The effect of the Tomatis® Method on self-regulation in a sample of South African university students.

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Abstract

Aim: To evaluate the extent to which the Tomatis® Method improves self-regulation in a sample of South African university students (N=49).

Method: A concurrent, mixed method approach using a three-group pre-post, and repeated post-assessment design, was used.

Results: The Tomatis® Method had a positive impact on hyporesponsiveness in the left ear and spatialization of the right ear, on introjected regulation and perseverance, as well as on psychological and social well-being. Benefits were also qualitatively observed regarding improved listening in social and academic contexts, attention and awareness, self-control and interpersonal regulation. Quantitative benefits regarding self-regulation obtained by the Tomatis group were shared to a certain extent by the Mozart group, while the benefits regarding well-being were only in comparison to the control group.

Conclusions: The Tomatis® Method has potential to improve the self-regulation skills of tertiary students. However, more research has to be done, with larger random samples to determine the extent to which the findings can be generalized, as well as to determine the possible role mediating and moderating variables play in the relationship between listening, self-regulation and psychological well-being.

Keywords: Academic performance; Intra-interpersonal relationships; Learning; Listening; Motivation; Self regulation; Tomatis® Method.

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Introduction

University students find themselves in a transitional phase that requires them to function as integrated social, cognitive and emotional beings, having to adjust to continuously changing environments. Developmentally, they have to establish a sense of identity and interpersonal meaning [1,2], while academically they are simultaneously required to achieve challenging cognitive tasks through multiple deadlines within set time frames [3,4]. In an effort to conflict between this multitude of tasks, students are often confronted with additional challenges like cross-cultural issues, dysfunctional family life, poor frustration tolerance, alcohol and drugs, interpersonal conflict, and increased levels of financial distress [5-7]. Within this challenging environment students have to continuously re-adjust the goal priorities, time management, and interpersonal communication within the context of their academic priorities and with parents, romantic partners, peers, and lecturers [7,8].

Not only do they have to establish quality romantic and friendship relationships, but they also have to clearly understand and communicate with lecturers to ensure optimal academic performance. When it comes to social relationships, students often have difficulty with directing and adjusting cognitions, emotions and behaviour.

Self-regulation

A critical resource in readjusting oneself and adapting to these challenging contexts is self- regulation, which literally means "changing oneself, or some aspects of one self, to bring thinking and behaviour closer to desired rules, norms, goals or ideals" [9]. Maes and Karoly define self-regulation as a systematic process that involves setting personal goals and directing behaviour towards achieving these goals [10]. Good self-regulation skills are therefore of great importance ineffectively managing diverse goals related to academic strategies, identity, health, and interpersonal relationships [11]. Self-regulation is a complex construct described from many different perspectives [12-14]. In this study, given the challenges university students are confronted with, self-regulation is primarily conceptualised from a multiple level perspective [15] in which the individual is seen as an agent of self-change [16]. According to this perspective, self-regulation is the ability to effectively adjust one's own behaviour based on monitoring, attention and feedback processes related to cognitive, emotional, and interpersonal aspects [15]. The ability to adjust own behaviour is associated with a sense of agency, which enables people to play a part in their own self-development, adaptation, and self- renewal [16,17]. Baumeister and Vohs further indicate that agency implies reflexiveness, in that "... the selfis active, involved, and responsive, intentionally engaging in volitional processes to change, alter, or modify

itself" and"...the self takes action, selects a response from numerous options, filters irrelevant information, and is responsible for responses selection and enactment" [18]. According to Distel, self-regulation also involves physical and emotional regulation in balance. Biologically it is assumed that the body adjusts itself to create balance in the sympathetic and parasympathetic autonomic nervous systems by producing fight and/or flight behaviours. When stressed, self-regulation changes the chemical balance within the brain and body, which impacts overall well-being [19].

Because of its potential as a human strength, self-regulation has been included as signature character strength in the Virtue Category of Temperance. Strengths in this category share aspects of the self-management processes, which include control over cognitive, emotional and behavioral responses [20].

The effectiveness of self-regulation depends on different resources and processes, including intrinsic motivation, self-efficacy, self-monitoring, creativity and flexibility [21]. Self-monitoring, which Bandura defines as the comparison of performance with goals, standards and values in an effort to gain feedback about the success of one's behavior [16,22,23], is of particular importance to this study as it is dependent on the quality of an individual's levels of awareness and attention. Berger defines attention as "the mechanism that enables adaptive behavior by selecting, integrating, and prioritizing among competing demands on cognitive and emotional systems by external as well as internally generated goals" [24]. According to Peterson and Seligman, attentional processes often constitute the first step toward success or failure in self-regulation [20]. Successful self-regulation is dependent on directing attention to own behavior, which limits automatic behaviors, such as the prejudice that follows preconceived ideas, and subsequently produces the condition for self-change [25].

It is therefore evident that self-regulation is essential for adaptive behavior and therefore not surprising that failure in self-regulation is associated with most major social and personal problems in contemporary society, for example drug abuse, crime and violence, prejudice and stereotyping, eating and sexually-related diseases [9]. These problems are clearly relevant to student populations, who often struggle with impulsivity, impatience, distractibility, or delay behavior such as procrastination, which negatively impact executive functioning and academic performance [26-28]. Effective self-regulation, in contrast, is associated with higher levels of quality of life and psychological well-being [29]. Students who effectively apply self-regulation skills are known to have higher levels of self-satisfaction, are psychologically more healthy, motivated for learning, perform better academically, and a recapable of pro-social behavior [3,4,21,30]. They have also been found to be more satisfied with the quality of their lives, have meaningful relationships, and experience overall happiness [31].

The role of listening in self-regulation

Although different systems are involved in attentional processes, most previous research on self-regulation has focused on visual attention, despite the fact that processing of auditory stimuli plays an equally significant role in attention, specifically in relating self to self, to others and the environment on affective and general sensory integration levels [24,32-34]. Due to this strong focus on visual processing, auditory dominance found in early developmental stages often goes undetected in adulthood [35,36].

Listening, as the most basic aspect of processing auditory stimuli, already starts to develop before birth, since the inner ear is fully developed and can process and integrate sound by the fifth month of pregnancy [37]. The foetus is therefore capable of hearing "auditory cues within the mother's environment". It is therefore not surprising that new-born babies who are exposed to music and light during pregnancy, develop more structured neural and auditory pathways [38]. The relationship between listening and self-regulation can already be observed when infants suck their thumbs after hearing aloud sound in order to regulate responses to the environment, therefore becoming aware of sound and responding to the feedback [34,39]. Later, in an academic environment, self-regulation is clearly not only determined by personal processes (i.e. perception of efficacy), but also seems to include listening on external and internal levels: externally to stimuli from the environment such as encouragement from lecturers, and internally to one's inner speech or voice, known as self-observation, assumed to affect self-judgment, which in turn affects self-reaction or self-instructive action [40]. Vandergrift also found listening to correlate positively with both intrinsic and extrinsic motivation, processes directly linked to self-regulation [11]. This link between motivation and self- regulation is confirmed by research in self-determination theory [41].

Good listening skills are further crucial in paying and directing attention, the basis for inhibition, control and strategies of problem solving and self-monitoring [24]. Self- monitoring through the process of listening does not only include cognitive, perceptual or attentional processes, as explained by the perceptual-loop theory [42,43], but also integrates affective and emotional processes [44] in which listening plays acritical role. Listening should therefore be an important aspect in effective self- regulation as it provides important feedback information not available through other sensory systems.

The Tomatis® Method

The Tomatis® Method of auditory stimulation has specifically been developed with the improvement of listening skills in mind, and due to its potential value in feedback processes and sensory integration needed for effective self-regulation, may be a key aspect in addressing the current gap in knowledge. Dr Alfred Tomatis, a French ear, nose and throat specialist, developed this method from both a neurophysiological and psychosocial theoretical perspective [37,45]. It can be described as a sound-based intervention method that stimulates

sensory integration via listening to enhance learning and regulation of intentional behavior [11]. For effective listening to take place, neurosensory integrators, specifically the vestibular, visual and cochlear systems, must be well established. Although the focus of the Tomatis® Method is on listening, the theoretical context is holistic and humanistic [46]. From this perspective, listening is "to actively use hearing intentionally and attentively, in a way that is acceptable on a cognitive and emotional level for the purpose of learning and communicating" [47]. Listening motivates action, personal growth and a healthy attitude towards the self and others [45]. Many learning problems originate from poor "communication" between important parts of the ear; the vestibule and the cochlea. When the separates of the ear work together in harmony, the brain retains energy to be attentive, learn and effortlessly convert language to be understandable [48]. This is known as a "good listening ear", which plays an important part in the regulation of cognitions, behavior and emotions, and brings about a sense of well-being [37,45,48].

For the development of a"good listening ear", Tomatis developed a device known as the Electronic Ear (EE). The ears are trained by listening to music played through special earphones that combine both air and bone conduction after being modified by the EE [49]. The Tomatis® Method and exercise the whole ear through air and bone conduction specifically aiming to strengthen the effects of the middle ear, the inner ear, the auditory system as a whole and the central nervous system for the purpose of awakening the connections needed for the brain to fully process auditory information [50,51]. The Tomatis® Method therefore has the potential for enhancing self-regulation skills through its focus on the improvement of listening skills that impact cognitive-judgmental and affective functioning [52-54]. Research also found that it is possible to learn better and achieve better results when following a Tomatis programme due to its positive impact on regulating sensory integration and attention skills, factors specifically associated with self-regulated learning [48].

Previous research has reported the Tomatis® Method to be an effective intervention model for addressing learning disabilities and behavioral problems [55], attention deficit disorders [56], stuttering [57], auditory processing disorders [58,59], and psychological disorders [60]. Some, such as Corbett, Shickman and Ferrer, have been particularly critical of the lack of clinical research on the method and its reported findings. The proponents of the Tomatis® Method also agree that further research and development are needed.Based on these gaps in knowledge, the aim of this study is to evaluate the impact of the Tomatis® Method on the self-regulation of a sample of South African university students [61].

Method

Design

A concurrent, mixed-method experimental design [62] was conducted for this study. Data was collected using a three-group pre-post, and repeated post-assessment design. Pre-measures took place a week before the intervention, post-measures within a week after the intervention was completed, and repeated post-measures four months later.

Sampling / Participants

A purposive sample of 49 first-year undergraduate students from the Potchefstroom Campus of the North-West University participated in the study. This sample consisted of 13 males and 36 females, of whom 25 were White, 23 Black and 1 Coloured. A full biographical profile of the study population is provided in Table 1. Participants were randomly assigned to an Experimental group (group E) (n=18) who underwent the basic Tomatis programme, a first control group that listened to Mozart music, but without the gating effect of the Tomatis® Method (group M) (n=16) and a second control group that did not listen to any music (group C) (n=15). Ofthe49 participants, only 26 (E, n=8; M, n=9; C, n=9) were available to complete the post- and 21 (E, n=9; M, n=6; C, n=6) to complete the repeated post-assessment phases.

The Listening Programmes

Selected participants for Group E and M reported to the Audio-psycho-phonology facilities at the Institute of Psychology and Well-being at the Potchefstroom Campus of the North-West University (NWU). Group E took part in the standard fundamental, previously known as the basic Tomatis programme. The researcher is a qualified Tomatis practitioner and presented the programme with the technical assistance of an intern psychologist. The Tomatis® Method is played through aportable So listen® device that reproduces the gating effect of the Electronic Ear (EE), which Tomatis developed for the stimulation of listening skills [37]. This device has been created with 2 sessions of 30 hours each for good follow-up scope, but can be combined and connected in accordance with the needs of the participant [47]. For the purposes of this study the programme consisted out of2 sessions of 25 hours each. The sessions consisted of2 hours a day over a period of 15days (session 1) and 10days (session 2). During the programme participants listened to various Mozart compositions, modified by the gating effect of the EE [37,63]. Tomatis found the rich harmonics of Mozart's violin concertos ideal and necessary for the mechanism of electronic gating to work [64]Group M were given the same amount of time listening to the Mozart compositions without the gating effect of the EE. Participants could perform activities such as drawing, painting, building puzzles or just relaxing during listening. These activities have been proposed for participants not to get bored and it enhances the integration of reflex and tactile sensory systems [34]. These activities were, however, not collected or interpreted as data.

Procedure and Ethical Issues

Ethics approval was received (NWU 00103-11-A1) and the study was advertised through contact with lecturers, who acted as gatekeepers. The researcher were granted some time before the start of lectures and provided information about the planned research to students during that time. The same information were placed on the online student portal and

ensured all relevant students received an equal opportunity to take part in the study.

Written informed consent was obtained prior to conducting the research. Participation within the study was voluntary and anonymous; research codes were allocated for each participant and used as identifier throughout the study.

Random assignment into the three experimental conditions was done, after which data were gathered during a pre-post and repeated post-stage. The two control groups received the opportunity to complete the Tomatis programme after all data were captured. Psychometric tests were administered by the researcher, who is a qualified and registered practitioner in terms of the regulations set out by the Health Professions Council of South Africa (HPCSA). Captured data was stored and is locked securely at all times providing access to the researcher only. The listening programmes were conducted by the researcher, who is a trained Tomatis Consultant.

Data generation

Data was collected from all three study groups during the pre-post and repeated post phases. The following materials were used:

Biographical information (47)

The Adult Solisten® Programme Background Questionnaire provided a biographical profile of the study population (Table 1).

Table 1. Biographical profile of study population.

	Frequency	**%**
Gender:		
Male	13	26.53
Female	36	73.47
Population Group:		
White	25	51.02
Coloured	1	2.04
Black	23	46.94
Residential Status:		
Private	32	66.67
Hostel	16	33.33
Highest Qualification:		
Senior Certificate	41	93.18
Diploma	1	2.27
Degree	2	4.55
Marital status:		
Single	45	91.84
Married	1	2.04
Widow	1	2.04
Partner	2	4.08
Wear glasses:		
Yes	12	25
No	25	52.08
For reading	11	22.92
Impaired hearing:		
Yes	2	4.08
No	47	95.92
Colour blind		
No	49	100
Handedness:		
Right	42	85.71
Left	4	8.16
Both	3	6.12
Functioning difficulties:		
*ADD/ADHD**	2	100

Note: ADD/ADHD = Attention Deficit Disorder/Attention Deficit and Hyperactive Disorder

Tomatis® Listening Test (TLTS)[37,45,48]

This TLTS is a direct outcome of Tomatis' distinction between hearing and listening [60]. The listening test shows distortions in relation to the Ideal Listening Curve (ILC) [48]. Frequencies ranging from 125 to 8000 hertz are evaluated by means of the following parameters: 1) Air conduction (AC) and Bone conduction (BC) thresholds. The AC/BC relationship is compared to each other in each ear [60]. The relationship is evaluated in terms of Hypo-responsiveness (AC parallel and above BC) and Hyper-responsiveness (AC above with BC withdrawn); 2) Selectivity of air conduction, the ability to discriminate sounds of different pitches; and 3) Spatialization of bone conduction, how a person localizes sounds in space.

The test reflects how the desire to listen is utilized or resisted, therefore revealing listening strengths or listening weaknesses [60]. The TLTS is performed using a Diagnostic Audiometer AD229b and has mainly been used as a clinical tool to monitor progress [65]. Aubert-Khalfa et al., however, found the test to be valid and reliable for research purposes [66].

Self-Regulation

Shortened Self-Regulation Questionnaire (SSRQ: Carey, Neal, & Collins, 2004; Potgieter & Botha, 2009)[67,68]: This 31-item scale measures the average ability to regulate behaviour to achieve a desired goal. Potgieter and Botha [68] proposed a seven-factor structure relevant in a South Africa context, and criterion-related validity and reliability reported a Cronbach alpha of 0.90, and has been successfully used within the South African context [69]. For the current study two Cronbach alpha values below 0.6 were obtained and the decision was made to exclude them from the study. The other

constructs obtained Cronbach alpha values between 0.61 and 0.83.

CogLab 2.0 [70]: CogLab 2.0 allows better understanding of certain cognitive functions, including self-regulation as part of the brain's executive functions. Participants completed the Attention and Working Memory subtests. Previous research found reliability and validity indices between 0.72 and 0.96 for various experiments of CogLab [71].

Academic Motivation Scale (AMS-C 28) [72]: The AMS measures intrinsic, extrinsic and a motivation within an educational context. This 28-item questionnaire has shown Cronbach alphas for the seven subscales between 0.62 and 0.86 [72]. The current study obtained alpha values between 0.50 and 0.88.

Zin Obelisk Problem Solving Task (ZIN) [73]: This method was used to assess participants' interpersonal self-regulation. Du Plessis found the ZIN to be of specific importance for evaluating interpersonal communication and listening skills [74]. These interactions were audio-visually recorded, observed and documented by a panel that consisted out of the researcher and two additional observers. Specific focus was paid to listening skills during the interactions.

Self-reflective journals: Groups E and M were asked to keep self-reflective journals [75]. To reduce bias the researcher did not disclose which research group participants were assigned to.

Semi-structured interviews: Individual and group interviews were conducted with participants in group E and M during the last week of the intervention stage. All interviews were audio-recorded and transcribed.

Well-being

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Mental Health Continuum – Short Form (MHC-SF)[76,77]

The 14-item MHC-SF measures positive mental health and consists of three subscales namely: 1) Emotional well-being, 2) Psychological well-being, and 3) Social well-being. The MHC-SF has shown to be reliable and valid for use in an African context [77]. Cronbach alphas of 0.74 and 0.84 have been reported. In this study the alpha values were between 0.74 and 0.80 [77,78].

Social Support Questionnaire 6 (SSQ6)[79]: This 6-item questionnaire is a shortened version of the Social Support Questionnaire [80], designed to measure social support. It showed good internal consistency in previous studies with Cronbach alphas ranging between 0.83 [81] and 0.92 [82]. The Cronbach alpha in this study was 0.84.

Data analysis

Quantitative

Quantitative data were captured and analysed using SAS 9.3 [83,84]. Cronbach alpha reliability coefficients were computed to determine reliability, while confirmatory factor analyses were done to confirm construct validity. Analyses of variances (ANOVA) were done to determine if differences existed among group means. Dunnet's post hoc, one-sided tests were done, using the Tomatis® group as control, to determine if the two control groups differ statistically significantly from the Tomatis® group. These tests were done at a 0.05 significance level. As a result of small groups in this study, non-parametric Kruskal Wallis and multiple comparison tests were also done to confirm and compare results obtained by the ANOVA's and Dunnet's test results.

Qualitative

To standardize observations between the three observers, a self-compiled rating scale was used as a guideline to assess participants' interpersonal self-regulation during the ZIN. Participants were rated as good when they displayed the ability to listen empathically, giving others the opportunity to speak, and assertively communicated their own ideas; poor when participants did not take part in the discussion, interrupted others in the group, or overpowered the group; and average when they did not clearly comply with the criteria for either good or poor. Observations for each participant were also written down and blinded observation and evaluation were done with two of the panel members not knowing which group the participants were from, as well as which phase they were observing.

Thematic analysis was done with ATLAS TI © [85] on the transcribed data of the ZIN, reflective journals, individual and group interviews. Investigator triangulation was done as the researcher and a co-reviewer completed thematic analysis independently, where after themes were compared, reviewed and refined, named, defined and a final report compiled [86,87]. Trustworthiness was ensured through the keeping of notes and memos during the analysis. By making use of different sources of qualitative data, additional reviewer and observers, data triangulation were used as quality assurance method [88].

Results

Reliability and validity of the quantitative measures

All possible reliability indices were computed for each scale and subsequent subscales as captured in Table 2. Two subscales yielded α-values <0.6, namely SSRQ Self-evaluation and SSRQ Creativity. These were not used for further analyses, but are included in the table for transparency [89].

Table 2. Reliability analysis.

Variable	α
SSRQ_Monitoring	0.83
SSRQ_Decision Making	0.61
SSRQ_Learning from mistakes	0.76
SSRQ_Perseverance	0.69
SSRQ_Mindful awareness	0.69
SSRQ_Self-evaluation	0.20*
SSRQ_Creativity	0.33*
SSQ6_TOTAL	0.84
AMS_Intrinsic Motivation towards knowledge	0.78
AMS_Intrinsic Motivation towards accomplishments	0.82
AMS_Intrinsic Motivation towards stimulation	0.88
AMS_External motivation	0.79
AMS_Introjected regulations	0.8
AMS_Identified regulations	0.64
MHC_EWB	0.8
MHC_SWB	0.74
MHC_PWB	0.76

Note: * α-values < 0.6, not used for further analysis; SSRQ = Shortened Self-Regulation Questionnaire; AMS = Academic Motivation Scale; MHC= Mental Health Continuum; EWB= Emotional Well-being; SWB= Social Well-being; PWB= Psychological Well-being.

Between one and two factors were retained, explained by each confirmatory factor analysis on each construct of the SSRQ and MHC-SF. The decision was made to keep the constructs according to the scoring instructions of the standardised SSRQ, especially due to the fact that these constructs had Cronbach alpha values higher than 0.6 [89].

MSA scores > 0.5 indicate appropriate inter-correlations among the variables [90]. The proposed factor structure for the SSRQ consists of seven constructs, which explained between 39.44% and 65.99% of the variance, and MSA scores ranging between 0.49 and 0.77. The three constructs of the MHC-SF explained between 45.41% and 71.14% of the variance with MSA scores ranging between 0.62 and 0.72. SSQ6 yielded one factor, explaining 58.33% of the variance, with an overall MSA of 0.82. The seven constructs of the AMS, each constituted by four items, all yielded one factor for retention. Constructs explained between 50.51% and 74.60% of variance, with MSA scores ranging between 0.63 and 0.78. These results therefore indicate that construct validity was attained for all measures.

ANOVAS

Between-group differences (Table 3, Table 4) were compared by subtracting the pre-results from the post-results (difference 1=Diff1), and the pre-results from the post-post results (difference 2=Diff2) to determine the longevity of the results. The parameters of listening as measured by the TLTS (Table 3) show statistically significant differences ($p<0.05$) in Diff1 on AC/BC Hypo responsiveness in the left ear between groups E and M, and groups E and C. Group E showed an increase in mean scores, while both groups M and C showed a decrease in mean scores. On Diff2 statistically significant differences ($p<0.05$) were found between groups E and C on Spatialization of the right ear, with a decrease of spatial errors in group E and an increase in group C.

Table 3. Between group differences in listening test parameters.

Group	Mean of diff	Std of diff	ANOVA F value	Degrees of freedom	One-sided Dunnet sign on 0.05 level
Hypol (Diff1)					
E	0.28	0.78			
M	-0.98	1.02	4.73	(2;23)	C with E
C	-0.61	0.8			M with E
Right_ear_sp (Diff2)					
E	-0.83	1.62			
M	-0.67	0.98	2.76	(2;17)	C with E
C	0.8	0.84			

Note: Hypol = Hypo-responsiveness left ear; Right_ear_sp = Right ear spatialization; Diff1 = Difference 1, subtraction of pre- from post-measures; Diff2 = Difference 2, subtraction of pre- from post-post measures.

Statistically significant differences ($p<0.05$) were also found in Diff1 on Psychological Well-being (MHC_PWB), and Social Well-being (MHC_SWB between group E and group C. Scores indicated an increase in Psychological Well-being and Social Well-being in group E, and a decrease in Psychological Well-being and Social Well-being in group C. Finally, statistically significant differences ($p<0.05$) were found in Diff2 on Perseverance (SSRQ) between group E where scores increased and group C where scores decreased, and on Introjected regulations (AMS) between group E where scores increased and group M where scores decreased (Table 4).

Table 4. Between-group differences in self-regulation and well-being.

Group	Mean of diff	Std of diff	ANOVA F value	Degrees of freedom	One-sided Dunnet sign on 0.05 level
MHC_SWB (Diff1)					
E	4.50	5.48	2.43	(2;23)	
M	1.44	4.88			C with E
C	-0.67	4.15			
MHC_PWB (Diff1)					
E	2.75	4.33	4.48	(2;23)	
M	-1.56	4.10			C with E
C	-2.56	3.05			M with E
AMS_Introjected regulations (Diff2)					
E	1.14	1.11	2.81	(2;18)	
M	-0.50	2.08			M with E
C	0.08	0.58			
SSRQ_Perseverance (Diff2)					
E	1.22	2.39	2.67	(2;17)	C with E
M	0.00	1.87			
C	-1.50	2.26			

Note: MHC_SWB = Mental Health Continuum, Social Well-being; MHC_PWB = Mental Health Continuum, Psychological Well-being; AMS_Introjected regulations = Academic Motivation Scale, Introjected regulations; SSRQ_Perseverance = Shortened Self-regulations Questionnaire, Perseverance; Diff1 = Difference 1, subtraction of pre- from post-measures; Diff2 = Difference 2, subtraction of pre- from post-post measures.

Qualitative results

Four themes were identified, namely improvement in listening skills, awareness and attention, interpersonal self-regulation, and self-control. Although both groups E and M reported improved listening skills, it was more prevalent in group E. Both groups experienced improved attention and awareness, as well as improved interpersonal self-regulation. Lastly, improved self-control was reported primarily by group E. These themes will briefly be discussed.

Improved listening

Improvements in hearing and listening ability within social and academic settings were found in the majority of group E, and a few of group M participants:

"My listening, like at first I would like miss some words when someone was speaking and asking what were you saying? Pardon? You didn't get that. Like now I can like, I hear every word that she says and respond."(M7); "Yes, I think I listen better now in classes", "I don't get bored in class, because now I hear...Yes, because I can hear what the lecturer is saying". (E8).

Improved interpersonal self-regulation

Both groups felt that they were more self-assured, and experienced a higher tolerance for social interactions after the intervention:

"I think I'm a bit calmer now and I can talk to people…" (E9); "…usually I would get irritated quickly, but now I am more calm and listen…." (M4).

Notable improvements during the ZIN observed in group E compared to the other two groups, showed less overpowering in interpersonal problem solving and more openness to provide others the opportunity to take part in the discussion. During the repeated post-intervention only Group E showed further improvements in their ability to listen, reflect, and openness to discuss problems and provide various solutions.

Improved attention and awareness

Participants indicated that they became more able to pay and sustain attention: "You are just in this moment so when you do, you focus on what you do now or on the people there…" (M12); "...I'm a bit more alert. ..It's like an eye opening, I see things or realise things better, or notice." (E17).

Further benefits were better understanding of and are more active involvement with their studies: "I have been able to understand most of my work so far better than I did before and it is all because of the focus that I am to have busy with the

sessions" (M8); "Help you stay focused…refreshed for classes ready to learn and listen to teachers." (E4);

Changes in attitude towards studies increased motivation and contributed to improved academic performance: "I decided to put more effort in."(M17); "I am a little more motivated to go to class."(E16); "I studied for one test here and I got 77%", previously "I had 50's, 60's."(M11); "Since I have been on the programme my first test I got 70", "The previous marks were up and down…I did not get 70 in a whole year … Always about in the 50's." (E16).

Improved self-control

Improved self-control, adapting behaviour, thoughts and emotions to circumstances were primarily experienced by group E:"Forget about stresses", "…give a different way to look at problems while calm and refreshed."; "…since I've been listening, I've been teaching myself to relax a bit more" (E17)

This led to improved decision-making, self-discipline and organisation: "…now I summarize a situation better and can therefore make the right decision."(E14); "I find it easier to apply self-discipline" (E3); "…my organising skills have changed a bit, so how I do things has changed…" (E8).

Discussion

This study evaluated the extent to which the Tomatis® Method improved self-regulation in a sample of university students. Two subscales, SSRQ Self-evaluation and SSRQC reactivity yielded α-values<0.6 and were excluded from further analyses.

Using the ideal listening curve(ILC) as reference point, a global view of the listening curves as measured by the TLTS is obtained by focusing on various parameters that highlight listening strengths and weaknesses [48]. In the current study, changes that occurred in participants' desire to listen are reflected in the statistical significant difference of hypo-responsiveness in the left ear of the Tomatis group, compared to both the Mozart and Control groups. These results showed improvements in the Air/Bone conduction (AC/BC) relationship of the listening curves. According to Tomatis [47] a good AC/BC relationship is characterized by the balance between energy invested internally (BC) and energy invested externally (AC), with BC situated below AC.A close AC/BC relationship, without touching or crossing each other, translates as functional harmony between the stirrup and hammer muscles found in the middle and inner ear. The functioning of these two muscles is controlled bythe5thand 7thcranial pairs, which are directly linked to the amygdale [47], which plays an intricate role in self-regulation [91,92]. As highlighted by Thompson and Andrews, the stimulation that takes part during a Tomatis programme improves the interconnections between the ear, the nervous system, and the brain, which leads to better integration in human behaviour.

Why these changes were only significant in the left ear, may firstly be due to the neurodevelopmental principle that underlies the Tomatis® Method. The stimulation promotes nerve growth, which happens over a period of time [34]. Students, due to their developmental stage and level of differentiation, are often confronted with adjustment and emotional challenges [93]. Therefore, it is not surprising that the results portray improved integration of pathways between the ear and the brain, providing a wider ability to receive, accept and process an acoustic message and also created more of a desire to connect and communicate with the outer world [47,49].

A second reason for the significant change of hypo-responsiveness in the left ear might be that all sound traveling through the left ear is projected to the right hemisphere of the brain [94]. Based on the knowledge that the right hemisphere is regarded as the dominant emotional processing hemisphere, it is not a surprise that participants of group E experienced improvements in this area. Davidson, Fox and Kalin explain that emotions regulate "adaptive behaviour and decision making in response to salient events" [95]. Tomatis also describes left ear laterality in terms of the ear's connection with the brain [37,45,47]. The improve mention AC/BC relationship in the left ear therefore also improved the participants' ability to be emotionally more available to themselves, others and the environment.

Statistical significant results on Diff2 of right ear spatialization further indicated a decrease in the spatial errors made by the participants in the Tomatis group to locate sounds, whereas the Control group showed an increase in the same parameter. This indicates that the Tomatis® Method had a positive effect on the participants' ability to locate sounds which has a direct impact on their levels of energy, memory and attention" [96]. Sollier explains that spatialization errors are still frequent during times of auditory stimulation and could be seen as a form of defence by distancing "threats" of change to make it seem less threatening [48]. Thus, even though spatial errors were not totally eliminated in group E, thestatistical difference in comparison to the control group clearly shows the effect the Tomatis® Method had. The results on the TLTS were confirmed by participants' subjective experience. They noted improvements in the irgeneral ability to hear (more in tune with everyday sounds) and to listen, specifically within social contexts and within class (able to better follow lectures).

Regarding self-regulation, participants from group E were found to have statistically better long-term (Diff2) Introjected regulations regarding academic motivation in comparison to participants of group M.Introjected regulation represents an extrinsic or controlled type of motivation, as opposed to intrinsic or autonomous motivation, in which people experience volition, or a self-endorsement of their actions. It refers to when action has been partially internalized and is energized by factors such as an approval motive, or avoidance of shame or guilt [97]. The individual therefore engages in activities not for the pleasure of the activity itself, but out of obligation [98]. This result is in line with previous research on motivational factors of potential student dropouts. Meyers, Pignault, and Houssemand [99] found that "potential dropouts have less intrinsic motivation, less introjected regulation, more a motivation and less academic self-efficacy." The improved introjected regulation of participants in group E therefore

reflects a stronger sense of responsibility and obligation to perform academically, which is better than being a motivated, although it would have been more beneficial if the motivation was more intrinsic in origin [100]. At this point in research it is unsure whether or not the direction in which the motivational orientation of participants who completed the Tomatis® Method is moving towards or away from intrinsic motivation. Further research should be considered for clarification.

Participants of group E further show edastatistically significant longer term (Diff2) increase in Perseverance on the SSRQ, compared to the decrease in group C. Perseverance is the ability to remain focused on at ask and not be shifted by distractions [101]. The improvement in perseverance seems to be related to the improvement in introjected regulation. Skinner and Edge indicate that perseverance is based on an introjected style of regulation in which the individual, in response to environmental demands, is subjected to strong internal pressures to submit [102]. In a negative sense perseverance may reflect rigid compliance, conformity or submission. However, perseverance may also reflect a strength as it relates to commitment and confidence to achieve goals even in the face of adversity [103], while it could also positively reinforced intrinsic motivation [101]. This compares favourably with the finding by Meyers et al. that potential student dropouts "have less perseverance of effort, poorer learning strategies, and less resistance to peer influence" [99]. Because of the potential disadvantages and advantages of perseverance, the secret would be to flexibly apply it, based on Brandtstädter and Rothermund's definition of adaptive flexibility: "The ability to flexibly switch between different means for reaching a goal, whether persevering, changing, or even disengaging from a goal, depending on what would be most appropriate or effective in any given situation" [104].

Improved self-regulation was also subjectively perceived by participants. Participants from groups E and M further perceived improved attention and awareness, often in the form of being able to better self-reflect on their academic work, and being able to listen and understand their lecturers better. Diehl, Semegon and Schwarzer [105] emphasize the importance of attention to self- regulation when they refer to attention as a person's "ability to focus his or her attention on a given task, to control and regulate external and internal distractions, and to work toward a desired goal or outcome". Brown, Ryan and Creswell further propose that directing attention to subject ivemental, emotional, and physical experience is key to healthy self-regulation, while Luszczynska, Diehl, Gutiérrez-Doña, Kuusinen and Schwarzer specifically indicate that attention regulation organizes incoming stimuli in order to, for example, maintain a calm state of mind, delay gratification, and tolerate change [106,107].The ability to successfully direct attention is therefore often the first step towards successful self-regulation [20]. As participants from both groups E and M reported better attention, however, it would be difficult to conclude that the difference was due to the Tomatis® Method only.

Improved self-control was reported primarily by participants from group E.Self-control is a pivotal function within the self-regulation process, and refers to the ability to simultaneously "maintain distance from tempting stimuli and proximity to goal-related stimuli, in order to increase the likelihood of adhering to long-term goals"[108]. Effective self- control relies on self-observation or the extent to which the individual accurately generates and interprets feedback [21]. Gibbons etal. Further indicate that good self- control includes the ability to self-reflect, for example "I like to plan things ahead of time", and "I think before I act", while S olso, Maclin and Maclin emphasize the importance of inner speech in self-reflection. This result emphasizes the potential importance Tomatis may have for self- control through improving self-listening [26,48,109].

Improvements were further observed in the quality of interpersonal self-regulation in participants of group E and to a lesser extent in participants of group M. Self-regulation is extremely important in interpersonal relationships. According to Leary being accepted by others provides an adaptive advantage, while rejection has adverse consequences. As a result, Leary indicates, human beings developed a psychological system for regulating their relationships that monitors and responds to events that are relevant to interpersonal acceptance and rejection [110]. Fitzsimons further explains that interpersonal monitoring enhances self-regulation ability, which allows individuals to more effectively achieve goal fulfilment by selectively engaging in beneficial social relationships and social situations [111]. It would therefore make sense to argue that participants' improved interpersonal abilities may be the result of their improved listening skills and better ability to monitor themselves interpersonally.

Given the changes in listening and self-regulation, it is not surprising that significant statistical differences were found between the Tomatis and Control groups on Psychological and Social Well- being regarding pre-and post-measures (Diff1). Qualitatively, Nel reported enhanced Psychological Well-being and interpersonal communication as a result ofthe effects of the Tomatis® Method on a boy with A sperger Syndrome [112]. Coetzee, DuPlessis et al. and Vercueil et al. also measured and reported significant increases in Psychological Well-being of participants who completed a Tomatis programme [60,113,114].

These differences indicate that exposure to the Tomatis® Method lead to at least short-term improved well-being, in comparison to participants who did not receive any sound stimulation. From a Tomatis perspective the improvement in Psychological Well-being would be seen as an improvement in self-listening and the improvement in Social Well-being as an improvement in external listening [48].

Conclusion, limitation and recommendations

The findings of this study indicate that the Tomatis® Method had a positive impact on hypo- responsiveness in the left ear and spatialization of the right ear, which implies that participants had a stronger desire to listen, and were more able to locate sounds, on introjected regulation and perseverance, as well as on psychological and social well-being. Benefits were also qualitatively observed regarding improved listening in

social and academic contexts, attention and awareness, self-control and interpersonal regulation. The difference in listening skills clearly benefitted the Tomatis group in comparison to both the Mozart and control groups. However, the benefits regarding self-regulation were shared by the Mozart group, while the benefits regarding self- regulation specifically as psychological and social strength (well-being) were only in comparison to the control group. As a result, the differentiation between Tomatis® Method and listening to Mozart music needs further explanation and perhaps further research. Research have found evidence that suggest listening to unmodified Mozart music to be just as effective as the Tomatis® Method. Thompson and Andrews however, argue that listening to Mozart music does not have the "integrated neurological response" of the Tomatis® Method, which explains why the Tomatis group benefitted more than the Mozart group in this study [49]. Although some questions still exist regarding the lateralization of improved listening skills, and spatial errors have not been eliminated in total, as well as the implications of improved introjected rather than intrinsic regulation, the general consensus is that the results a repromising indeed.

The study was not without limitations, however. Even though a proper design was followed, the small sample size limits the generalizability of the findings. The sample also consisted of a group of relatively well functioning university students, which limited the scope/range for improvement in self-regulation. Even though every effort was made to ensure participation in the listening sessions, the total numbers of hours spent by each participant on the Mozart and Tomatis programmes varied between 12 and 44. However, research indicated that stimulation between 30 and 60 hours are sufficient for a Tomatis programme [49], depending on the type of training needed.

It can thus be concluded that the Tomatis® Method had a positive impact on specific aspects of self-regulation in a small group of tertiary South African students. The Tomatis® Method therefore clearly holds positive potential to improve the self-regulation skills of tertiary students. However, more research has to be done, with larger random samples to determine the extent to which the findings can be generalised, as well as to determine the possible role mediating and moderating variables play in the relationship between listening, self-regulation and psychological well-being.

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