are quite pellucible by visual inspection between established analogies: one can easily tell a sports car from a sedan, a jeep from a van, a two seater from a four or five seater and so on. Although visual inspection unfolds most established order credentials, the inmost qualifiers remain hidden. Many models share the same body car, but a multitude of offered engines partake the overall automobile performance. Even further, these characteristics form a sonic image that uncovers a hidden, rich potential unimaginable to the unversed in the secrets of the trade.

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A skilled mechanic by hearing the sound effects of the engine will attest the equipoise level of performance the very same way that an experienced physician will perform auscultatory examinations over a patient's affliction with his stethoscope (Jiang and Choi, 2006). In the same sense, whether educating no more, no less healthy students or impaired ones, educators have to provide formative and final evaluations of their pupils' competence. For this reason, they will use creditable, long established methods that calibrate learners' competences and aptitudes. However, these achievement quotients do not appropriate a pellucid image of the student as far as the extrapolation of his literacy has to do with how well he integrates himself into a complex social environment which demands strict observance of its decencies (Holt and Kirk, 2005). For instance, the augmented reality environment that most students live in within, offers rich learning experiences that alter the type of instruction. Abundantly sponsored multimedia learning objects are undisruptive and ubiquitously distributed in a worldwide scale and constructively alter the Complexity of Content or the Stability (of Content) that formal education provides. While formal education reshapes and moves decisively to gaudy, massive blended learning environments, informal education is also upheavingly soaring and penetrating even greater audiences: a major part of the underaged world population owns smart, mobile devices, deploying ubiquitous on-line availability, while social media of any kind are continuously expanding and proving to be a major driving force for communication and information exchange in unprecedented volumes (Cap, 2014). The academic community cannot ignore these facts: young students are more likely to learn how to sing by listening to the radio, the TV and the Internet broadcasts than by attending the music courses of their normal schooling context; likewise, they are expected to dig into augmented reality environments much easier and faster by playing games with their console than by attending the regular computer classes their schooling curriculum has preordained for them. However, this paper does not focus on the managerial potential of the "new" classroom, which is characterized by a plethora of technological attainments: whiteboards, smart phones, tablets, laptops, computers, smart TV sets and many, many gadgets (depending on the subject taught) that have almost become a necessity for the teaching process (Karsenti, 2013). Instead, this research stages the evolutional process of learners' certified skills (Liyanagunawardena *et al*., 2013) as a refurbishment of the Gamification of Learning process (Liyanagunawardena *et al*., 2013). Indeed, more and more Wearable Computing Systems are used not only for the pool of disabled but also for Somaesthetics, 3D-User Interfaces, Semi-structured Qualitative Studies, Context-Aware Computing, Human-Robot Interface, and many others (Soegaard and Dam, 2013). What thus far was a necessity for the impaired is turning to a privilege for the healthy subjects in their schooling habitat.

This in practice means:

a. Instructors proceed to enhance the listening comprehension of their students, especially when training the impaired in hearing children, by applying a *child-centered interventional restructure of the schooling system*. In simple words, the instruction team that offers special education to handicapped learners, applies a holistic approach in teaching with a method that is characterized by unprecedented amplification. A group of experts, like the ENT surgeon or the rehabilitating physician that calibrate the patient's acoustics, the speech therapist that delicately treats dyslexia, the psychologist that aids his incorporation to normal schooling, the special education teacher which privately enhances and monitors his competences and the inmost cognatic circle that augments his schooling productivity, comprise an assessment tool that can exercise diagnostic procedures of unprecedented depth and accuracy. They may provide a compendium of the learners' prospects that is unequalled with the "simplistic" competence labels used in normal schooling.
b. Special education as a schooling practice highly involves psychometric and differential evaluation of children or teen-agers with learning disabilities. Some tools that may help the criteriologic calibration of impaired subjects are mathematic tools, and recently, audiologic and musical attestations (Aleksić and Ivanović, 2016). They have to do with the recently evolving theory of multiple intelligences (Politis *et al*., 2014), which has boisterously evolved via the Gamification of Learning (Kumar and Herger, 2013). According to the theory of multiple intelligences, the player's experience, memories and expectations, to mention a few, are key elements in shaping his excitement, leading to active involvement with Gamification, and finally enhanced performance, excitement and involvement. But Gamification is not factor for isolation; on the contrary, it should lead participants to certain feelings, according to the interaction, the events occurring at a certain time, and abundant communication with fellow players, and the environment itself.
c. Under this prism, the dipole of oral and aural communication, somewhat disregarded due to inefficient multimedia support, emerges as a key player for the augmentation of the learning potential (Dunleavy and Dede, 2014). The classroom has no longer walls and boundaries; the young learners, considered as digital natives, strive in the information era and are very competent in navigating the voluminous folds of the knowledge society, while, what an oddity, older pools have to "go back" to school to actualize their professional practices.

This survey explains how detailed competence metrication, commencing from special education pools may shape detailed performance shapes. Then, by extrapolating these findings to normal schooling audiences, and using reverse engineering neurophysiological techniques, experienced users attempt to analyze sonic contours.

PROBLEM FORMULATION: MATERIALS AND METHODS

In special education, to evaluate the linguistic development of children with profound sensorineural hearing loss who use Cochlear Implants and compare it to the linguistic development of those that use Hearing Aids, two standardized criteria are widely used in Greek language: The Detroit Test of Learning Aptitude (DTLA) (Tzouriadou *et al*., 2008) and the Psychometric Criterion of Language Acquisition Competence Test (L-a-T-o) (Tzouriadou *et al*., 2008). Niche technologies, like Bionics, Prosthetics and Implantations are exuberantly used in these special training courses to aid the impaired young learners (Nikolopoulos *et al*., 1997). This support equipment in all cases compensates for the Insufficient Resources of either of them, the user, the classroom, or the schooling system.

The collective intelligence tools that thoroughly search the Web 4.0 habitat transform the Traditional Classroom to a Web/Virtual Synchronous Classroom. The benefit of such a renovation is not merely the abatement of local confines, but mainly the increase of educational assets: with plentiful Asynchronous Interactions, usually offered by MOOCS or similar tools (Liyanagunawardena *et al*., 2013) schooling moves from Limited Resources to Vast Resources. Using long established tests, scientists may probe key schooling competences in the Verbal and Nonverbal domain, in Attention-Enhanced and Attention-Reduced probes, in Motor-Enhanced and Motor-Reduced skills, etc (Politis *et al*., 2014). A long-lasting survey was conducted in the Special Training Unit of the 1st ENT Academic Department of the AHEPA Hospital in Thessaloniki, Greece. The sample of this research included 140 children with profound, prelingual, sensorineural hearing loss, between the age of 4 and 15, integrated in the mainstream school system, that use oral speech in order to communicate (Nikolopoulos *et al*., 2004). 68 of them were Cochlear Implant (C.I.) users and 72 were Hearing Aid (H.A.) users (Kyriafinis, 2005). These tests investigate the problems detected in oral or written communication and administer the application of the appropriate interventional pedagogic program (Nikolopoulos and Papadimitriou, 2007; Faculty of 1st and 2nd ENT Clinic of AUTh, 2008). The comparison of the two groups according to the Detroit Test of Learning Aptitude (DTLA) revealed that C.I. users had better performance with a mean difference of 0.6 Standard Score comparing to the H.A. users in all the fields of academic and cognitive development, s seen in Fig. 1.

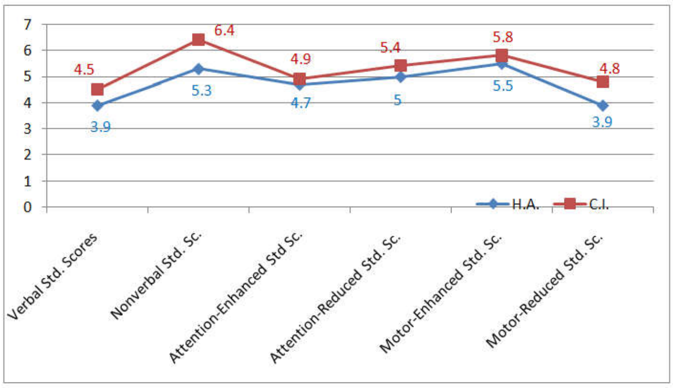

Fig. 1. Comparison of Standard Scores of the learning potential of Hearing Aids users and Cochlear Implant users according to the Detroit Test of Learning Aptitude (DTLA)

As seen in Fig. 2, C.I. users (31.8 Sum of Standard Scores) had better performance with difference of 3.1 at Sum of Standard Scores comparing to H.A. users (28.7 Sum of Standard Scores) in all the fields of their learning development, according to the Detroit Test of Learning Aptitude (DTLA). These differences of 3.1 at Sum of Standard Scores reflected in the General Mental Ability Quotient of development between the C.I. users (72.9 Quotient) and the H.A. users (63.9 Quotient), having a difference of 9 units, according to the DTLA.

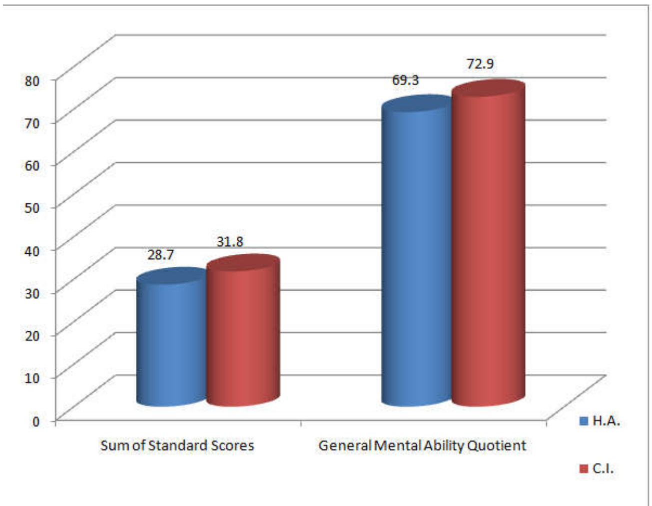

Fig. 2. Comparison Sum of Standard Scores and General Mental Ability Quotient development of Hearing Aids users and Cochlear Implant users according to the Detroit Test of Learning Aptitude (DTLA)

The difference in the performance of the two groups was found not statistically significant, revealing that the two groups had initially similar learning potential. In order to evaluate the differences in the learning development of the two groups, the Independent Sample T-test was administered (see Table I).

The characteristics of the two groups that were revealed were

i. In the Verbal domain, they were supposed to be able to complete, understand, and use oral speech, revealing adequate knowledge of vocabulary and syntax. This index can predict the skill of writing since it is related to reading and writing. Children with low grading have poor vocabulary, do not use elaborate speech, and have difficulty in recalling oral directions or organizing verbally their ideas in coherent sequences.
ii. In the Nonverbal domain, they were supposed to understand spatial relationships and nonverbal, abstract, symbolical thinking. This is also related to the skill of recalling objects or letters and organizing them by using memory. It allows children to realize reasonable relationships and abstract concepts, to think without the use of words, to recall schemes with the use of their memory. Children, who receive low grades in this field, have difficulty in recalling nonverbal information, motoric responding, organizing and solving visual problems, and understanding abstract symbols like letters.
iii. The Attention-Enhanced domain, indicates the skill of the children to successfully complete actions that require instant recalling, the use of short-term memory, and focused attention. Children who receive low grades in this field have the tendency to be easily distracted, they are careless, and they do not focus.
iv. The Attention-Reduced domain, indicates the skill of the children to use their long- term memory, necessary in vocabulary activities, in understanding and thinking, and in realizing abstract complex relationships. It also indicates the skill of recalling information and ideas and using them in everyday situations.
v. In the Motor-Enhanced domain, we can evaluate complex motor skills that relate to the visual- motor coordination which are essential for writing. Low grading in this field may reveal problems in coordination.
vi. The Motor-Reduced domain, reveals the skill of a child to respond to a free motoric frame. High grading in this field is in accordance with improved speech, naming, and recognizing of symbols.

The comparison of the linguistic development of the two groups with the Language Acquisition Competence Test (L-a-T-o) revealed that C.I. users had better performance at the acquisition process (Mean: 3.6 Standard Scores) compared to the H.A. users (Mean: 2.6 Standard Scores) in the three linguistic systems (reception, organization and expression), as well, as seen in Fig. 3

Cochlear Implant users revealed improved performance compared to the Hearing Aids users to:

I. The system of reception of oral speech, which indicates the ability of a child to understand speech, concepts, and syntax as well.
II. The system of organization of oral speech, which indicates the ability of a child to organize input, to correlate input, and relate it to knowledge by using strategies.
III. The system of expression of oral speech, which indicates the ability of a child to produce intelligible speech, using the right concepts, and organizing them syntactically.

In addition, C.I. users had improved performance (Mean: 3.5 Standard Scores) compared to the H.A. users (Mean: 2.7 Standard Scores) in the three language modalities (semantic, phonological and syntactic) - see Fig. 4.

Table 1. Comparison between the differences of means of the learning aptitude of Hearing Aids users and Cochlear Implant user, according to the Independent Sample T-test

N= 140		Verbal Standard Scores	Nonverbal Standard Scores	Attention-Enhanced Standard Scores	Attention-Reduced Standard Scores	Motor-Enhanced Standard Scores	Motor-Reduced Standard Scores	Sum of Standard Scores	General Mental Ability Quotient
H.A.	Mean	3.9	5.3	4.7	5	5.5	3.9	28.7	69.3
C.I.	Mean	4.5	6.4	4.9	5.4	5.8	4.8	31.8	72.9
	F	14.6	5.0	2.0	0.7	1.8	6.0	0.7	0.4
	Sig.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Table 2. Comparison between the differences of means of the linguistic development of Hearing Aids users (H.A.) and Cochlear Implant users (C.I.), according to the Independent Sample T-test

N= 140		Reception System Standard Scores	Organization System Standard Scores	Expression System Standard Scores	Semantic Modality Standard Scores	Phonological Modality Standard Scores	Syntactic Modality Standard Scores	Sum of Standard Scores	Spoken Language Quotient
H.A	Mean	2.2	3.2	2.6	2.5	3.2	2.5	15.9	55.2
C.I.	Mean	3.2	4.4	3.2	4	3.6	3	20.7	60.4
	F	23.6	51.2	0.9	14.7	27.0	3.1	21.3	7.8
	Sig.	p<0.001	p<0.001	p<0.05	p<0.001	p<0.05	p<0.01	p<0.001	p<0.001

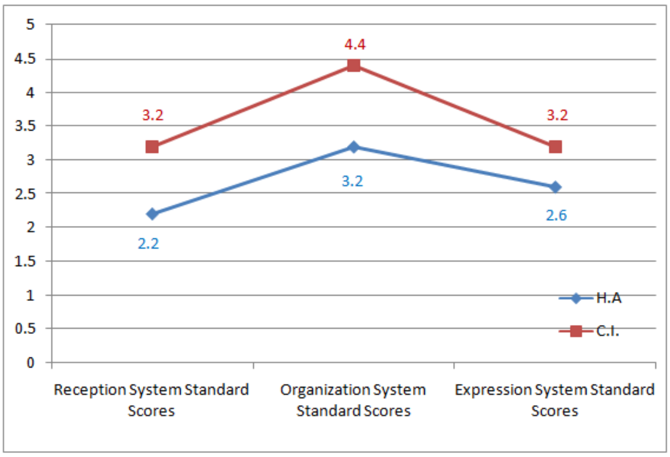

Fig. 3. Comparison of Standard Scores of the linguistic systems (reception, organization and expression) of Hearing Aids users and Cochlear Implant users according to the Language Acquisition Competence Test (L-a-T-o)

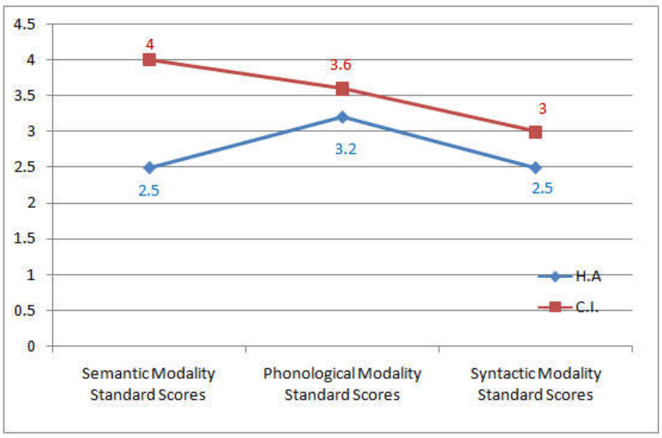

Fig. 4. Comparison of Standard Scores of the language modalities (semantic, phonological and syntactic) of Hearing Aids users and Cochlear Implant users according to the Language Acquisition Competence Test (L-a-T-o)

Cochlear Implant users revealed improved performance compared to the Hearing Aids users in:

a) The Semantic modality that evaluates the knowledge of a child that refers to the words and the relationships between them.
b) The Phonological modality that indicates the skill of a child to use the phonemes of his/her language meaningfully, and realize the basic rules that influence their use.
c) The Syntactic modality that evaluates the ability of a child to realize and produce syntactically and grammatically correct sentences.

According to Fig. 5 data, the C.I. users (20.7 Sum of Standard Scores) have improved performance with a difference of 4.8 at the Sum of Standard Scores compared to the Hearing Aids users (15.9 Sum of Standard Scores) in all linguistic forms according to the Language Acquisition Competence Test (L-a-T-o). These differences of 4.8 at Sum of Standard Scores reflected in the Spoken Language Quotient of development between the C.I. users (60.4 Spoken Language Quotient) and the H.A. users (55.2 Spoken Language Quotient) having a difference of 5.2 units, according to Language Acquisition Competence Test (L-a-T-o), as seen in Fig. 5.

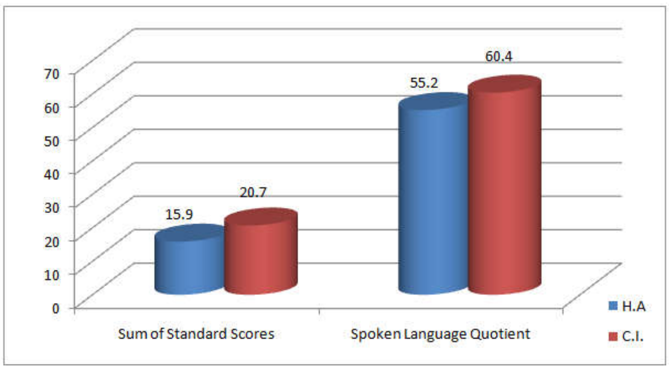

Fig. 5. Comparison between the Sum of Standard Scores and the Spoken Language Quotient development of Cochlear Implant users and Hearing Aids users according to Language Acquisition Competence Test (L-a-T-o)

According to Table II data, there were statistical by significant differences (p<0.05-0.001) between the results of the linguistic forms of the two groups of children. The C.I. user's revealed higher performance compared to the Hearing Aids users in the linguistic development according to Language Acquisition

Competence Test (L-a-T-o). However, for the first time, collectively, instructors can envisage assessing more advanced concepts in the fields of

- **Senses:** The receptiveness of the five external senses is examined, and the increasing variability of the complex phenomenon of synaesthesia which involves more than 15 "internal" senses.
- **Feelings:** the emotional response to obscure or ambiguous is inquired, along with aggressive, embarrassing or disagreeable, sheer or other strong sentiments.
- **Disabilities:** incurable, severe, light, exhausting, etc.
- **Conversation:** squelching or with clinching arguments, negative, vague, hurried, equivocal, easy, difficult, clever-cute, etc.
- **Bodily movements:** "druggy", hurried, rapid, with stride, leisurely, etc.
- **Memories:** inextinguishable, sweet, sour, disagreeable
- **Looks:** careless, indiscreet, effulgent, ominous, nasty, ravishing expressional, inquiring , clouded mind – turbid, glassy – vacant stare
- **Oral and aural communication:** rambling, boring-colorless, enthusiastic, meaningful, insignificant, polite, rude, disconnected, careful
- **Complexion:** dark, heavy, lightsome, pleasant, lissome, agile, nervy, restless, etc
- **Attitude:** socialable, amiable, reclusive, cautious, chary, etc.

RESULTS AND DISCUSSION: AURAL COMMUNICATION ANALYSIS AND MUSIC PERCEPTION

The survey was conducted in January 2017, on the sample of 15 graduate students aged 24-32, seven (47%) males and eight (53%) females. Students participated anonymously, voluntarily and individually. The role of the examiner was to give initial instructions and ensure testing conditions. Testing was administered at the Aristotle University of Thessaloniki, Greece. The students that participated in this game-like interaction, combined their personal experience from singing and/or listening to music/songs with deduced reasoning and created a virtual profile of the singer. Participants evaluated voice characteristics of seven semi-professional singers that have been singing the "happy birthday to you ..." tune. Among other queries, evaluators were asked if they can sing this tune better than the performer they assess every time. Along the singing specifics, listeners attempt to identify the singer age, musical education, background and mood. This paper is the second step in a research on melodious acoustic evidence, attempting to decipher how speech signal variability relates with multimodal, psycho-kinetic and predominantly sparkling bodily sensations. This research explores the major factors that enable this synaesthetic augmentation. Neurophysiological information about each singer provides complementary intelligence about the accuracy of the research. In order to improve the transparency of the results, the deduced outcome is discussed for each performer individually.

Dora (Female)

When participants assessed Dora's singing technique, they estimated that she achieved 69% capability for maintaining rhythmic sounds. Students participated that Dora's performance was about 3% slower in tempo rendition and 5% higher in frequency than perfect. In terms of prosodic stability and pitch stability, participants assessed that her voice was flawless 66% of the time. Dora's estimated age was 23 year (SD = 0.8), which was extremely close to actual (24). When her "music age" was questioned, students mostly perceived that she was in the last years of secondary education. An independent samples t-test was conducted to examine whether there was a significant gender difference between students estimation of the Dora's signing technique. The test revealed that there were statistically significant differences between male and female students in estimating rhythm and stability, (t = -0.69; df = 7.8; p = 0.513) and (t = -1,.12; df = 8.2; p = 0.296) respectfully. Males perceived significantly lower capability (M = 6.6; SD = 2.0) of maintaining rhythm than females did (M = 7.1; SD = 0.8). Males also perceived significantly lower prosodic and pitch stability (M = 6.0; SD = 2.4) than females did (M = 7.1; SD = 1.1). When students were asked to determine Dora's mood, they most often described it as relaxed and as serious, which was contradictory. The results are presented in Fig. 6.

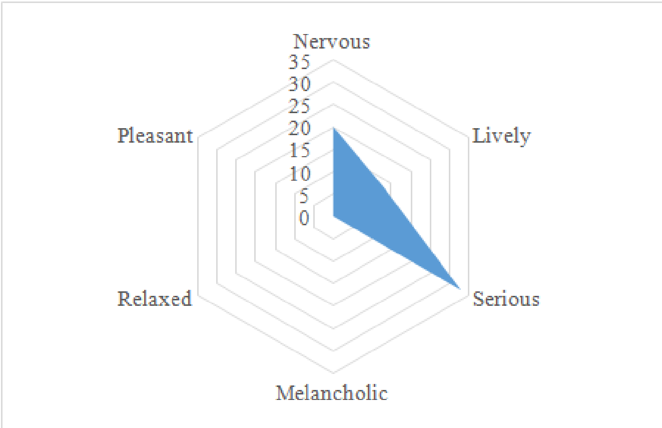

Fig. 6. Dora's perceived mood

Dora has intense voice. Her perceived voice and volume is presented in Fig. 7. A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found (p = 0.120; p = 0.218 and p = 0.965 respectfully).

Eleni (Female)

When participants assessed Eleni's singing technique, they estimated that she achieved 81% capability for maintaining rhythmic sounds. Students participated that her performance was about 1% faster in tempo rendition and 8% higher in frequency than perfect. In terms of prosodic stability and pitch stability, participants assessed that her voice was flawless 65.6% of the time. Eleni's estimated age was 25 years (SD = 0.6), which was extremely close to actual (26). When her "music age" was questioned, students mostly perceived that she was clearly in College of University level. The t-test revealed that there were statistically significant differences between male and female students in estimating proper voice pitch level (t = 0.22; df = 7.5; p = 0.832). Males perceived significantly higher frequency (M = 0.86; SD = 1.2) of voice pitch than females did (M = 0.75; SD = 0,.46) as perfect. When students were asked to determine Eleni's mood, the results were colorful, as seen in Fig. 8. This is due to the fact that Eleni has a strong personality.

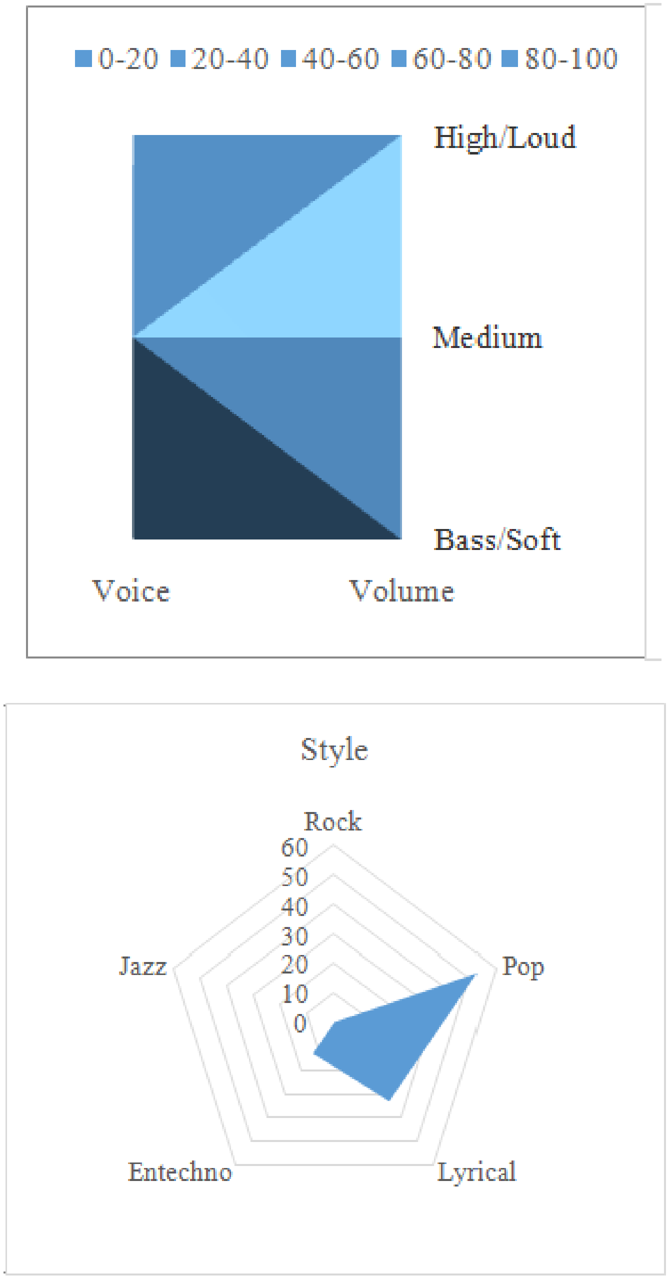

Fig. 7. Dora's perceived voice profile

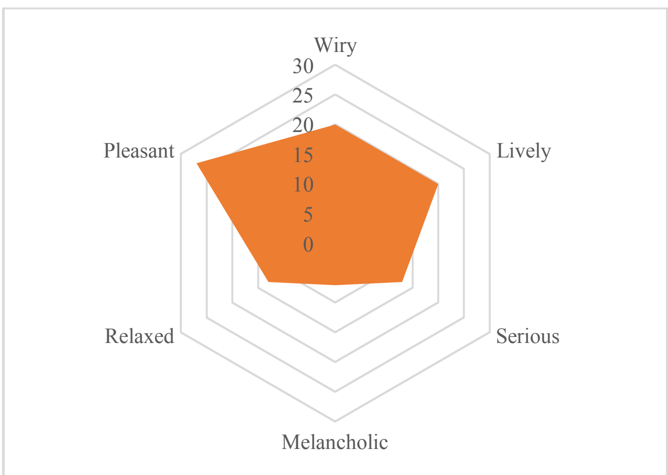

Fig. 8. Eleni's perceived mood

Eleni has a piercing, penetrating voice. Her voice and volume perceived by students is presented in Fig. 9.

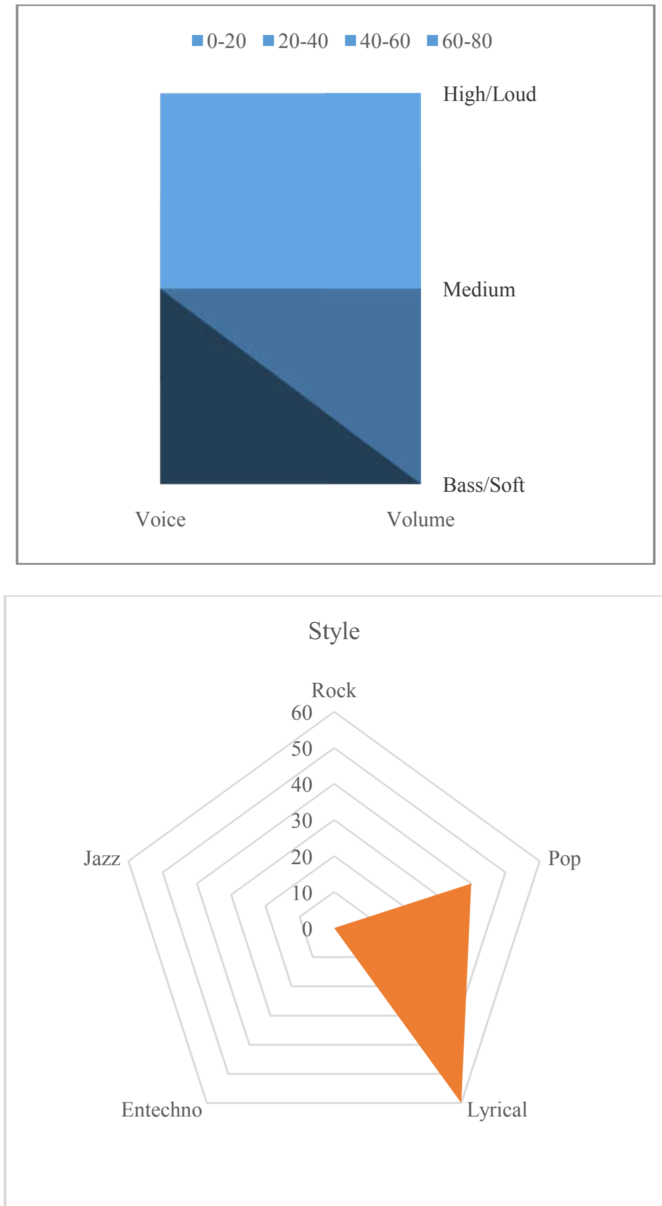

Fig. 9. Eleni's perceived voice profile

A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found ($p = 0.999$; $p = 0.435$ and $p = 0.234$ respectfully).

Nikos (Male)

When participants assessed Nikos's singing technique, they estimated that he achieved 46% capability for maintaining rhythmic sounds. Students participated that his performance was about 5% slower in tempo rendition and 10% lower in frequency than perfect. In terms of stability, participants assessed that his voice was flawless 51% of the time. Nikos's estimated age was 27 (*SD* = 0.5), which was much lower than actual (32). When his "music age" was questioned, students mostly perceived that he was in the middle years of secondary school. The t-test revealed that there were no statistically significant differences between male and female students in estimating rhythm, tempo, pitch and stability. When students were asked to determine Nikos' mood, students mostly perceived it as lively. However, Nikos is not very social, but students did not perceived it. The results are presented in Fig. 10.

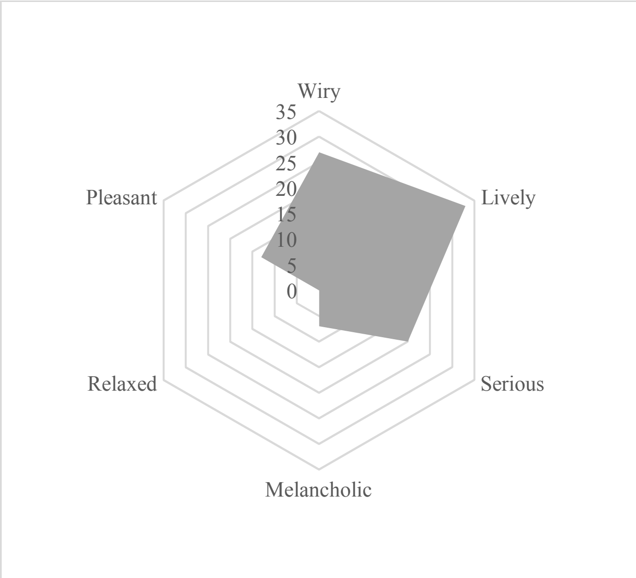

Fig. 10. Nikos's perceived mood

Nikos has a deep, bass and hoarse voice. His voice and volume perceived by students is presented in Fig. 11.

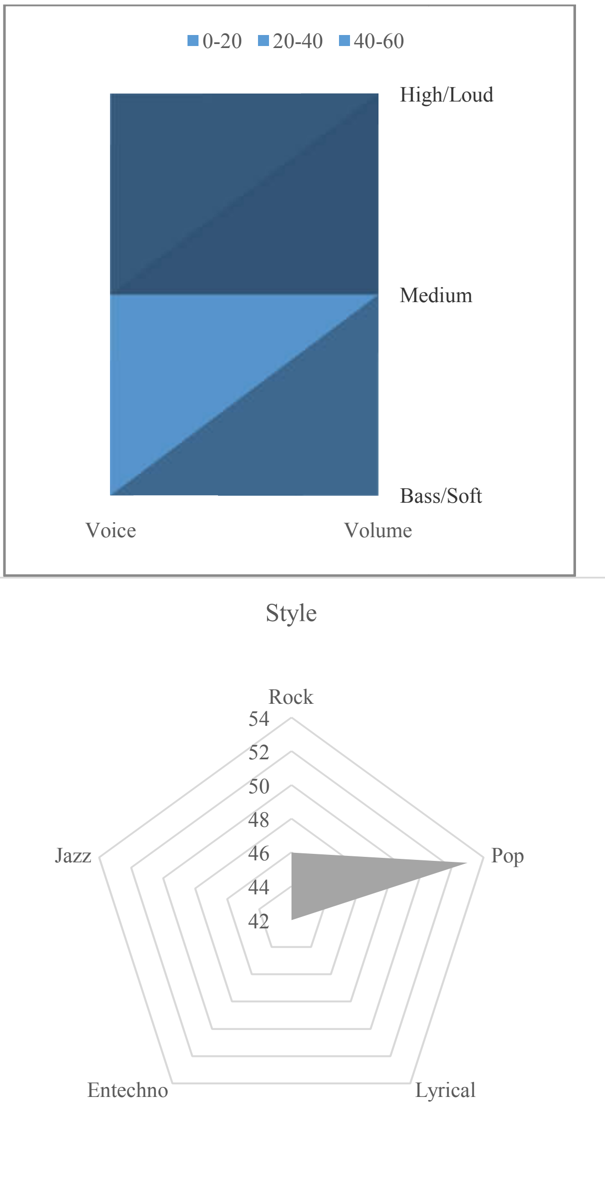

Fig. 11. Nikos's perceived voice profile

A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found (p = 0.323; p = 0.483 and p = 0.435 respectfully).

Michalakis (Male)

When participants assessed Michalakis's singing technique, they estimated that he achieved 49% capability for maintaining rhythmic sounds. Students participated that his performance was about 6% slower in tempo rendition and 5% higher in frequency than perfect. In terms of stability, participants assessed that his voice was flawless 65% of the time. Michalakis's estimated age was 24 (*SD* = 0,5), which was a bit lower than actual (27). When his "music age" was questioned, students mostly perceived that he was in the middle years of secondary school. The t-test revealed that there were no statistically significant differences between male and female students in estimating rhythm, tempo, pitch and stability. When students were asked to determine singer mood, most perceived him as wiry/nervous (40%). The results are presented in Fig. 12.

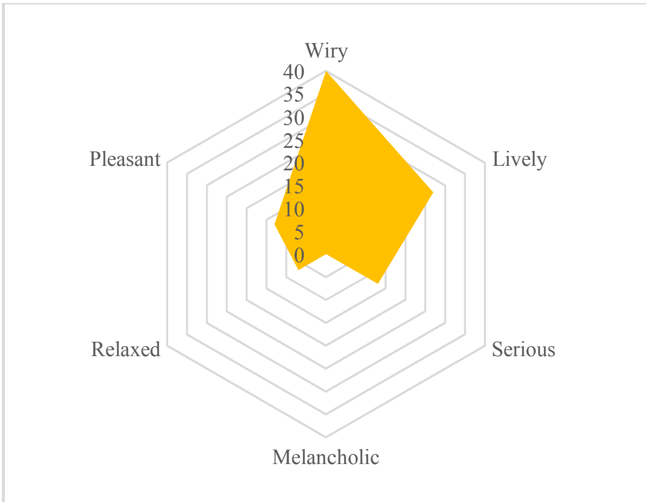

Fig. 12. Michalakis's perceived mood

Michalakis is brownish and has a mild and deep voice. His voice and volume perceived by students is presented in Fig. 13. A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found (p = 0.234; p = 0.847 and p = 0.877 respectfully).

Petros (Male)

When participants assessed Petros's singing technique, they estimated that he achieved 39% capability for maintaining rhythmic sounds. Students participated that his performance was about 23% slower in tempo rendition and 3% higher in frequency than perfect. In terms of stability, participants assessed that his voice was flawless 50% of the time. Petros's estimated age was 25 (*SD* = 0,6), which was significantly lower than actual (33). When his "music age" was questioned, students mostly perceived that he was in the first years of secondary school. The t-test revealed that there were statistically significant differences between male and female students in estimating capability for maintaining rhythmic sound (t = -1.1; df = 12.5; p = 0.205). Females perceived significantly higher capability (M = 4.9; SD = 3.4) for maintaining rhythm than males did ($M = 2.9$; $SD = 2.4$). When students were asked to determine Petros's mood, most of them correctly perceived him as relaxed (40%). Petros has a calm and gentle personality. The results are presented in Fig. 14.

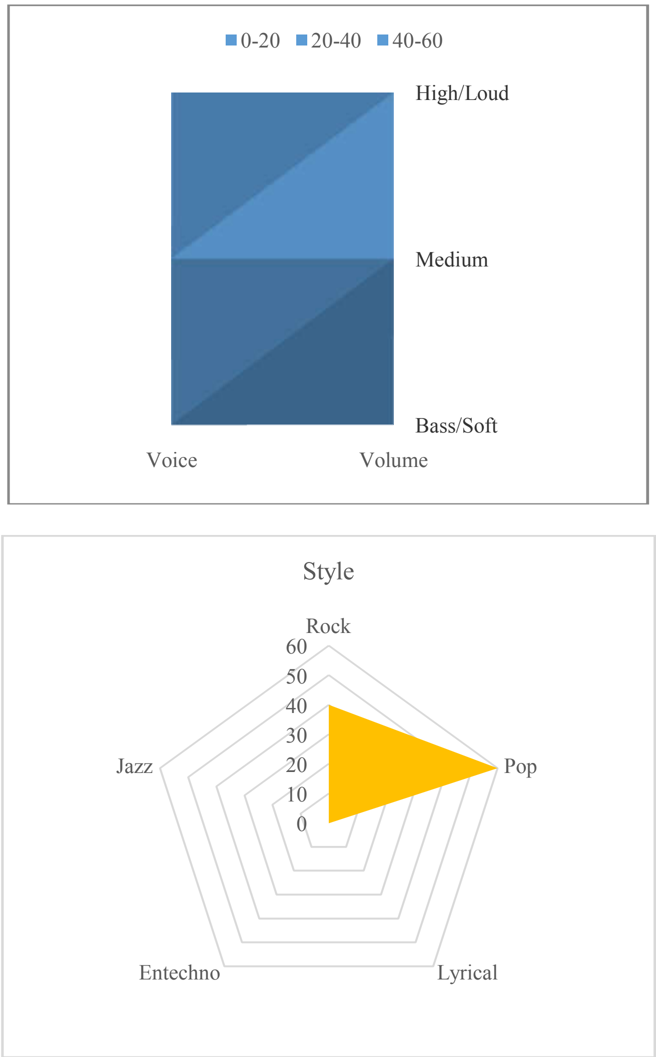

Fig. 13. Michalakis's perceived voice profile

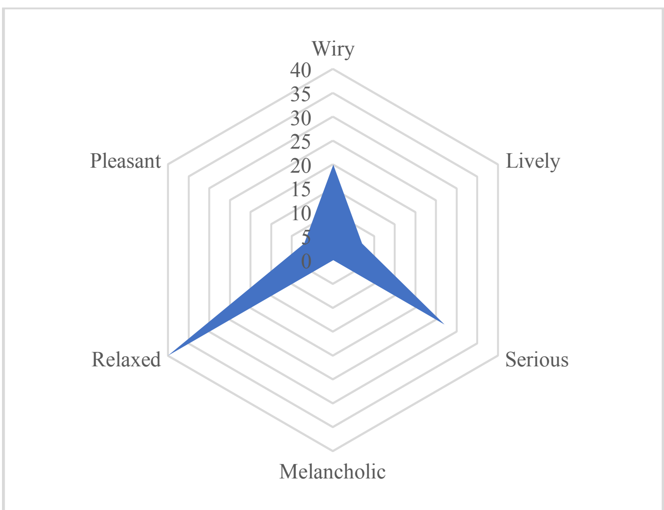

Fig. 14. Petros's perceived mood

Petros is brownish and has a whiny and irritating voice. His voice and volume perceived by students is presented in Fig. 15.

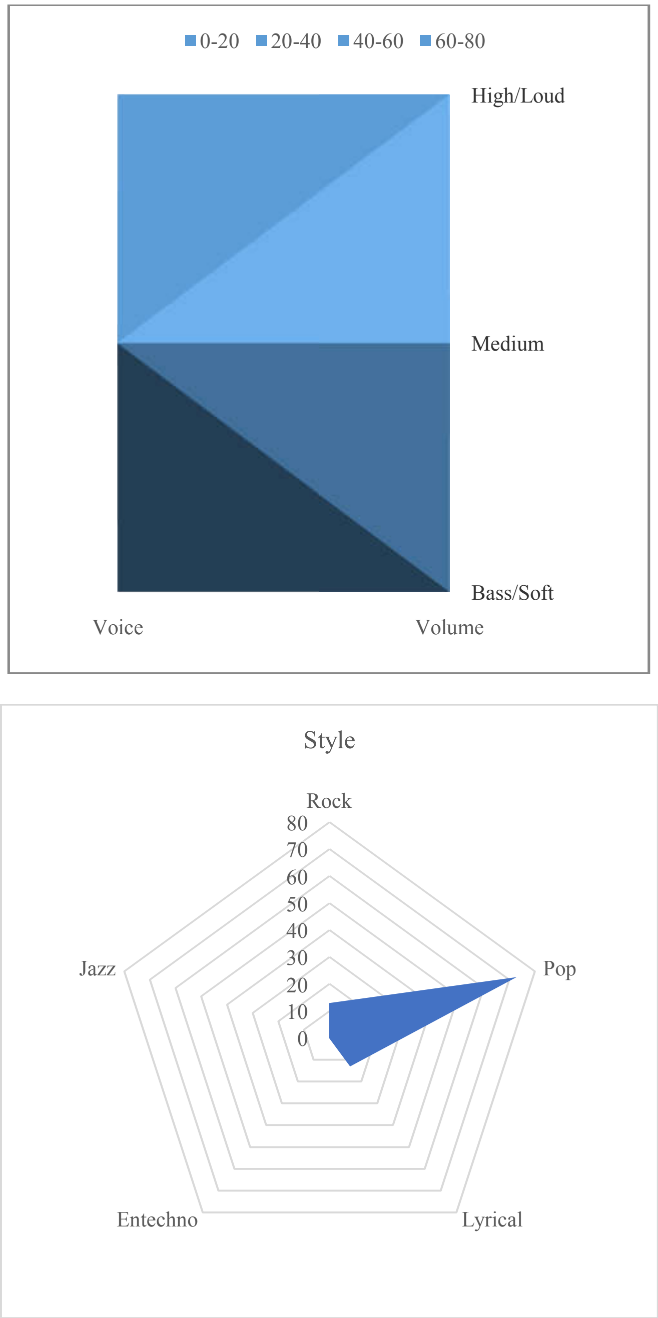

Fig. 15. Petros' perceived voice profile

A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found ($p = 0.333$; $p = 0.420$ and $p = 0.234$ respectfully).

Tolis (Male)

When participants assessed Tolis's singing technique, they estimated that he achieved 61% capability for maintaining rhythmic sounds. Students participated that his performance was about 12% slower in tempo rendition and 2% higher in frequency than perfect. In terms of stability, participants assessed that his voice was flawless 54% of the time. Tolis's estimated age was 25 ($SD = 0.5$), which was lower than actual (30). When his "music age" was questioned, students mostly perceived that he was in the middle years of secondary school. The t-test revealed that there were no statistically significant differences between male and female students in estimating rhythm, tempo, pitch and stability. The results of perceived Tolis's mood are presented in Fig. 16.

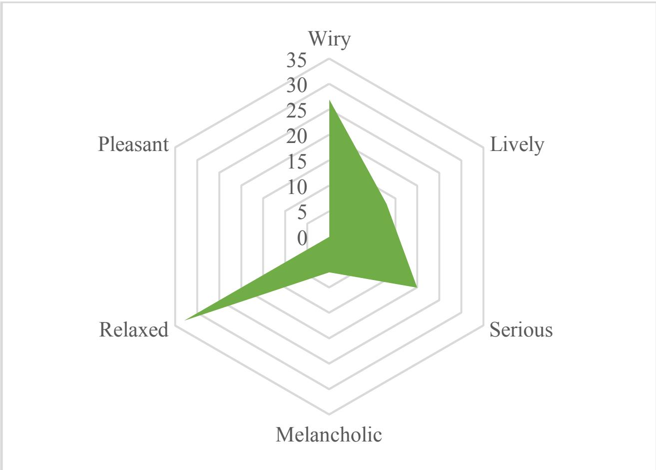

Fig. 16. Tolis's perceived mood

Tolis is a socialite and has a "childlike" voice. Tolis's voice and volume perceived by students is presented in Fig. 17.

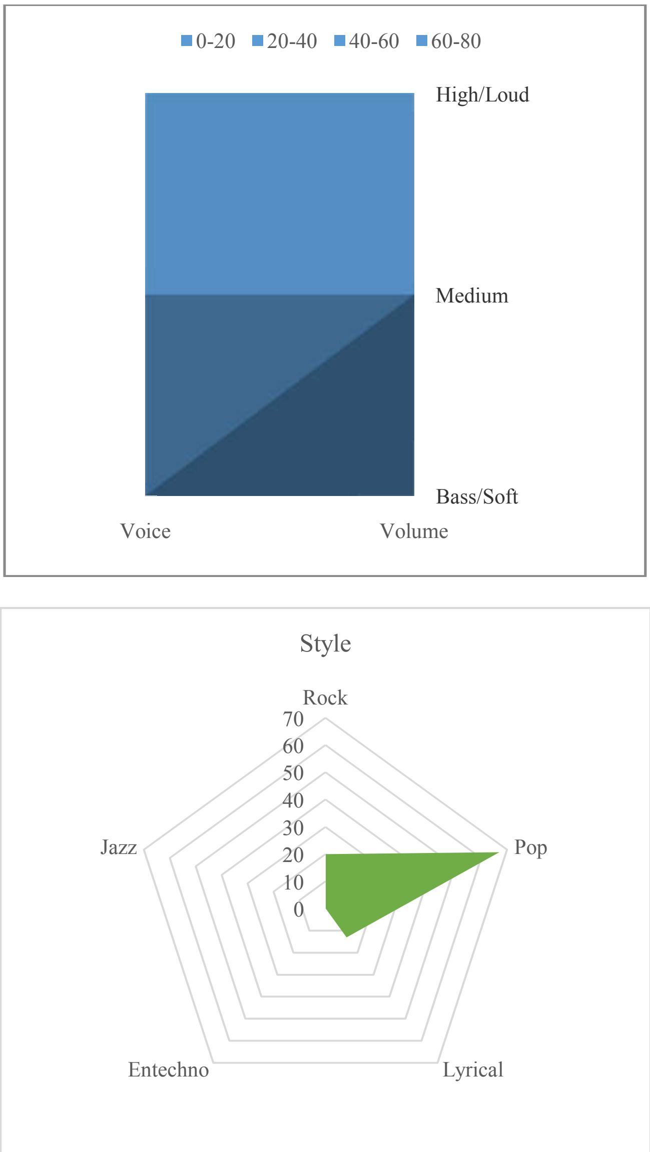

Fig. 17. Tolis's perceived voice profile

A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found (p = 0.800; p = 0.130 and p = 0.950 respectfully).

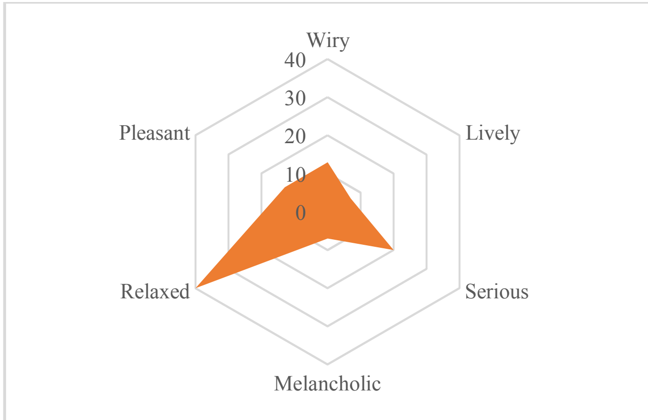

Fig. 18. Rene's perceived mood

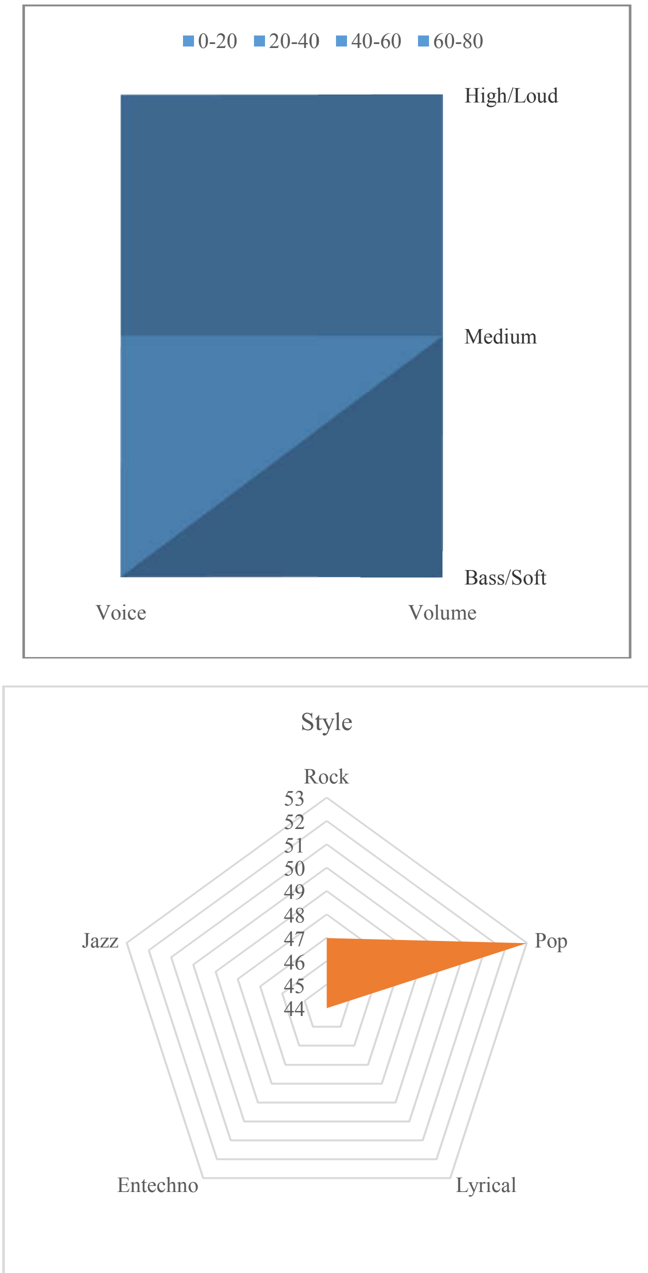

Fig. 19. Rene's perceived voice profile

Rene (Male)

When participants assessed Rene's singing technique, they estimated that he achieved 39% capability for maintaining rhythmic sounds. Students participated that his performance was about 23% slower in tempo rendition and 3% higher in frequency than perfect. In terms of stability, participants assessed that his voice was flawless 50% of the time. Rene's estimated age was 25 (SD = 0.6), which was close to actual (27). When his "music age" was questioned, students mostly perceived that he was in the first year of secondary school. The t-test revealed that there were no statistically significant differences between male and female students in estimating rhythm, tempo, pitch and stability. When students were asked to determine Rene's mood, most of them perceived him as relaxed (40%). Rene has indeed a unique and special personality. The results of perceived Rene's mood are presented in Fig. 18. Rene has a light brown complexion and a deep and heavy voice. Rene's voice and volume perceived by students is presented in Fig. 19. A multiple linear regression was calculated to predict singers' voice profile (voice, style, volume) based on student gender, but no significant regression equation was found (p = 0.079; p = 0.248 and p = 0.234 respectfully).

Conclusion

Hard of hearing and deaf children that use Cochlear Implants can acquire academic linguistic skills easier and faster than those with Hearing Aids. This will allow them to participate in the educational process in the school class successfully as their hearing classmates. The analysis of the results revealed that although the two groups had similar cognitive and learning potential, the C.I. users demonstrated improved linguistic development in all three linguistic systems (reception, organization, and production of oral speech) and in the three linguistic modalities (phonological, semantic, syntactic) as well, in comparison to the Hearing Aids users. These finding are similar to those of Osberger, Maso, and Sam (Osberger *et al*., 1993), and McConkey Robbins, Kirk, Osberger, and Ertmer (Mc Conkey *et al*., 1995), that compared the intelligibility of speech of Cochlear Implant users to Hearing Aids users. In addition, Van Lierde, Vinck, Baudonck, De Vel and Dhooge (Van Lierde *et al*., 2005) compared the articulation and the vocal characteristics of hard of hearing and deaf children and revealed improved performance for the C.I. users. Baudonck, Dhooge, & Van Lierde (Baudonck *et al*., 2010) compared the mistakes in the production of consonants of deaf C.I. users and H.A. users and concluded in similar findings, since C.I. users made fewer phonological mistakes compared to the Hearing Aids users. It seems that the hard of hearing/deaf children that use C.I. can achieve academic linguistic skills easier and faster than hard of hearing/deaf children that use Hearing Aids. This will allow them to fully participate in the educational process as their hearing peers. Extrapolating the findings of the special education schooling unit to the sphere of music intelligence, an audition-like probe was devised to assess out of a practical demonstration the candidate's suitability and skill. It seems plausible that the auditory impression out of a stringent "musical competition" may well be transformed to sonic contours that typically shape the neurophysiological attributes of the contestants. Therefore, researchers have plentiful feedback on how extended social, kinetic, neurophysiological factors are linked with skills that may be conveyed with beauty of form, harmony and expression of emotion. The Speech Therapy Unit of the 1st ENT Academic Dept., AHEPA Hospital in Thessaloniki is currently devising a protocol that will allow these "extended" neurophysiological attributes to be incorporated into the mainstream Learning Aptitude tests.

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REFERENCES

Aleksić, V. and Ivanović, M. 2016. Psychometric Evaluation of the Reliability of IPVIS-OS Multiple Intelligences Assessment Instrument for Early Adolescents, *Journal of Educational Sciences and Technology*, 6(1):21-34.

Baudonck, N., Dhooge, I., Van Lierde, K. (2010). Intelligibility of Hearing Impaired Children as Judged by their Parents: A Comparison Between Children using Cochlear Implants and Children Using Hearing Aids. *International Journal of Pediatric Otorhinolaryngology*, 74:1310 - 1315.

Cap, C. 2014. Would Socrates have used the iPad in Class? In *Proceedings of the International Conference on Interactive Mobile Communication Technologies and Learning IMCL2014*, Thessaloniki 13-14 November 2014, Greece.

Dunleavy, M. and Dede, C. Augmented Reality Teaching and Learning. In Spector, J., Merrill, M., Elen, J. and Bishop, M. (Eds.), *The Handbook of Research for Educational Communications and Technology (*4th ed.). New York: Springer, 2014, pp. 735-745.

Faculty of 1st and 2nd ENT Clinic of AUTh. 2008. *Otorhinolaryngology-Head & Neck Surgery.* Medical School, Aristotle University of Thessaloniki, Thessaloniki: Publish City.

Holt, R. and Kirk, K. 2005. Speech and Language Development in Cognitively Delayed Children with Cochlear Implants. *Ear & Hearing* 26(2):132-148.

Jiang, Z. and Choi, S. 2006. A Cardiac Sound Characteristic Waveform Method for in-home Heart Disorder Monitoring with Electric Stethoscope. *Expert Systems with Applications*, 31(2):286-298.

Karsenti, T. 2013. What the research says. *International Journal of Technologies in Higher Education*, 10(2):23-37.

Kumar, J. and Herger, M. 2013. Gamification at Work: Designing Engaging Business Software, Publisher: The Interaction Design Foundation.

Kyriafinis, G. 2005. *Cochlear implantation*. Thessaloniki: Publish City.

Liyanagunawardena, T., Adams, A. and Williams, S. 2013. MOOCs: A Systematic Study of the Published Literature 2008–2012. The International Review of Research in Open and Distance Learning, 14(3):202–227.

Mc Conkey, R., Kirk, K., Osberger, M. and Ertmer, D. 1995. Speech Intelligibility of Implanted Children. *Annals of Otology, Rhinology & Larhyngology* Suppl. 166: 399 – 401.

Nikolopoulos, Th. and Papadimitriou, N. 2007. Hearing Aids and Cochlear Implants in the Rehabilitation of Deaf

Children. *Otolaryngology - Head and Neck Surgery*, 27:22-29.

Nikolopoulos, Th. P., *et al*. 1997. Preoperative Radiologic Evaluation in Cochlear Implantation. *The American Journal of Otology*, 18(6):73-74.

Nikolopoulos, Th. P., *et al*. 2004. Development of Spoken Language Grammar Following Cochlear Implantation in Prelingually Deaf Children. *Archives of Otolaryngology - Head & Neck Surgery*, 130(5):629-633.

Osberger, M., Maso, M. and Sam, S. 1993. Speech Intelligibility of Children with Cochlear Implants, Tactile Aids, or Hearing Aids, *Journal of Speech and Hearing Research*, 36:186 – 203.

Politis, D., Tsalighopoulos, M. and Kyriafinis, G. 2014. Dialectic & Reconstructive Musicality: Stressing the Brain-Computer Interface, in Proceedings of the *International Conference on Interactive Mobile Communication Technologies and Learning (IMCL2014)*, 13-14 November 2014, Thessaloniki, Greece.

Soegaard, M. and Dam, R.F. 2013. The Encyclopedia of Human-Computer Interaction, Publisher: The Interaction Design Foundation.

Tzouriadou, M., Anagnostopoulou, E., Toutountzi, E. and Psoinou, M. 2008. Detroit Test of Learning Aptitude (DTLA, DTLA-P: 3, DTLA-4), Aristotle University of Thessaloniki, Ministry of Education, Thessaloniki.

Tzouriadou, M., Sigkollitou, E., Anagnostopoulou, E. and Vakola, I. 2008. Psychometric Criterion of Language Acquisition Competence L-a-T-o, Aristotle University of Thessaloniki, Ministry of Education, Thessaloniki.

Van Lierde, K., Vinck., B., Baudonck, N., De Vel, E. and Dhooge, I. 2005. Comparison of the Overall Intelligibility, Articulation, Resonance, and Voice Characteristics between Children Using Cochlear Implants and Those Using Bilateral Hearing Aids: A Pilot Study. *International Journal of Audiology*, 44:452 - 465.

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