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REVIEW ARTICLE

MUSIC PERCEPTION V. LINGUISTIC REHABILITATION IN HYBRID EDUCATION: TECHNOLOGY ASSISTED SENSORY APPREHENSION AND CLASSIFICATION

Dimos Charidimou^{1,*}, Rafail Tzimas¹, Dionysios Politis¹, Georgios Kyriafinis², Sophia Aidona²,
Jannis Constantinidis², Nektarios-Kyriakos Paris³ and Veljko Aleksić⁴

¹School of Informatics, Aristotle University of Thessaloniki, Greece

²Cochlear Implantation Center, AHEPA University Hospital, Thessaloniki, Greece

³Dept. of Music Science and Art, University of Macedonia, Thessaloniki, Greece

⁴Faculty of Technical Sciences - Čačak, University of Kragujevac, Serbia

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*Corresponding Author:

Dimos Charidimou

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ABSTRACT

Animated pedagogical content when combined with affective tactics aims to stimulate interest, if not enthusiasm, to the learning community. As students combine both formal learning systems and socio-cultural influences, pledging human figures as models for deploying human-computer interaction processes becomes a commitment strategy appealing to the senses. Therefore, learning objects in their transformational route to acquiring multiagent system characteristics, actively encourage autonomy, socialibility, student models that transfer their universe of discourse to the Internet, adaptability, and intelligent cognitive evaluation. As a result, interactive learning involves the transmutation of classic instructional structures to arrangements that provide incentives for cooperative action over computerized environments, for both special education and regular schooling.

INTRODUCTION

As interactive multimedia encompass new technologies for expression or communication of their content, they alter the sphere of broadcasting adding new services to traditional audiovisual technology. Music distribution, a key element for both radio and TV transmission, is enhanced with novel interactivity capabilities between the user and the broadcasting hub, which is undoubtedly more computer oriented. As this reality has percolated through institutionalized education as well, the association of processing music dexterities to linguistic skills comes into perspective (Besson & Schön, 2001). Most clips heard are not merely audio files, but also moving pictures of some kind, encompassing video-on-demand as well. Music servers therefore are systems streaming continuously broadcasted video or audio data, implementing cost-effective business models overwhelmingly supplying users with virtualization platforms, i.e., Software-as-a-Service networks (Duckworth, 2005).

Some function as on-demand amenities basing their vast interactivity on public media-like promotional campaigns (Tanzi, D., 2004) while others dispense music as investment to popular products, like video games (Collins, 2013). In any case, viewers choose their own filmed entertainment, by means of a PC, interactive smart TV or mobile phone as contrasted with the previous models of TV-like or Radio-like broadcasts for prime-time transmitting content (Sexton, 2007). Cost-effectiveness is one factor for consideration, presumed within a set of technological circumstances where planned public events are easily recorded and readily made available via social platforms and media (Margounakis & Politis, 2013). Usefulness is another, related to indices containing information on comparison of results to some reference magnitudes. In addition to, it is essential to procreate benchmarks and norms extending across linguistic, cultural and national boundaries for these manifestations. The educational perspectives of such activities are pursued to be very creative (Linnavalli et al., 2018; Kasuya-Ueba et al., 2020)

For example, in Fig. 1 three distinguished choirs are presented, with content performed mostly in their mother tongue, through variable however influences from international standards for common acceptance.



Fig. 1. Melting-point concerts in Thessaloniki, 2017-18: Turkish, Serbian and Greek choirs with their accompanying orchestras perform ethnocentrically appraised melodies in large concert halls

Their repertoire embraces tunes from Caucasus, Asia Minor, the Balkans and the Eastern Mediterranean. The first depicted is the *Bahçeşehir Üniversitesi* choir and orchestra from Istanbul, Turkey, under the direction of Muammer Ketenoğlu. The second is the *Branko* choir from Nis, Serbia, directed by Sara Cincarević. The third is the *Yannis Mantakas* choir of the Aristotle University of Thessaloniki (AUTH), in collaboration with the same University's orchestra, under the direction of Dimitrios Dimopoulos. Such happenings, somehow rare a few years ago, are commonplace in the virtual world. This research aims to decipher not that much how entertaining or influencing a cultural event may be but what learning potential could be developed out of it. Special education protocols and music instruction practices are the focal points of this research (Fonseca-Mora *et al.*, 2011). Even further, as such recorded performances may be openly made available on a global perspective, vast audiences of developing countries have the possibility to interact with amenities like music streams, on-line (music) education or artistic study of

some kind in circumstances of generic affordability and low risk for any adverse consequences. The online world, amidst its haphazard, seems to be offering a much wider range of meanings and definitely a considerably larger number of stimuli for functional reactions (Karpati *et al.*, 2016). This has been recently recognized as a basic pillar for development in the training and therapy of rehabilitation in hearing disorders (Habib *et al.*, 2016). Moreover, younger generations do not acquire anymore as much social skills via communal practice, i.e., interfacing with online events; as social gatherings further diminish, in the real world, lively synchronized movements wither as kinesthetic feedback to collective organization of public events. From this point of view, it is interesting to see how musical skills are mingling with literacy disorders within the context of rehabilitation (Overy *et al.*, 2003). Last, but not least, as the scientific community has a profound insight on how online learning (Margounakis *et al.*, 2020) and remote fitting (Kyriafinis & Chriskos, 2017) have performed during the COVID-19 restrictions, it seems that a hybrid way of combining different elements, that of face-to-face instruction and the ability to influence on the virtual sphere people's behavior comes into view (Politis *et al.*, 2020).

PROBLEM FORMULATION: INSCRIBING AN ACOUSTIC SUBSTRATE ENDORSING ACUTE

CHANGES: Sensory input deprivation is a severe damage for homo dialogicus (Kent & Taylor, 2016). As far as impaired in hearing patients or completely deaf are concerned, the last three decades Cochlear implants (CIs) have emerged mainstream (Lenarz, 2001) the last two decades, achieving gradually some 90+% recovery rate worldwide (Amaral *et al.*, 2019; O' Neill & Tolley, 2020). CIs are expensive, miniature scale electronic devices that work as an artificial ear, surpassing damaged or ill-functioning parts of the hearing organ and stimulating directly the acoustic nerve. Therefore, hearing "acoustic" waves is transformed to bionic sensing, using an analysis - reconstruction mechanism (Politis *et al.*, 2018). CIs are providing a much better access to sonic stimuli, especially music, for impaired in hearing patients, in comparison to classic hearings aids. Input is coded and parameterized. Then, a suitable representation of sound is transferred to the patient's cochlea (Azadpour & McKay, 2014). Features as rhythm or tempo (Gfeller & Lancing, 1991) and even more advanced passages of music like vocalized lyrics may be sensorineurally committed with clarity (Gfeller *et al.*, 2005) while recently it has been achieved to perceive more subtle entities, like the timbre of instruments or human voice (Sucher & McDermott, 2007). Medical rehabilitation, including post-operational training, usually takes quite a while. Its time lapse commences from the difficulties of early and in-time diagnosis, especially when very young patients are involved, still in progress with waiting lists, when the surgical resolution depends solely on public health funding resources, and concluding with a variably prolonged rehabilitation process, which usually takes place in special schooling habitats (Pimperton & Walker, 2018). Generally speaking, depending on the pre-CI speech communication epoch of each patient, it takes time, significant effort and extortionate medical back-up after the first activation to make a subject an eloquent verbal communicator (Jones *et al.*, 2015). As it has been monitored with recovered patients, it is rather a new way for communicating with others than a mere substitute of hearing (Távora-Vieira *et al.*, 2013). Even further, CIs a decade or

more ago did not have the quality of modern bionics to cope with more advanced hearing levels, like those of music for instance. Impaired in hearing or completely deaf children comprise a special interest group since some 30%-40% of them are subjected also to mild kinetic-cognitive disabilities; additionally, deterioration of clear vision, mental handicap syndromes, developmental disorders and various emotional or behavioral associated symptoms set the agenda. Many factors have been found to contribute to the outcomes of the rehabilitation process, which in general is a complex process. The sex of patients, their socio-economic environment, their cognitive background, their family's status (for nomads, migrants or refugees), the age when hearing commenced to deteriorate, their self-effacing stance and the disparity from an early diagnosis are some to start with (Pickett & Ahlstrom, 1999). A display of how well 123 patients (57 male, 66 female) with CIs in two major cities (Athens, Thessaloniki) completed their therapeutic reintegration between 2012-16, overall accomplishing speech audiometric tests is shown in the Tables and figures that follow. The sampling pool consisted of 43 adults and 80 children of both sexes. Their average age was 16.47 and the monitoring interval was 2years at least after having undergone Cochlear Implantation (CI) for each and every one of them. Patients were classed together in four distinct subgroups:

- 29 adults with post-lingual deafness/hearing impairment
- 60 children aged 6-17 with post-lingual deafness/hearing impairment
- 20 children aged 6-17, post-lingually deaf with comorbidity or other chronic diseases - comedication
- 14 adults with pro-lingual deafness, before CIs where widely available, treated and trained subsequently afterwards

The medical sensory recovery achieved for deaf or severely impaired in hearing patients and the diagnosed progress in conveying uncomplicated speech context is presented in Table I and Fig. 2.

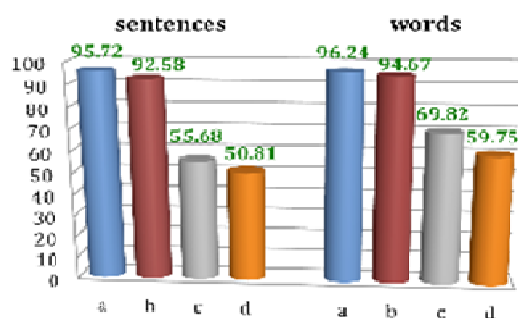
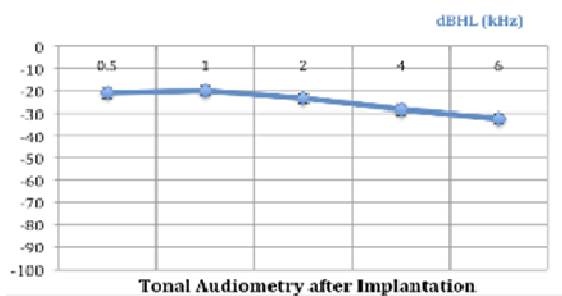


Fig. 2. Upper part, pure tone audiometry average performance for all 123 subjects after cochlear implantation and lower part, their average speech audiometry results as grouped: (%) a: adults post-lingually, b: children, c: children with comorbidity, d: adults pre-lingual 95+

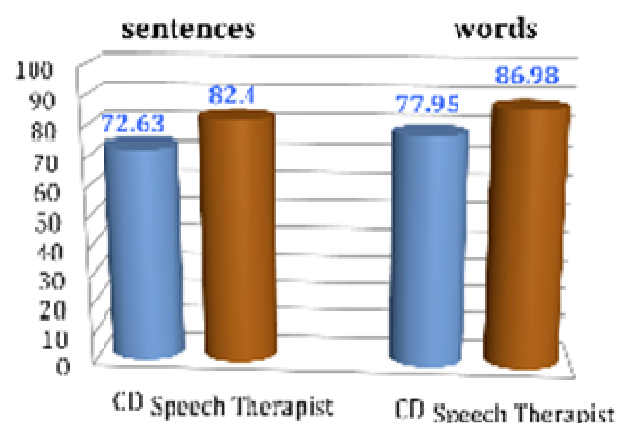
In practice, in Fig. 2, left, pure tone audiometry detects physical and mental sensori-neural feedback in tones for 500 Hz, 1KHz, 2KHz, 4kHz and 6KHz, i.e., the success of the medical intervention. Since audiometric measurements refer more to the medical aspects of the rehabilitation process rather than the cognitive ones (Vandali *et al.*, 2005), testing was enhanced with speech audiometry, i.e., with sets of words or sentences conveying to meaningful assertions, expressing judgement or opinion. As seen in Fig. 2, upper part, when it comes to sentences patients achieve a recognition rate for the aforementioned four groups: a. = 95,7%, b: 92,5%, c: 55,7% and d: 50,8%. When it comes to words the corresponding figures are: a: 96,2%, b:94,7%, c:69,8% and d: 60,1%. However, while these findings form the essential foundation for complete recovery, an augmentation with psychometric tests escalates to more integrated assessments of everyday communication, linking various aspects of the patients' personality.

In particular, all subjects were assessed with:

- The Sander's Profile Questionnaire for Rating Communicative Performance, in Greek, linking linguistic and processing theories of text representation (Sanders & Jutai, 2004)
- Questionnaires evaluating acoustic responses for "Categories of Auditory Performance" (Stacey *et al.*, 2006), accompanied by the
- "Glasgow Benefit Inventory" which turns coherence relations to appropriate numerical evaluations (Lui, 2021).

The procedures I and II concluded to spoken examinations to measure quality performance on speech communication. To increase the engagement of patients within the rehabilitation processes a CD with prerecorded sessions with the speech therapist was used as well.

As indicated in Fig. 3, the average rate for recognizing successfully sentences heard via the CD is 72,63% while when a speech-therapist provides his treatment it raises to 82,4%. When it comes to specific words, the average rate for correct identification via the CD is 77,95% while via the speech therapy session it is 86,98%. By way of no direct link to the performance achieved in Fig. 3, upper part, with the 4 aforementioned categories [a, b, c, d], in the lower part of Fig. 3 the GBI performance is demonstrated for each and every subgroup.



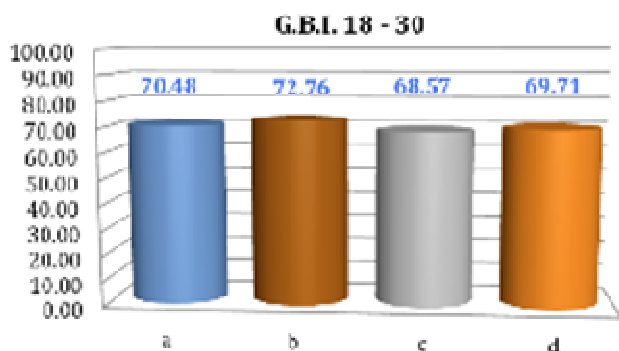


Fig. 3. Upper part, speech audiometric performance achieved by CD-instructed sessions and regular speech therapy sessions. Lower part, Glasgow Benefit Inventory performance levels for all subjects (%). a: adults post-lingually, b: children, c: children with comorbidity, d: adults prelingual 95+

As it happens with recognized schooling, in CI rehabilitation, formal instruction is given in most disciplines. However, the controlled behavior and assessable performance that results from such training is enhanced largely by the learner's own efforts and his ability to assess and initiate things independently. Learning via CD instruction drops-in this fundamental philosophical concept. Linguistic skills are not examined intrinsically, as a self-proclaimed skill but, rather, as a communicative performance. As the general public assesses this skill by default, on the contrary to impaired in hearing patients, the degree of compliance would be tested optimally in other cognitive areas, that simulate the linguistic, kinetic or distinctive mental qualities of the simulated proficiency.

UPGRADING STRESS TESTS TO AUTONOMOUS AND EMPATHETIC LEARNING: Special education and rehabilitation have learning features with similar effects in problematic skill accomplishment when the actual world is envisaged. When coping with elliptic conceptualization, the gamification of learning emerges as a viable solution. Indeed, for young children almost all rehabilitation transactions are invested with such features (Iverson & Fagan, 2004). Actually, CIs regenerate the computer model of hearing. In psychometric terms, the brain of the patient commences adopting itself to the distinctive or unusual features of the sounds heard via bioprosthesis, and relearns to cope with sound features arranged during transmission, amplification and what other processing of sound waves emerges. As it has been thoroughly monitored by CI centers, in ENT terms the speech communication development process for toddlers (Bauch *et al.*, 2021) is a continuous process that begins the very first day of a child's life and builds up uninterruptedly with intensely raising levels for physiological, kinesthetic and mental activities, till the 48th month of its life, based on autonomous and empathetic learning processes (McMullen & Saffran, 2004; Kirschner & Tomasello, 2010). After this critical age, the child's linguistic skills are dependent on communal schooling practices. At this milestone, he has acquired mostly self-taught the dexterities shown in Table II. Prominence is given in this research to the interactions that have musical affinity (Salselas, 2013).

However, the development of linguistic skills and musical ones are not developed always on the same route; they follow, rather, parallel trajectories (Marin & Peltzer-Karpp, 2009; Fenk-Oczlon & Fenk, 2009). When a patient recovers from

deafness, he repeats the stages seen in Table II during his process of relearning speech communication. If he has been prelingual deaf and no significant time intervened between diagnosis and implantation, then he may recover very quickly and reach easily his previous performance levels. If the mentioned criteria do not more or less comply, then relearning is a rather adventurous developmental process, repeating the perilous early language acquisition process. When it comes to the real world, people without hearing impediment do not struggle in recognizing words or sentences, nor experience communication disorders. However, as mobility increases, people relocate, have to learn foreign languages, to adopt to new environments and technological structures, coping thus with similar issues to child development processes (Bergelson and Swingley, 2017). Therefore, extending the metaphor of CI rehabilitation, the situation of selective circumstances in hearing and the opportunity for conveying feelings, emotions or ideas in public communication is studied in the world of non-impaired in hearing people so to inspect the learning potential for the general public on performing similar tasks (Cooper and Aslin, 1994). The musical understanding of each and every listener is not shaped arbitrarily, in the broader sense, but is formed as a culmination of figurative actions and knowledgeably aware events marking significant changes in his stages of development (Rodrigues *et al.*, 2010). As large amounts of acoustical stimuli are accumulated, especially the ones that are pleasantly deep and strong, the full of diversity and complexity surfaces of musical understanding are formed (Brandt *et al.*, 2012). Traditionally, for centuries the acquisition of music stimuli, combining vocal or instrumental sounds required expensive materials and workmanship, as contrasted with televised broadcasts, recorded materials in various forms, and more recently, computer-generated distribution (Christiner & Reiterer, 2015). More or less, this formation process involves the following stages for characteristically marking the shape of things:

- Childhood and schooling years: receivers have little or no experience in this particular area; however, they demonstrate an exceedingly absorbent attitude in storing and processing stimuli from their specific environment. In most cases it is family concentric (Besson & Schön, 2001).
- Localized sociocultural achievements: dependent on the ideas, social behavior or economic, technological and intellectual accomplishments of their community, youths demonstrate accordingly a distinguishable standpoint for their musical understanding. (Misgeld *et al.*, 2021)
- International networking and virtualization: massive exchange of multimedia information, primarily in the form of simultaneous broadcasts and on-demand resourcefully arranged stations, operate as horizontal or vertical providers of music (Mailman, 2016).

Ethnolinguistic Influence and Technology: Linguistic behavior is related to the cultural one through the mother tongue or the languages that a person has grown up speaking fluently from early childhood. When it comes to young adults, the stressful situation for an impaired in hearing person to achieve adequate levels of speech communication seems to be in parallel with that of an ordinary youth when playing instrumental music, singing or dancing (Smit *et al.*, 2022). As a matter of course, there are always professional or amateur musicians, dancers etc. within this population, but it seems that the majority comprises self-taught performers having acquired grasp of field by various sources and occasions. At least this

was the case with the performers and evaluators that took part in this survey. However, when performing within an ethnically intrinsic substrate of cultural events (Morrison, 2009), the amalgamation of an international worldwide asserted civilization in arts, music and education confronts the occasions process of gradual or unconscious assimilation of ideas, knowledge, live styles, etc. (Stevens 2012) There seems to be to a degree considerable common substrate worldwide (Egermann *et al.*, 2015) but categorization in distinctive cultures is vigorously operational as well (Wang *et al.*, 2021).

Thus, it would not be exaggerate if the term Balkanization was not taken into account at this point (Cvitanovic, 2009). Indeed, some 100 years ago, starting from political and military incentives, this term started to indicate how osmosis concludes between assimilation and upbringing based on cultural roots.

Although ancient civilizations are located around Middle East, paradoxically the last millennium the strongest influence has its epicenter on Western cultural traditions. Even further, in music or cinematography, the most influential hub for nearly a century lies in Northern America. Indeed, USA oriented technology is overwhelmingly penetrating cultural borders and shaping the artistic continuum; conversely, in Europe, the Balkans, Asia Minor, Middle East and Northern Africa there are vivid remnants of linguistic, cultural, architectural, and musical spheres of civilization that have flourished from the second millennium BC until the first millennium AD. They were the predominant global powers of their times, claiming vigor of the social, educational and artistic enlightenment the very same way that (English) American hegemony is established as linguistic supremacy and technological mastery (Duckworth, 2005). The changing instigation force in this diachronic flash-back amalgamation, is the exaggerated computer-generated establishment for spheres of influence via the Internet, for Virtual Reality recreations and for ubiquitous Artificial Intelligence spread out (Chow, 2020).

It is not unanticipated that this culture permeates the electronic music continuum via its instrumentation, as far as its musical interfaces are concerned. Indeed, the music produced the last few decades is heavily relying on protocols, instrumentation and synthesized digital ontologies (Hewitt, 2010). As seen in Fig. 4, unspecified conditions in music matters, seen in past as extremely unconventional seem to be developed from different directions in a unified environment mediating multiple access protocols. Therefore, contemporary instrumentality has been used extensively to revive with considerable accuracy and consciousness Balkan and Eastern European melodies, Byzantine Music, Middle-East tunes, Turkish, Persian or Arabic maqams, melodies of North African traditions and other folklores stretching beyond borders to the countries of the Indian subcontinent, and some times, even further. Some noted examples deploying new musical protocols of such kind are the Isokratis™ (Playstore app) and VariPiano (Politis *et al.*, 2015) applications. As it appears, the electronic culture is infusing triumphantly the musical tradition of ancient civilizations by reproducing with digital protocols hearings with form, style or subject matter that has been vivid for centuries - if not it were audaciously bold to say millenniums (Iverson, 2017). To validate the analogies of the organizational, technological and cognitive substrates involved in realizing, acting and measuring the material or sources involved, the following research was conducted. 12 ATh student groups attending the course of Computer Music in the

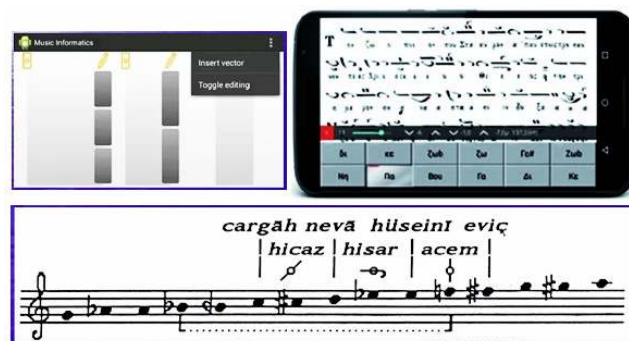


Fig. 4. The Balkanization of Music as transferred to the technological impetus of mobile computing interfaces: Left, the Vari Piano interface and right, the Isokratis™ one coping with abysmal differences in notation, scales, genres

Spring semester 2019 heard a dancing piece of vocal - choreographic music publicly performed in a Middle East capital, in October 2018. The language of singing was the local one. However, the piece itself had significant portions of technologically imputed electronic dance music. The producers promoted their folk music in one of the most frequented plazas of a major city, demonstrating various styles of how to dance this piece; its style blends elements coming out of long - established customs by artists, movements and overall traditions of ancient East Mediterranean cultures, like cyclic dances. However, the rendering of the mellurgy has been achieved with contemporary computer and electronic music tools, usually assigned in popular music styles like techno, hip-hop, rap, etc. Yet, the 12 students actively participating in this survey did not see any footage of the public event (Fig. 5). They only accessed the audio file produced out of it.





Fig.5. By passers and fans dance alongside the promoters in a frequented Jerusalem plaza (October 2018)



Fig.6. Snapshots from the video recorded and produced in 4 (out of 12) Dancing Experiences

Multifacet Cognitive and Affective Modelling: The learning methodology used in this survey relies on computer-based tutoring environments, widely used since the commencement of the recent lock-downs; additionally, it focuses sturdily on models that enhance the recourse on experience. Learning in a face-to-face mode does not always guarantee satisfactory outcomes, especially if students are situated far from the main centers of activity. On the other hand, e-Learning of any kind may provide well advised remote control over the acquisition of knowledge processes, but the skills achieved in Table II are mostly attained through meritorious education based on experience and behavioral approaches (Droit-Volet, 2013). The cognitive models sustained by the present technological status-quo for musical education have some difficulty in sustaining “social robotics” to a level equal in social or professional standing; however, they are constantly improving their standards. (Turker *et al.*, 2017)

For this reason, the results of this survey from peers were comparatively measured upon their similarity to evaluations from experts in the field for creating affective states in performance. For instance, music science and art professional are accustomed to promoting ubiquitously affective tactics in order to increase the student's self-efficacy in performing in front of a public (Scherer, 2013).

IMPLEMENTING NOVEL INTERACTIVE LEARNING PROCESSES: As described in the previous section, when impaired in hearing subjects rehabilitate via CD instruction sets, as ENT specialists outline, they lack the supportive channel of lip-reading and overall visual observation of the facial moves of the speech therapist. Therefore, they are somehow deficient in their linguistic performance, usually exhibiting more hesitations, false starts and errors. To simulate the very same listening experience mode, as already stated, the subjects of the survey did not see the actual video of this performance; they merely heard its sound in the form of an audio CD. Nor were they given any information about the language or the actual place of the original public performance. They were asked to reproduce it in their own surroundings using their imagination about the scenery used rendering a dramatic performance of their own capacity (Fig. 6). In a way appropriate to the given circumstances they acted in accordance, dancing solo, in duets, or even accompanied by small groups.

The videos of their dancing performances, assessed with appraise, were evaluated not merely as dancing performances, but mainly on how well they were conforming to the assessed principles of harmonization with melody. The following criteria were used in specific:

C1: Rhythm synchronization (Vargic *et al.*, 2015; Fitch, 2012; Caccia & Loruso, 2020)

Recent research has been stressing out the connection between rhythm apprehension and possible linguistic deficits (Rathcke & Lin, 2021; Daikoku & Yumoto, 2020)

C2: Physical activity, mainly for hands and feet, according to the sequence of steps of the prototypal public performance (Hollands *et al.*, 2015)

Although bodily activity, it involves high level auditory, visual and somatosensory motor control. Significant improvement comes as result of training or recognition of award (Guo *et al.*, 2021)

C3: Overall accordance with the recreational pursuit of the original - aesthetic concordance of movement with the melodic motives (Juslin & Västfjäll, 2008)

Apart from correlating performance by correlating emotion to motivic shapes (Meyer, 1956), this criterion mingles the sociability of the subjects of this research with engagement in musical activities that have also a comprehensive content expressively conveying bodily movements (Su *et al.*, 2020;

Dell' Anna *et al.*, 2021) in theUs particular domain of dancing (Karpati *et al.*, 2016)

Evaluation, Estimation, Analysis: Learn and Re-learn via thy mistakes: Having submitted their videos, the 12 performing groups were allowed to see the original performance. They were asked to point out where they were in accordance with the dancers of the original video and where they overstretched or understated the thematic movements, the dancing style, the conceptual impression. This self-reporting process, known as Increasing Awareness in Human-Computer Interaction (HCI)terminology, is correlated with feasibility metrics linking cognition with motor outcomes and quality of life indices via an electronic voting system that followed up (Carapellotti *et al.*, 2022). Indeed, after having analyzed the musical background, the theatrical embodiment of the dancing performance and the academic literature on the subject, the 12 performing groups, with their facial characteristics blurredso not to be identified, were given for evaluation in various 2020, 2021 and 2022student groups of the same or other University classes in the Balkans. The reviewers were not affiliated with the performers; on the contrary, there was provision for considerable remoteness between them, in spatial and temporal distances, so to exclude any possible clues for personal affection (Laukka *et al.*, 2013). Two of the most "distant" reviewing groups were located the former in Greece, at the School of Pharmacy, Aristotle University of Thessaloniki, committing their assessments in January 2021 and the latter in Serbia, at the Faculty of Technical Sciences in Čačak, for the University of Kragujevac, committing their assessments in April 2022. They have responded in evaluating the performers within a 5-point scale, with 5 points reserved for an outstanding performance and 1 for an incompetent one. Zero (0) would be rarely deserved for a performance totally developed on the wrong direction. They have also accompanied their marks with explanatory notes elucidating in detail the critical points of their assessment according to criteria C1, C2 and C3. The evaluations according to criterion C1 yielded the points seen in Fig. 7.

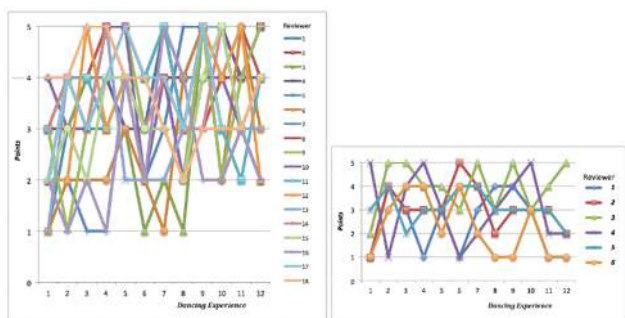


Fig. 7. Evaluation according to criterion C1. Left, the Serbian group, right, the Greek one

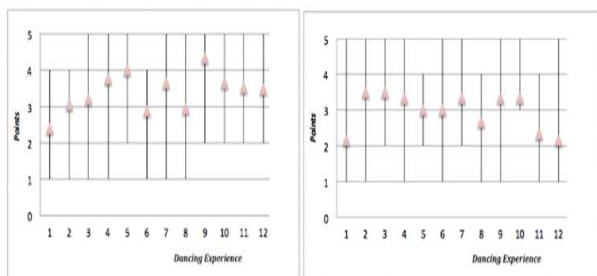


Fig. 8. Average values and variation for C1 evaluations. Left, the Serbian group, right, the Greek one

The statistical processing of the C1 performance evaluation is depicted in Fig. 8. The evaluations according to criterion C2 produced the points seen in Fig. 9.

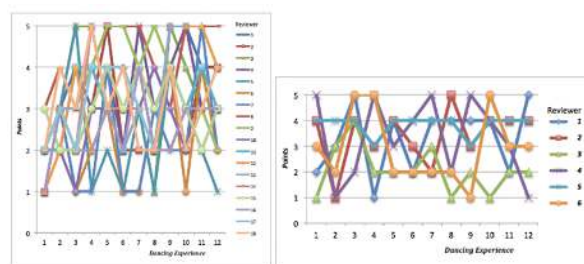


Fig. 9. Evaluation according to criterion C2. Left, the Serbian group, right, the Greek one

The statistical processing of the C2 performance evaluation is depicted in Fig. 10.

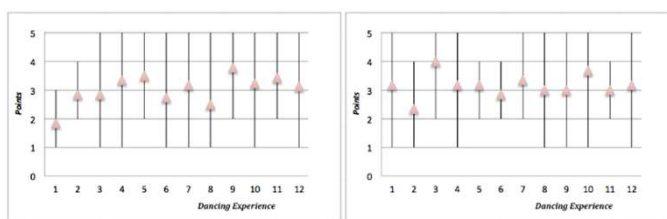


Fig. 10. Average values and variation for C2 evaluations. Left, the Serbian group, right, the Greek one

The evaluations according to criterion C3 generated the points seen in Fig. 11.

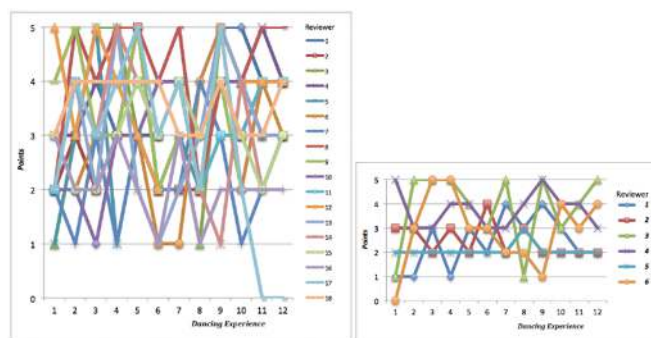


Fig. 11. Evaluation according to criterion C3. Left, the Serbian group, right, the Greek one

The statistical processing of the C3 performance evaluation is depicted in Fig. 12.

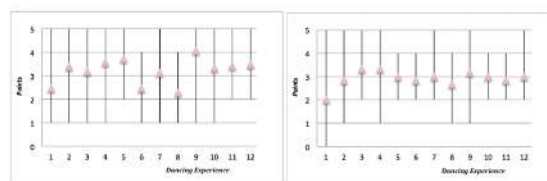


Fig. 12. Average values and variation for C3 evaluations. Left, the Serbian group, right, the Greek one

Both the diagrams and the t-tests committed between the Serbian and the Greek evaluating groups revealed convergence rather than divergence in their assessment.

Table I. Medical statistics on the success of hearing restoration after CI

		0.5 KHz	1 KHz	2 KHz	4 KHz	6 KHz
N	Valid	123	123	123	123	121
	Missing	0	0	0	0	2
Mean (dBHL)		21.26	20.20	23.66	28.50	32.48
Median (dBHL)		20.00	20.00	25.00	30.00	30.00
Std. Deviation		8.435	7.024	6.867	8.984	10.229
Min (dBHL)		5	5	10	10	10
Max (dBHL)		55	45	45	55	70

Table II. Speech Communication Dexterities accomplished by 48-month-old children

Audition (Hearing)	Perceptive Language	Expressive Language	Speech Communication	Cognition	Social Communication
<ul style="list-style-type: none"> Executes commands related to space Has a spatial memory (stereo separation) Locates sentences with 8 or more words Can recite small stories with 	<ul style="list-style-type: none"> Recognizes objects that are absent from the scene makes comparisons concerning speed / weight understands temporal concepts comprehends some 1500 - 2000 words 	<ul style="list-style-type: none"> Gamifies imagination and fantasy Uses negation Makes comparisons Sums up arguments with conclusions Utters some 800 - 1500 words 	<ul style="list-style-type: none"> Speed and rhythm are normal Reduces omissions and replacements Correlates brightness of speech with intensity Correctly applies stress patterns More combinations emerge in the beginning and end of phrases 	<ul style="list-style-type: none"> Correlates objects with actions Increases concentration Reproduces pictures with simple lines Sketches designs Develops fantasy even further Counts / indicates using fingers 	<ul style="list-style-type: none"> Increases confidence and self assertion Adopts to thematic changes Demonstrates communicative variability, i.e., imparts information, exchanges views, expresses sentiments... Uses correctly intonation

CONCLUSION

This research attempts to seek how new information systems and learning processes may be successfully employed for extending the boundaries of training. Indeed, for geographically dispersed learners or communities facing restrictions, like the recent Covid-19 lockdowns, the cost-effectiveness of e-Learning compliant training courses seems a desirable educative add-on. Emphasis is given in this research on how to cope with cases, like support training for rehabilitation, where orientation, teamwork and responsibility go hand-to-hand. The challenge is to procreate fully featured learning platforms with familiar, easy to use Interfaces enhanced with animated pedagogical content. Encouragement in the field of acoustic and vocal communication may enrich inexpressive training with emotional behavior so to accomplish web-based development, implementation and evaluation modules not only for rehabilitation courses, but for broader subjects of learning that have similarities with special education. Media and tools used in education during rehabilitation mingle with deployment mechanisms and protocols used for audiovisual interactions. As a result, versatile technologies yielding adequate learning outcomes seem to be the focal point for both health and education professionals designing engaging course content and schooling activities. Best practices from both worlds, from special education and from e-Learning, pursue, to advance consistent global capabilities through web portals alongside engagement to activities with inherent localization attributes.

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