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Translation and cross-cultural adaptation methodology for soundscape attributes – A study with independent translation groups from English to Greek

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ABSTRACT

The use of questionnaires for soundscape evaluation is a key aspect of soundscape research. Since standards and protocols mainly exist in English, using an appropriate translation and cross-cultural adaptation (CCA) methodology is necessary to maintain content equivalence between source and target language. However, many examples can be found in the literature where no appropriate methodology was applied. This study addresses the neglected aspect of the translation and CCA process in soundscape research by selecting, applying and evaluating an appropriate methodology. After a survey of the relevant literature, an approach based on a combined technique of the forward translation, synthesis, back translation, pre-test and a committee approach was selected. Additional translation guidelines drawn from the literature are suggested and implemented. For the case study of the Greek translation of ISO/TS 12913–2:2018 attributes (Method A), the steps of the methodology were applied by four independent translation groups with different compositions according to the biculturalism and bilingualism of the group members. A method for categorization of bilinguals according to the literature is proposed. In order to compare and validate the results, translated and original attributes were used in listening tests with Greek and English participants respectively, and principal component analysis (PCA) was applied. The most important findings of this research are: the results of the bicultural translation group were closer to the PCA results of the English participants for every attribute, translation of bilingual groups may not be always sufficient, translation errors may be misinterpreted for cross-cultural differences without proper application of a translation methodology and the process of back translation can be effective, especially in cases where there are not corresponding words in the target language. Finally, PCA can be used as a validation methodology for comparison of different translations.

1. Introduction

Translation is the communication of the meaning of a source language text by means of an equivalent target language text [1]. While the practice of translation has always been important in human civilizations and societies, the study of the field now generally known as 'translation studies' developed into an academic discipline in the latter part of the twentieth century and is described as being concerned with 'the complex of problems clustered round the phenomenon of translating and translations' [2]. Cross-cultural adaptation (CCA) refers to the process of considering any differences between the source and the target culture so as to maintain equivalence in meaning [3]. It is now recognized that if measures are to be used across cultures, the items must not only be translated well linguistically, but also must be adapted culturally to maintain the content validity of the instrument at a conceptual level across different cultures [4]. The term CCA can also be used to encompass the process that looks at both translation and cultural adaptation issues [4].

The success of a translation depends on achieving equivalence, a demanding task which involves many difficulties 'since no two

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languages are identical, either in the meanings given to corresponding symbols or in the ways in which symbols are arranged in phrases and sentences' [5]. Problems and different types of equivalence have been studied by many researchers [6,7]. One of the most used and probably practical approach, is that of Sechrest et al. [6], who have identified five distinct problems:

- Vocabulary Equivalence: The most obvious kind of equivalence is in vocabulary, in the words used in two or more translations where one would need to find comparable terms.
- Idiomatic Equivalence: Problems in translation arise because idiomatic speech is employed in one language, and idioms never translate properly, if at all.
- Grammatical-Syntactical Equivalence: Languages differ widely in their grammars and syntaxes and these differences are often critical to the meanings in various translations.
- Experiential Equivalence: In order for translations to be successful from one culture to another they must utilize terms referring to real things and real experiences which are familiar in both cultures, if not exactly equally familiar.
- Conceptual Equivalence: Conceptual equivalence is the problem of insuring that the concepts used in the measures, interview, or other translated materials are equivalent in the two cultures.

Regarding types of equivalence one should also refer to the comprehensive framework provided by Herdman et al. [7,8], who in a literature review identified 19 different types of equivalence, finally categorized into 6 main types: conceptual, item, semantic, operational, measurement and functional.

To achieve equivalence, the use of a suitable translation and CCA methodology is essential. Various methodologies can be found collectively in [3,9,10]. Aspects of the methodologies (according to which they were categorized) were found to be [3,11]: forward translation, synthesis I /reconciliation, back translation, synthesis II/ back translation review, expert committee, pilot testing, particularities (e.g. decentering, pretest etc..). A similar categorization can be found in [9,10]. Description of the aspects of the methodological approaches can be found in many studies [6]. In general, methods and guidelines for CCA of questionnaires use a combination of these aspects and variations of the techniques.

Application of translation and CCA methodologies in order to achieve equivalence is important in many scientific fields such as soundscape research, especially since standards and protocols mainly exist in English. However, examples can be found in the literature were no translation and CCA methodology was applied. In some studies the translation was performed by members of the research team [12,13], by informal focus group [14], by native speakers [15], with the use of dictionaries [16], a methodology wasn't reported [17] or the participants were allowed to have access to both original attributes and the translation in order to minimize the inaccuracy [18]. Because of the complexity of the translation task and its cultural implications, the above practices may be insufficient for translation and CCA.

For direct translation, several approaches have been proved unworkable, since as stated by Sechrest et al. [6]: 'The translator himself may not be sufficiently skilled on one or the other of the languages in which he is working, he may not be culturally representative of the group for which the materials are to be used, and he may, by reason of his own experience, have peculiarities of word understanding or word use'. Also, especially for brief material (such as of this study) it has been pointed out that a method of direct translation is likely to be most inadequate [19]. Similar problems have been identified for translations with the use of dictionaries [20]. Problems also occur when the translators 'are often chosen from a population of highly educated persons (e.g. academics) who speak and write somewhat pedantically in both their languages' [6]. However, some examples can be found in the literature of soundscape research, to which a translation process (back translation) was used [21,22].

Issues achieving equivalence and translation problems have been reported in the soundscape research literature in cases where no appropriate translation and CCA methodology was applied. In a study by Nagahata [16], the attributes used in Swedish Soundscape-Quality Protocol (SSQP) [23] were looked up in six popular English-Japanese dictionaries. The translated words for 'uneventful' and 'calm' seem to overlap with each other. Regarding 'eventful', while the meaning of the word seems to have a positive connotation in English, the Japanese literal translations are neutral words. 'Monotonous' in Japanese means a pleasant and uneventful evaluation, in contrast with 'monotonous' in English which generally means unpleasant and uneventful evaluation [24]. In another study by the author [25], linguistic problems are discussed for the translation of words such as soundscape or sound.

A study by Jeon et al. [13] examined the effect of socio-cultural context, including language, on soundscape assessments in urban parks. Attributes of SSQP were translated in French, Korean, and compared with Swedish and English. The term 'chaotic' in SSQP could not be translated into Korean, and was replaced with the word 'noisy'. For 'monotonous' and 'exciting', there was a larger variation on soundscape assessments between countries showing that there were larger disagreements on these attributes among the participants. In another study by Aletta and Kang [26] it has been reported that three or four words were often required for an accurate translation of some soundscape attributes in Chinese (Mandarin). In a study by Weber [17], attributes have been translated into Dutch and applied in interviewing citizens. During the study respondents seemed to be distracted and misled by some verbal descriptions, such as the Dutch translation 'opwindend' of 'exciting'.

Another example is a study by Delaitre et al. [27] about the French translation of 'quiet areas' (*zones calmes*) which focuses on the definition of the word 'calme'. A lexicographic study has been carried out using a corpus of French dictionaries from the 16th century until today, showing that the definition of 'calme' has greatly evolved through time, from a first one connected to the sea (calm sea) to the latest associated with acoustic notions (absence of noise). In all these definitions, it appears that 'calme' is characterized by a spatial or temporal dimension. Similar problem with 'calme' reported in a study by Tarlao et al. [12], were the authors state: 'we adapted the standard SSQP and further removed one descriptor (uneventful) due to the difficulty of finding a unique and appropriate translation (tranquille, calme) that did not encroach upon the meaning of other items of the scale'. In the same study, the English and the French scale of the SSQP were compared using the results of a research conducted in Montreal. Analysis of the results revealed that the French translation of the SSQP yielded similar components to the English translation, with one main difference concerning the 'monotonous' scale ('monotonous' only in English, 'monotonous' and 'calm' in French). Also, a comparison between French and English ratings revealed that French ratings are significantly lower for the 'chaotic' item and significantly higher for the 'eventful' item of the SSQP than the English ratings, denoting as the authors state 'chaotic' and 'eventful' in English seem closer in meaning than their French translations.

Similar issues were encountered when standardizing other socio-acoustic survey methods, like the assessment of noise annoyance, where the questions/wording of the protocol is proposed in various languages. However, the standard now [28] comprises of questions on annoyance which have been translated using a detailed procedure for translations and back translations to make

sure that the original meaning has been kept intact. Soundscape preference measurement will need to adopt similar approaches to achieve international standardization [29].

Currently, some standardized perceptual attributes are available for soundscape assessment in the ISO/TS 12913–2: 2018 in Method A; these are derived directly from the SSQP, which is in turn based on the circumplex model proposed by Axelsson and colleagues [23]. The attributes are: *pleasant, calm, uneventful, monotonous, annoying, chaotic, eventful, and vibrant*. However, the ISO Technical Specifications only includes an English version. The applicability and reliability of these attributes in non-English speaking regions remains an open question, as research investigating translations of soundscape attributes is limited. To address this gap, an international collaboration was initiated with soundscape researchers from all over the world named 'Soundscape Attributes Translation Project (SATP)' [30]. As a part of this project, this paper presents the case study of the Greek translation of ISO/TS 12913–2:2018 attributes. For this purpose an appropriate translation and CCA methodology was selected and applied independently by four translation groups. The translated attributes from all groups were assessed in listening tests for a variety of soundscape sounds and compared with the results of English participants. For this study, more specifically, there are two sets of research questions, each containing two related sub-questions. The first set of research questions is:

- Which is an appropriate translation and CCA methodology for soundscape research?
- How the suggested translation and CCA methodology can be best implemented according to the relevant literature and international practices?

The second set of research questions is:

- What result in translation equivalence has the application of the selected translation and CCA methodology by different translation groups of varied dynamics?
- How can the result of the application of the selected translation and CCA methodology by different translation groups of varied dynamics can be validated in the case of ISO/TS 12913–2: 2018 (Method A) attributes?

This paper has been organized as follows: Section 2 presents the literature review and scoping stage for translation methodologies. Furthermore, the selected methodology for this study is presented and additional translation guidelines are suggested. Next, a categorization of bilinguals and biculturals is proposed, necessary for the implementation of the selection methodology. Section 3 presents the methodology employed in this study. The selected translation methodology is implemented by four independent translation groups with different compositions according to the biculturalism and bilingualism of the group members. As a next step, the translated attributes (14 in total) of the four translation groups are used for listening tests with Greek participants (N = 30) with the use of 27 sound recordings. Listening tests with the original attributes are performed with English participants (N = 32) and the same 27 sound recordings are used (for comparison reasons). Section 4 presents the results of the four translation groups. In addition, a comparison of results between English and Greek participants is presented with the use of Principal Component Analysis (PCA) and Heatmaps. Section 5 presents a discussion of the research questions. Additionally, the issue of 'Cross cultural difference or translation error' is discussed. Furthermore, PCA is presented and discussed as a validation methodology for translated attributes. Finally, conclusion section gives a brief summary and contextualizes the study.

2. Review and scoping stage for translation methodologies

For the selection of an appropriate translation and CCA methodology, various methodologies and related review studies in the literature were considered [3,9,10,31]. A study by Epstein et al. [3] (2015) reviewed all methods and guidelines for CCA of questionnaires published between 1970 [32] and mid-2014 (31 in total) and found no consensus for the best methodology. As the authors stated 'we did not find strong scientific evidence for what would be a 'gold standard''. A study by Acquadro et al. [10] concluded that 'there is no empirical evidence in favor of one specific method'. A study by Danielsen et al. [31] pointed out that translation of questionnaires is not standardized (however some methodological actions should be considered). In a study by Cha et al. [33] it is stated that: 'there is no gold standard of translation techniques because the research environment (e.g. accessibility and availability of bilingual people) and the research questions are different'. Although it seems that there is no consensus for the best translation and CCA methodology, some conclusions drawn from the literature that are helpful for a proper selection of a methodology are:

- Panels or committees of people translate better than do individuals [34].
- It is fruitful to work in a team of at least three to four persons [35].
- Most methods use committees and focus groups [11].
- A combined technique is an appropriate method to maintain the content equivalences between the original and translated instruments in international research [33].
- Pilot testing is an important and valuable step because translators cannot anticipate all problems encountered by examinees taking a test in a second language [34].
- Researchers should choose any validated method of adaptation that seems the most appropriate in the context of the questionnaire of interest [11].

An important issue on the choice of proper methodology is whether or not it will contain back-translation into the process. Many conflicting views were found in the literature. Some researchers agree that back-translation of an instrument is essential for its validation and use in a cross-cultural study [36–38]. Arguments in favor of back translation, are that it allows researchers to have some control over the final version of the translated instrument by examining the original and back-translated versions and make inferences about the quality of translation [39,40] and that as a step it often magnifies unclear wording in the translations [4].

However, others studies do not even recommend this step [41–47]. Researchers suggest that agreement between the back translation and the original source version does not guarantee a satisfactory forward translation, because it could be incorrect; it simply assures a consistent translation [48]. In a recent study about Cross-cultural adaptation of the Health Education Impact Questionnaire, four English to French translations were generated with and without committee or back-translation [49]. Experimental results showed that expert committee, not back-translation, added value. Additionally, it has been found that, when translators knew that their work was going to be subjected to back translation, they would use wording that ensured that a second translation would faithfully reproduce the original version rather than a translation using the optimal wording in the target language [50]. Furthermore, back translation precludes the use of meaningful and appropriate substitutions of item content for cultural reasons [51]. Studies comparing methods suggest that the back translation should not be mandatory but can be useful as a communication

tool with the author of the original questionnaire [3]. However, in the review study by Epstein et al. [3], most methods included back translation [11].

2.1. Selected methodology by Cha et al. [33] and additional translation guidelines

In order to select an appropriate methodology for translation and CCA, conclusions and methodologies presented in the previous section were taken into account. Methods used for Greek translations in various scientific fields were also considered [52–55]. A method by Cha et al. [33], initiated from Jones et al. [37] was selected for this study since it meets the above criteria. As the authors state, 'it is a user-friendly and valid translation method which uses a combined technique of the back translation method, the committee approach and the pretest procedure using a monolingual sample'. For the application of the method four bilinguals and one monolingual are required. Initially 'three independent bilingual people independently translate the instruments' [33]. As a next step, each translated instrument (by one of the three translators) is assessed by the two other bilingual translators (remaining two translators from the group of three). Therefore, every-one of the three independent translations (from the three translators) is assessed by the other two translators (remaining two translators from the group of three). Any differences identified between the reviewed versions and their own translated versions are discussed in a committee meeting of the three bilingual translators. This procedure is continued until they all agree on the translated instruments.

Secondly, the translated version is back translated into the original language from a bilingual translator. A monolingual speaking person compares the back translated version and the original version. If a difference between the original and the back translated versions is identified, detailed explanations of the usage differences in both versions of the instruments are provided. These differences and the explanations are shared with the three bilingual translators to retranslate the items. The process is continued until the two versions (original and back translated) are identical or translators reach a consensus.

In order to improve the effectiveness of the selected methodology, additional guidelines were selected from the literature and applied to this research. These are:

- Translators should be fluent in both source and target languages (bilingual) [56].
- Translators should be familiar with both cultures (bicultural) [6,35,56,57].
- Translators should have some knowledge of the content of the instrument being assessed [56].
- Several words can be used for the translation of terms (if impossible to find an equivalent term) [19].
- If several words are used for the translation of terms, differences in length should be kept within close limits [6].
- Translators should not be informed that their work is going to be subjected to back translation [3].
- Translators should not be (only) chosen from a population of highly educated persons (e.g. academics) [6].
- Target population input should be included (translators should have good acquaintance with the language as used by the prospective test respondents) [3,6].
- Translators should preferably translate into their mother language [58].

For this study, its authors served as consultants during this process in order to clarify the meaning of items for translation. In

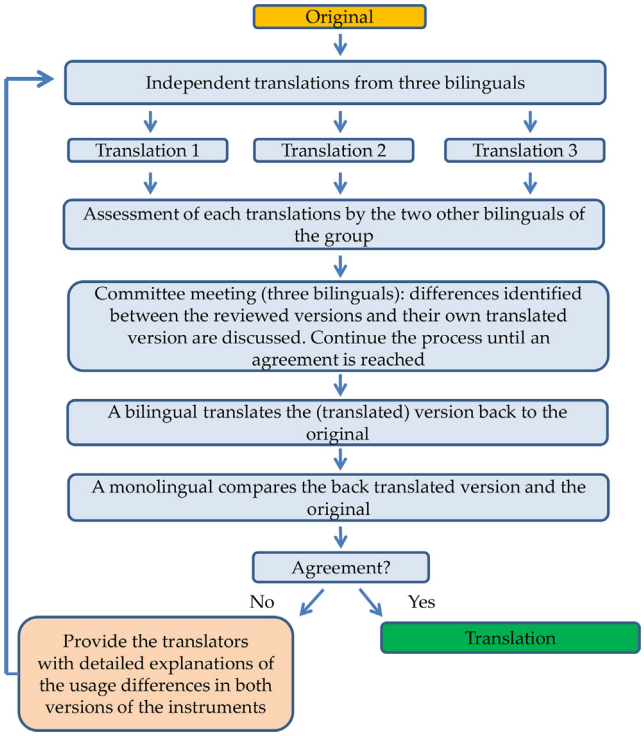

Fig. 1. Block diagram of the selected methodology.

Fig. 1, a block diagram of the translation and CCA methodology is presented.

2.2. Categorization of bilingual and bicultural translators

Bilingual translators are required for the application of translation and CCA methodologies, such the one used in this research by Cha et al [33]. However, a relative question that is not clear around this issue is who may or may not be considered a bilingual. Regarding bilingualism, the definition seems to be a subject of debate with many different approaches in the literature [59,60]. Bloomfield [61], defines bilingualism as 'the native-like control of two languages'. In contradiction, Macnamara [62] proposes that a bilingual is anyone who possesses a minimal competence in only one of the four language skills, listening comprehension, speaking, reading and writing, in a language other than his mother tongue. Between these two extremes one encounters a whole array of definitions. For example, the one proposed by Titone [63], for whom bilingualism is the individual's capacity to speak a second language while following the concepts and structures of that language rather than paraphrasing his or her mother tongue. A proposal for categorization (Table 1), applied in this study, is that bilinguals who are subject to the definition of Bloomfield [61] are considered to be

Table 1
Categorization of bilinguals.

Grade of bilingualism	Definitions of bilingualism	Ref.
3	Native-like control of two languages	[61]
2	Individual's capacity to speak a second language while following the concepts and structures of that language rather than paraphrasing his or her mother tongue	[63]
1	Minimal competence in only one of the four language skills, listening comprehension, speaking, reading and writing, in a language other than his mother tongue	[62]

grade 3, to the definition of Titone [63] are considered to be grade 2 and subject to the definition of Macnamara [62] are considered to be grade 1. There may be gradations between categories.

Regarding biculturalism, there seems to be consensus for the definition in the literature. A common definition is that biculturals are defined as people who have easy access to multiple cultural meaning systems [64]. It is applicable not only to immigrants but also to children of immigrants who even if born and raised in the receiving society are likely deeply embedded in the heritage culture. It may also apply to individuals living in ethnic enclaves [65]. Beside language use, biculturalism focuses on cultural behaviors such as choice of friends, media preferences and the like [66].

3. Methods

3.1. Application of translation methodology and translation group compositions

The selected translation and CCA methodology by Cha et al. [33] was used for the translation of ISO/TS 12913–2:2018 attributes from English to Greek. The methodology was applied by four independent translation groups in order to compare the results. The group members were not informed that the translation would also be applied by other groups. The steps of the methodology and also the additional translation guidelines presented in section 2.1 were followed. Therefore, e.g. translators were informed by the authors about the content of the instrument being assessed and that several words can be used for the translation of terms. Also, group members were not informed that their work is going to be subjected to back translation. The remaining guidelines of Section 2.1 were applied to the selection and composition of the translation groups.

The compositions of the four translation groups were formed according to various criteria such as biculturalism, bilingualism and target group input of group members. The intention of this research was the translation groups to have different characteristics and dynamics. The first group consisted of four bicultural members, the second group of one bicultural, while the rest of the groups were without bicultural members. All the members of the first two groups had native-like control of two languages subject to the definition of Bloomfield [61]. The third and fourth group had one and two members respectively, for whom the ability in the language was somewhere between the definition of Bloomfield [58] (grade 3) and the definition of Titone [60] (grade 2).

Additionally, for the translation groups composition, target population was considered since it is considered important for the translation process [3]. Target population input assures experiential equivalence according to Sechrest [6] (or operational equivalence according to Herdmann [7]). For soundscape research a target population can be characterised by age, education, socio-economical distribution, and gender proportions [67]. In the context of this study, restrictive was the age of the participants. Appropriate age had one member from the first group who can be regarded as target population (below 30 years old). Unfortunately, this translator was the only one we could find that had this characteristic and was bicultural. However, we do not believe that this affected the outcome of the translation since this would usually have an effect for longer material and not translation of attributes. This is verified in this study by the fact that the outcome of the translation group was agreed upon by the whole group.

The final group composition is presented in Table 2. The first group (Gr.1) can be considered optimum according to the literature (e.g. fully bicultural, target population), while the last (Gr.4) can be considered less optimum but typical (two academics, two (Greek) English teachers). The other two groups are somewhere in between with the second group having a little better characteristics than the third group.

Additionally, in Appendix A, categorization and dimensions of bilinguals of the study is presented according to Hamers and Blanc [59]. Dimensions included are competence in both languages, cognitive organization, age of acquisition, presence of L_2 (second language) community in environment, relative status of the two languages and finally group membership and cultural identity.

3.2. Audio stimuli

For the soundscape assessment to work properly both for the English and Greek groups, it was important to carefully select the audio stimuli to be used in the experimental sessions. The same audio samples were used in the listening tests with both Greek and English participants. Audio stimuli used were recorded in public spaces across London during 2019 by operators wearing a calibrated binaural audio acquisition device. The operators performed the recordings while standing, at least 1 m away from any reflecting surfaces, at a location characteristic of a typical use of a place they were in, as recommended by Mitchell et al. [68]. The recordings were made using the head-mounted binaural data acquisition device (SQobold with BHSII by HEAD Acoustics), set at the resolution of 24 bit/44 kHz. For the sake of the experiment all the 27 audio samples were trimmed to be exactly 30-second long and a 10 ms fades were applied at the start and the end, while exporting the recordings to the common audio format, using the ArtemiS SUITE (v. 12.6). No other filtering or audio manipulation was performed. The audio samples provided a set of exposure conditions ranging between 44.90 dB(A) and 90.80 dB(A) L_{Aeq}, as measured by Bhan et al [69]. The rationale for selecting the audio stimuli was covering a relatively broad range of acoustic environments that one could reasonably expect in any urban context around the world (i.e., not posing risks of sounding "unfamiliar" to either the Greek or English groups). This would include acoustic environments with varied sound sources compositions (e.g., both natural and mechanical sound sources), which had the potential to elicit the full spectrum of assessments on either of the soundscape attributes scales scored by the participants.

3.3. Participants

In total, 62 persons participated in the experiments. They comprised 30 participants in Greece (19 males, 11 females, M_{age} = 26.1 years, SD_{age} = 3.6 years) and 32 participants in the UK (13 males, 19 females, M_{age} = 29.7 years, SD_{age} = 7.2 years). In order to achieve a homogenous group, a qualified majority of participants were university students, self-reporting no hearing impairment. In the UK, participants were compensated with a 5 GBP e-voucher as a token of appreciation for their participation.

3.4. Test procedures

During the experiments, the acoustic stimuli were presented to the participants in Greece and the UK through the same type of circumaural, acoustically open headphones (Sennheiser HD 650), at the original sound level as recorded on site. Playback was operated via a digital audio workstation deployed on a laptop and delivered using an external audio interface (BabyFace USB by RME). The experiments were performed in sound-proof listening rooms, with a background sound level of less than 40 dB(A). All participants were tested individually. On average, the experiment lasted 50 min for a participant, including instructions and pauses. The experiment was carried out between May and October 2021. Upon arriving, participants were asked to sign the informed consent. A training session was firstly proposed for the participants to

Table 2
Categorization of translators of the study.

Gr	Member	Category of bilingualism	Bicultural	Target group population
1	1 DT	3	Yes	Yes
	2 DT	3	Yes	No
	3 DT	3	Yes	No
	4 BT	3	Yes	No
2	1 DT	3	Yes	No
	2 DT	3	No	No
	3 DT	3	No	No
	4 BT	3	No	No
3	1 DT	3	No	No
	2 DT	3	No	No
	3 DT	2.5	No	No
	4 BT	3	No	No
4	1 DT	3	No	No
	2 DT	2.5	No	No
	3 DT	2.5	No	No
	4 BT	3	No	No

Note. DT: direct translation, BT: back translation.

familiarize with the experiment procedure and the meaning of the soundscape attributes. Participants individually experienced all the 27 audio stimuli presented in random order over consecutive sessions. The Greek participants evaluated the 27 sound recordings for each one of the attributes (14 in total) that the translation teams selected (Greek translations of attributes of ISO/TS 12913–2:2018). The English participants evaluated the 27 sound recordings for each one of the 8 attributes of ISO/TS 12913–2:2018. After a 30-second exposure, participants were asked to assess the soundscapes. Each of the attributes was presented with a 100-step visual analogue scale (VAS) of 'attribute-soundscape match' (i.e., the Greek translations of the attributes: pleasant, calm, uneventful, monotonous, annoying, chaotic, eventful, and vibrant). The scale ranging from 0 ('strongly disagree') to 100 ('strongly agree'). All participants scored the soundscapes of the audio excerpts by a vertical mark on the scale, representing how well the attribute matched their soundscape perception. The study was approved separately via the Committee on Ethics and Deontology of Research (C.E.D.R), Technical University of Crete (Project identification code: Protocol number 20/29.09.2020) in Greece, and via the UCL BSEER Ethics Committee for low-risk research (12.08.2019) in the UK.

3.5. Data analysis

In order to compare the results from the different translation groups and the two countries, Greece and UK, Principal Components Analysis (PCA) was performed on the rating scale data for perceived affective quality. For each of the twenty-two attributes (14 in Greek, 8 in English) of perceived affective quality, arithmetic mean values were calculated for the 27 locations, across the participants. This resulted in a 27 locations $\times$ 22 adjectives data matrix, which was subjected to a PCA. This allowed comparison of how the adjective attributes were used in the four groups and the two countries using a common PCA solution. To identify the optimized orthogonal components, varimax rotation with Kaiser Normalization was applied [70]. The statistical analysis was performed with the aid of SPSS 25 for Windows.

4. Results

4.1. Translation results of the four independent translation groups

The outcome of the translation process for the four independent translation groups is displayed on Table 3. It can be seen that it resulted in different translations in three out of the eight attributes. There are four different results for 'eventful' (each for every translation group), three results for 'uneventful', two for 'monotonous', while for the remaining five attributes results were the same for each translation group. It is also apparent that several words were used for the translation of the attributes eventful and uneventful. A possible explanation could be that there are no corresponding words in Greek for these attributes.

The translation and CCA methodology that was applied involved the process of back translation. Three repetitions of the process were needed for the first translation group, one repetition for the second and third group and no repetitions for the fourth group. For each translation group, repetitions of the back translation process were performed mainly for the attributes eventful and uneventful. Back translation process requires that if the monolingual reviewer identifies a difference between the original and the back translated versions, detailed explanations of the usage differences of the instruments are provided. These differences and the explanations were shared with the three bilinguals of the translation group to retranslate the items until the two versions were identical or translators reached a consensus. However, for this research the items after the back translation process were not identical. The translators came to a consensus after a synthesis of results and opinions.

In order to compare the results from the different translation groups, PCA was performed on the rating scale data for perceived affective quality. Kaiser-Meyer-Olkin test had a value of 0.804 while Bartlett's Test of Sphericity a value less than 0.001. Results show that our data are suited for Factor Analysis. After PCA, two components with Eigenvalues larger than 1 were obtained. Components 1 and 2 explained 48.14 % and 44.66 % of the variance in

Table 3
Translation results of the four independent translation groups.

English	Greek	Transliterations	Group 1	Group 2	Group 3	Group 4
Eventful 1	Με πολλά ή/και σημαντικά γεγονότα	Me pollá í/kai simantiká gegonóta	x			
Eventful 2	Με ενδιαφέροντα γεγονότα	Me endiaféronta gegonóta		x		
Eventful 3	Πλούσιο από γεγονότα	Ploúsio apó gegonóta			x	
Eventful 4	Με πολλά συμβάντα	Me pollá symvánta				x
Uneventful 1	Χωρίς πολλά ή/και σημαντικά γεγονότα	Chorís pollá í/kai simantiká gegonóta	x			
Uneventful 2	Αδιάφορο	Adiáforo		x	x	
Uneventful 3	Χωρίς συμβάντα	Chorís symvánta				x
Monotonous 1	Μονότονο, βαρετό	Monótono, varetó	x	x		
Monotonous 2	Μονότονο	Monótono			x	x
Pleasant	Ευχάριστο	Efcháristo	x	x	x	x
Calm	Ήρεμο	Íremo	x	x	x	x
Annoying	Ενοχλητικό	Enochlitikó	x	x	x	x
Chaotic	Χαοτικό	Chaotikó	x	x	x	x
Vibrant	Ζωντανό	Zontanó	x	x	x	x

Table 4
Euclidean distances between attributes in the circumplex (Fig. 3).

English	Greek translation groups			
	Group 1	Group 2	Group 3	Group 4
Eventful	0.043	0.665	0.127	0.070
Uneventful	0.021	0.383		0.092
Monotonous	0.109		0.151	
Pleasant		0.099		
Calm		0.036		
Annoying		0.119		
Chaotic		0.232		
Vibrant		0.509		

the data set, respectively. Fig. 2 presents the component loadings of the eight attribute scales for the four groups. All vectors in Fig. 2 are long, with their endpoints located close to the periphery of the graphs, represented by unit circles that correspond to the maximum length of the vectors. This shows that the PCA solution is mainly a two-dimensional plane, with limited variance in any other dimension. Second, for all four translation groups, all the vectors are organized in the same and expected order along the circumplex. They are also largely organized as expected in the two varimax-rotated components, easily interpreted to represent Pleasantness (Component 1) and Eventfulness (Component 2). As Fig. 2 shows, there is a difference between the translation groups regarding the attributes eventful, uneventful and monotonous.

4.2. Comparison of results between English and Greek participants

The outcome of the previous section (4.1) raised the question about what is the optimum translation among the four translation groups. In order to compare the results from the translation groups and also between the two countries, again PCA was applied on the rating scale data for the perceived affective quality. Results of the PCA solution are presented along the circumplex for the four translation groups and also for the English participants (Fig. 3). In addition, Euclidean distances between attributes of the four translation groups and the English participants were calculated (Table 4). More about the rationale of utilizing PCA for comparing translations is going to be presented in Section 5.2.3.

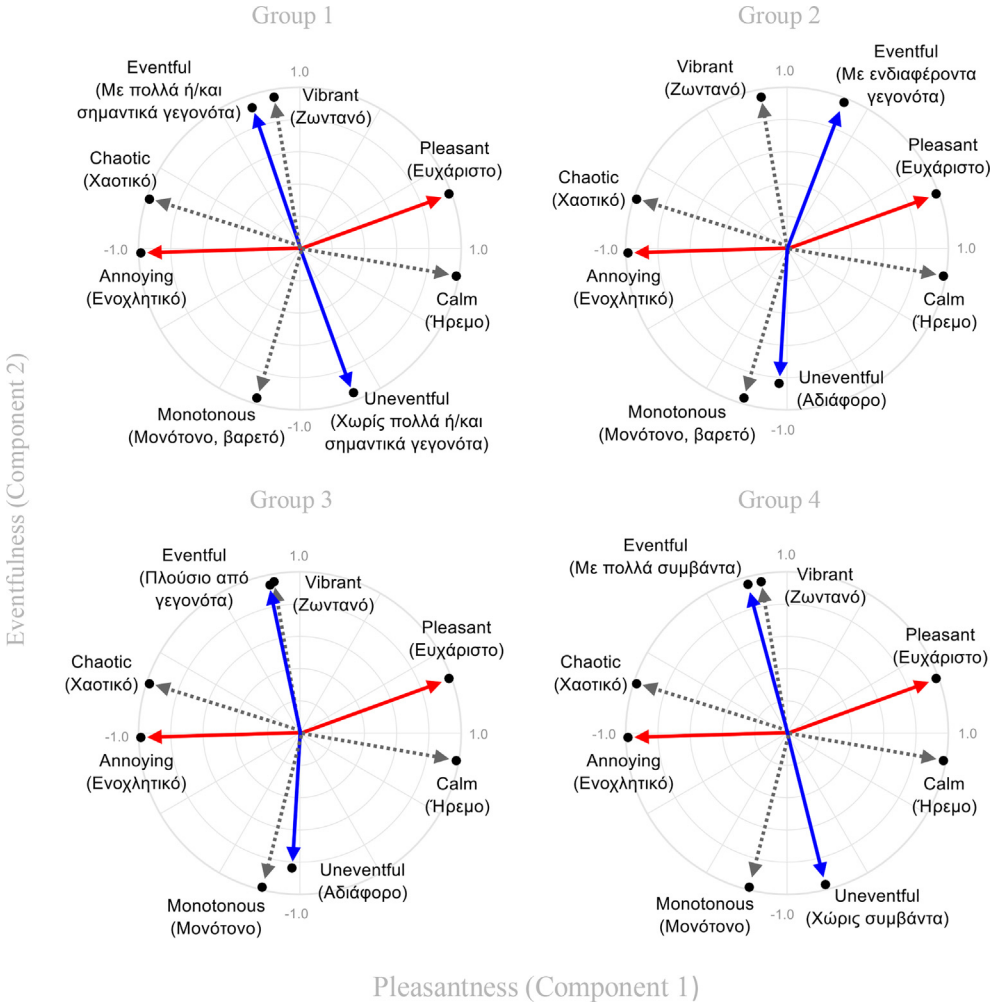

Fig. 2. Component loading plots of the eight adjective attributes for the four different translation groups.

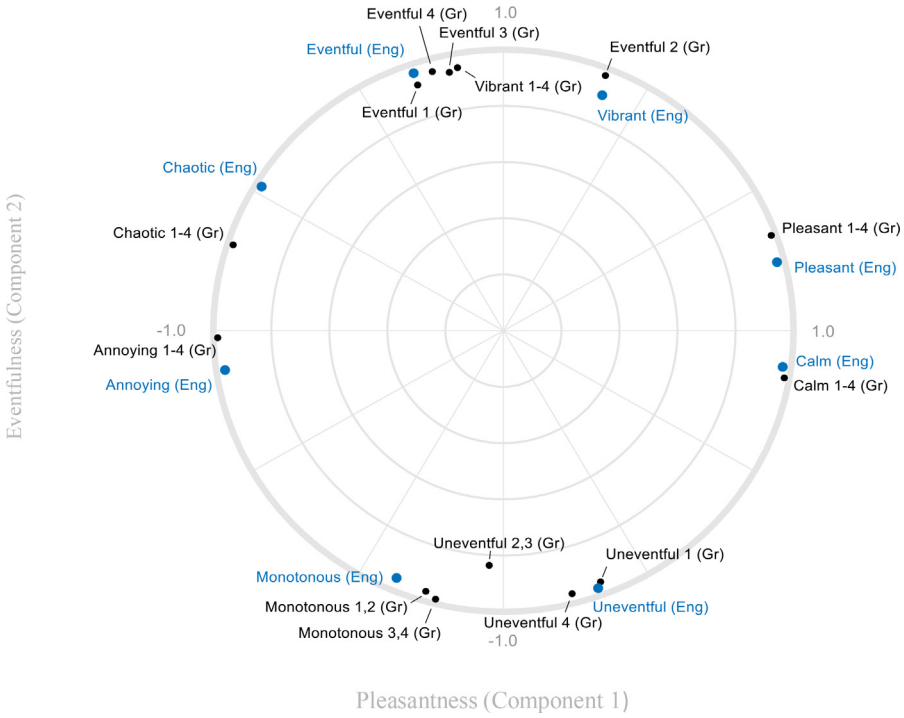

Fig. 3. Principal Component Analysis of the translated attributes.

Regarding the results concerning the different translation groups, the most marked observation is that the results of the group 1 (optimum, bicultural) are the ones closer to the results of the English participants for every attribute. Another important remark is that significant differences can be seen in some cases for the results of translation groups 2–4 (non-bicultural) in comparison to the results of the English participants in the circumplex (e.g. Eventful 2 (Gr)). Finally, regarding the attributes annoying, calm, pleasant and chaotic, the common results of the Greek translation groups 1–4 seem to be close to the results of the English participants in the circumplex (Fig. 3, Table 4). The largest deviation occurs for the attribute vibrant, which in Greek is much closer to the eventful dimension. The above are going to be discussed more in Sections 5.2.1 and 5.2.2.

Concerning comparison between countries, when looking at the PCA solution for the soundscape attributes in English and Greek, Fig. 3 shows that their locations in the bidimensional space match quite well the theoretical soundscape circumplex model with the two orthogonal dimensions of Pleasantness and Eventfulness. The Euclidean distances between the English and Greek translations show that there seems to be almost perfect agreement between languages on the dimensions of calm and eventful/uneventful (group 1 in Greek).

In order to further investigate the differences between results of the translation groups, the absolute differences of the mean values between Greek and English participants were calculated for each sound stimuli. In addition, sound stimuli were clustered according to their content, and more specifically based on the dominance of sounds embedded in their natural context. Dominance was defined as sounds perceived as foreground during a large segment of the 30 s soundscape excerpt [23]. Sound stimuli were clustered to ‘technological’, ‘natural’ and ‘human’. Two members of the research teams independently listened to all 27 soundscape excerpts and agreed for their categorization. Ten sounds were clustered as ‘technological’, six as ‘natural’ and eleven as ‘human’. Results displayed in the form of heatmaps are quite revealing in several ways (Fig. 4). For example, it seems that the ‘technological’ stimuli are the reason for the deviation of the attribute ‘vibrant’ between Greek and English participants. In addition, for the attribute ‘eventful 2′ (second group) it appears that the differences occur mainly because of the ‘technological’ stimuli, less from the ‘human’ sounds and almost at all by the ‘natural’ sounds.

5. Discussion

5.1. Remarks on the selection of a translation and CCA methodology and its implementation

With respect to the first set of research questions, this study set to explore an appropriate translation and CCA methodology and its optimum implementation for soundscape research following an extended bibliography survey. After careful consideration, a methodology proposed by Cha et al. [33] was chosen which fulfilled many of the proposed criteria suggested in the literature and presented in section 2. Furthermore, additional translation guidelines were proposed, which have been found in the literature to improve the translation results for the optimum implementation of the methodology (section 2.1). The results of the above, which will be extensively discussed in section 5.2, especially for the first translation group who fulfilled the additional proposed guidelines, indicate that the suggested methodology can provide satisfactory results for the purpose of soundscape research.

Regarding the implementation of the translation and CCA methodology, useful conclusions were drawn by the authors of this study as they served as consultants during the translations. Perhaps one of the most interesting aspects was the process of back translation and the way different groups managed this procedure. Our experience observing the back translation process of group 1 (bicultural group), was that while members knew exactly the uses, nuances and the weighting of the uses of the words in the culture, initially did not find appropriate translations probably since there are not corresponding words in the target language (eventful, uneventful). Final result and consensus was achieved after many

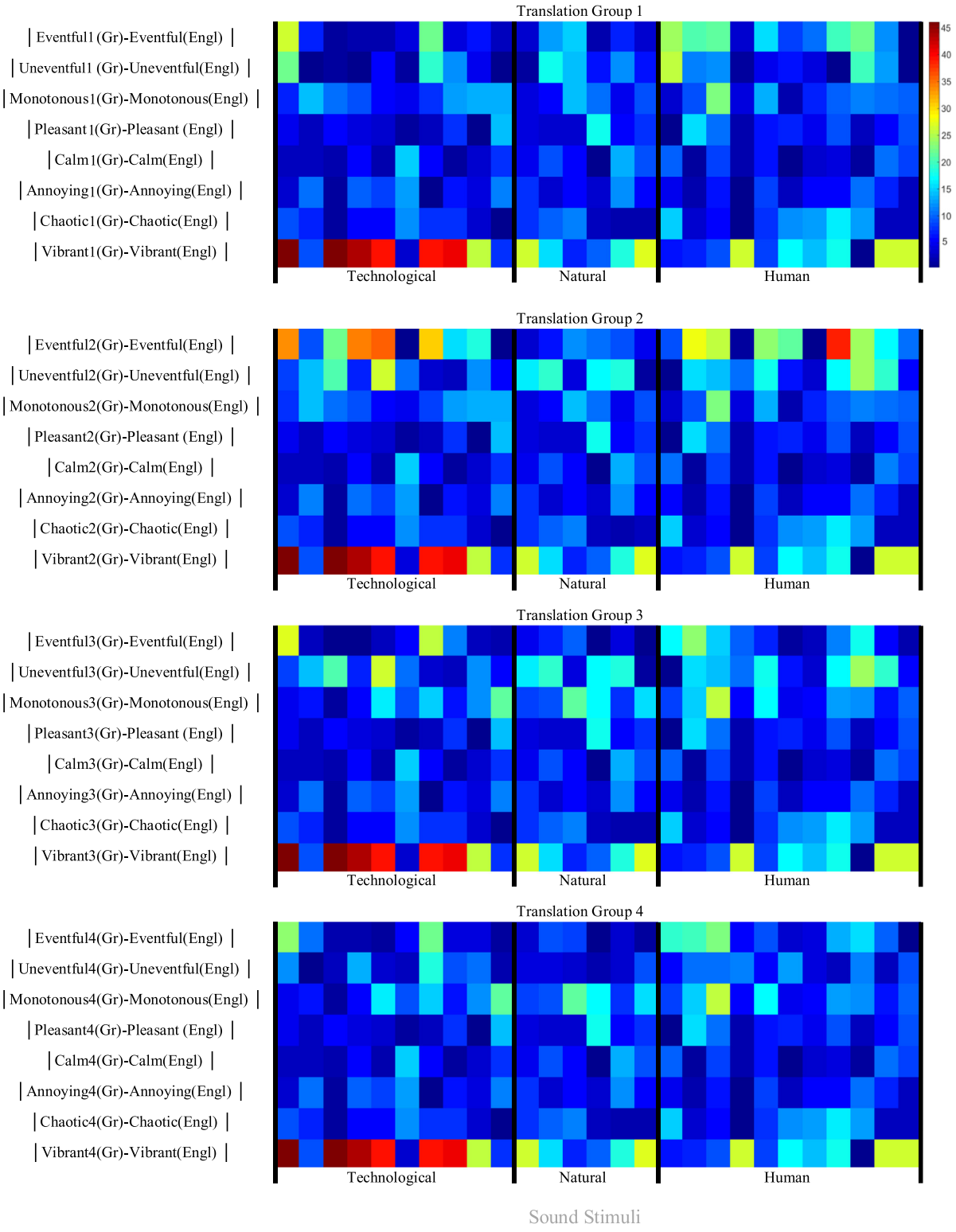

Fig. 4. Absolute differences of the mean values of the results of the listening tests between Greek and English participants for each sound stimuli and each attribute. Sound stimuli were assessed in listening tests in a 100-step visual analogue scale ranging from 0 ('strongly disagree') to 100 ('strongly agree') for every attribute. Results are presented in colour scaling in the form of heatmaps in order to identify significant differences. Sound stimuli (27) are clustered to 'Technological' (10), 'Natural (6) and 'Human' (11).

attempts (direct-back translation) and a synthesis of results and opinions. However, for group 4, it was evident that group members did not give the same weight to all the uses of the word (focused on a single use), resulting in a different result that could not be corrected (or steered in the right direction) by back translation. The other teams are somewhere in between resulting again in different translations. Therefore, our experience dictates that the use of back translation especially in cases where there are not corre-

sponding words in the target language is important. However, it has to be noted, that back translation can be a tedious process, but with rewarding results.

Another interesting aspect of the translations was the process of the committee meetings. Especially in the cases of the translation of attributes that were not corresponding words in the target language (eventful, uneventful), there was usually an additional discussion as there were different views. The process, by which the members of the translation groups agreed to the final result, was not in any case specific or predetermined. For this reason there is the likelihood that this process sometimes could possibly lead to incorrect decisions. It has been stated in the literature that 'the committee approach, although useful, is regarded as weak, because it does not necessarily control for shared misconceptions. A committee participant may be reluctant to criticize another participant's suggestions [9]'. This dictates that committee meetings should not be the only aspect of a translation methodology in order optimum results to be obtained. This is also supported by the literature were a combined technique is suggested as an appropriate method to maintain content equivalences between the original and translated items [33].

5.2. Outcome of the application and validation of the selected methodology employed by different translation groups

The second set of research questions concerned the outcome in translation equivalence of the application of the selected translation and CCA methodology employed by different translation groups of varied dynamics and how can this be validated in the case of ISO/TS 12913–2: 2018 (Method A) attributes. For a better presentation, remarks on the outcome of the application of the methodology and its validation, are going to be discussed separately. In addition, the issue of 'cross cultural difference or translation error' that emerged from the outcome of the application of the selected methodology is going to be presented in section 5.2.2.

5.2.1. Remarks on the outcome of different translations and proposed Greek translation

The most striking outcome to emerge from the application of the selected methodology by different translation groups is that the results of group 1 (bicultural) are the ones closer to the results of the English participants in the circumplex (Fig. 3). For the three attributes that were differences among translation groups (eventful, uneventful, monotonous), the Euclidean distances are the closest (Table 4). Since for the rest of the attributes the suggested translations are the same for all groups, this means that for all attributes the results from the first group are the closest to the result of the English participants. The difference between translation groups is only the composition of the group members as all other elements applied to translation such as the methodology and the additional translation guidelines were the same for every group. It can thus be reasonably assumed that the composition of group 1 by bicultural members is the most important factor for this result. This is in good agreement with the literature were the importance of bicultural translators is highlighted [6,35,56,57]. The evidence from this study supports the idea of utilizing biculturals for the translation of attributes in soundscape research.

Another important finding of the study, complementary to the above, is that significant differences were found in some cases for the results of translation groups 2–4 (non-bicultural) in comparison to the results of the English participants in the circumplex. The most evident example is the attribute Eventful 2 (Gr) (in comparison to Eventful (Eng)) in Fig. 3. Another example is Uneventful 2,3 (Gr) (in comparison to Uneventful (Eng)) in Fig. 3. This concurs well with the literature that in some cases translation by bilinguals is not enough [6,57]. Evidence from this study intimates that utilizing only bilinguals for the translation of attributes in soundscape research, in some cases can produce deviation of results. The above findings raise some issues that will be discussed further in section 5.2.2.

In addition to the above, some remarks can be made for each translation attribute separately. The attributes with different translations among groups were eventful, uneventful and monotonous. Regarding eventful and uneventful, as mentioned earlier, the different results probably stem from the fact that there are not corresponding words in the target language. A similar problem was reported in a study [12]: 'we adapted the standard SSQP and further removed one descriptor (uneventful) due to the difficulty of finding a unique and appropriate translation that did not encroach upon the meaning of other items of the scale'. Regarding monotonous, the results of the Greek translation groups 1,2 ('μονότονο, βαρετό') are the ones closer to the result of the English participants in the circumplex (Fig. 3). It should be noted that the origin of the word monotonous is from the Greek word 'μονότονο' (μόνο- (one), τόνος- (tone)) which literally means 'having one tone'. However, according to the results, 'μονότονο' in Greek seems to be a slightly more neutral term in the 'Pleasantness' component in comparison to the English results. Probably this is why the translation 'μονότονο, βαρετό' was preferred by translation groups 1,2 with 'βαρετό' meaning boring in Greek. Similar differences for monotonous have also been found in other languages. In a study [24] it is stated that: 'monotonous' in Japanese means a pleasant and uneventful evaluation, in contrast with 'monotonous' in English which generally means unpleasant and uneventful evaluation.

For the remaining attributes, the translations were the same for each group. Regarding annoying, calm and pleasant, the common results of the Greek translation groups 1–4 seem to be very close to the results of the English participants in the circumplex (Fig. 3, Table 4). For 'vibrant', significant difference was found for the common result of translation groups. As can be seen in Fig. 4, it seems that the 'technological' stimuli are the main cause for the deviation of the attribute 'vibrant' between Greek and English participants. Also, the Greek translation for this attribute 'Vibrant 1–4 (Gr)' seems to be closer to the 'Eventful (Eng)' in the circumplex. There is the case this is due to a cross-cultural difference between countries. Also, the translated attribute 'chaotic' seems to have a relative bigger difference in comparison to 'annoying, calm and pleasant' between countries in the circumplex. A suggested explanation that should be treated with caution, which also applies to the case of 'vibrant', is that this effect could (partly) stem from the different size of cities in Greece and England in which the listening tests took place. Greek participants were from a city with a smaller number of residents (<100,000, Chania), in contrast with the English participants (>9M, London). How chaotic a soundscape is perceived, is probably affected by the familiarity of an individual with similar soundscapes. Therefore, there is a possibility that residents of larger cities will assess certain soundscapes as less chaotic than residents of smaller cities. Research into investigating these issues (vibrant, chaotic) is already in progress.

Finally, according to the above, the result of the first translation group is the proposed Greek translation by this study of ISO/TS 12913–2:2018 attributes (Method A) (Table 5).

5.2.2. Cross cultural difference or translation error

An important issue raised in this study (section 5.2.1) is that differences in the results due to translation errors could probably be misinterpreted to be caused by another reason, such as a cross cultural difference. For example, there is a significant difference between the translated attribute Eventful 2 (Gr) and the result of the English participants (Eventful (Eng)) in the circumplex (Fig. 3). It should be noted that the second translation group that

Table 5
Proposed Greek translation of ISO/TS 12913–2:2018 attributes.

English	Greek	Groups
Eventful	Με πολλά ή/και σημαντικά γεγονότα	1
Uneventful	Χωρίς πολλά ή/και σημαντικά γεγονότα	1
Monotonous	Μονότονο, βαρετό	1,2
Pleasant	Ευχάριστο	1–4
Calm	Ήρεμο	1–4
Annoying	Ενοχλητικό	1–4
Chaotic	Χαοτικό	1–4
Vibrant	Ζωντανό	1–4

resulted in this translation, fully implemented the proposed methodology by Chat et al. [33]. The only difference between the second and the first group whose translation was very close to that of the English participants (Eventful 1(Gr)) was that the first group only composed by biculturals. Therefore, if we had proceeded only with the translation by the second group, we might have assumed that there is a cross cultural difference for this attribute, which is clearly not true according to the results of the first group.

Cross cultural soundscape research is an important aspect of the field since recent trends have led to a proliferation of studies that examine differences in the perception of soundscapes among countries and cultures. As presented in the introduction, there are not many studies in the field where an appropriate translation and CCA methodology has been applied. It is true that translation is a difficult and non-deterministic process [71] and adapting a questionnaire for a different cultural group can be arduous and requires a considerable investment of time and money [72]. Sperber et al. [39] stated that: 'Translating questionnaires for cross-cultural research is fraught with methodological pitfalls that threaten research validity. Some flaws are difficult to detect, leading to the erroneous conclusion that cultural differences are substantive when, in fact, they stem from semantic inconsistencies'. Therefore, in order to minimize the likelihood that a translation error may be mistaken for a cross cultural difference, a suitable translation and CCA methodology should be carefully applied.

An additional translation concern, relevant to the issue of 'cross cultural difference or translation error', named as 'the paradox of (translation) equivalence' has been identified by Sechrest et al. [6]. The paradox states that 'if one demands that a form of a test or other measure yield comparable results in two cultures in order to demonstrate equivalence, then the more equivalent two forms become the less the probability of finding cultural differences' [6]. In this study, it can be seen that there is a significant difference between the attributes Vibrant 1–4 (Gr) and the result of the English participants (Vibrant (Eng)) in the circumplex (Fig. 3). However, there is a small difference between the attribute Eventful 2 (Gr) and the result of the English participants (Vibrant (Eng)). Therefore, if we have chosen the attribute of Eventful 2(Gr) as the Greek translation for vibrant, we would have eliminated any difference in the circumplex. However, this would be a mistake and would prevent us from identifying the actual reason for this discrepancy. It is obvious that such an approach should be avoided in similar studies during the translation process so that it can be assessed if there is an actual cross cultural difference.

5.2.3. Validation methodology applied for ISO/TS 12913–2: 2018 (Method A) translated attributes

The findings of this study presented in section 4.1, demonstrate that if different translation groups of varied dynamics are employed, then in some cases it is likely to result in different outcome. The above, reasonably raised the question, which of the proposed translations is the optimum and how can this be validated. In general, cross-cultural (translation) validation aims to ensure that the new questionnaire functions as intended and has the same properties as the original and functions in the same way [3]. Various techniques have been used for cross-cultural analysis [73] and also for validation of translations [72,74]. A list of techniques for evaluating survey data comparability across nations and cultures can be found in [75].

PCA is among the techniques which have been used extensively for cross cultural analysis [75–77]. Additionally, PCA have been used for comparing the similarities and differences between translations [78]. In linguistics PCA have been used in various occasions, such as test of affix productivity in translated English [79] and to configure the latent structure of the distribution of different part-of-speech items [80]. Regarding soundscape research, Axelsson et al. [23] showed that with the use of PCA a circumplex model may be used in evaluating the perception of complex soundscapes. PCA have also been used in soundscape research for comparison of translated attributes between different countries [12,13].

Based on the above, for this study we used PCA for the comparison of multiple translations and also for the comparison of multiple translations in relation to the results of the source language participants. To the best of our knowledge this is the first time that PCA have been used for comparison of different translations in soundscape research.

5.3. Limitations

In this study we applied and validated the translation and CCA methodology by Cha et al. [33] with additional translation guidelines and find it suitable for soundscape research. Given that our findings are based on a limited number of translated attributes and comparisons, the conclusions from this study should thus be treated with caution. We hope that further studies will confirm our findings and the suitability of the methodology and the additional translation guidelines for soundscape research.

Additionally, another limitation of our research is that the proposed translation and CCA methodology was applied only from one language to another (English to Greek). Equivalence is not necessarily equally difficult to achieve between all pairs of languages and substantial differences have been found between languages in translation error rates [32]. Further research is required to determine the effectiveness of the proposed methodology between other pairs of languages. We hope that our research will serve as a base for future studies.

6. Conclusions

The present study investigated i) an appropriate translation and CCA methodology for soundscape research and its optimum implementation according to the relevant literature and international practices and ii) what result in translation equivalence has the application of the selected translation and CCA methodology by different translation groups of varied dynamics and how can this be validated in the case of ISO/TS 12913-2: 2018 (Method A) attributes.

Regarding the first set of research questions, the main conclusions are:

(1) Methodology by Cha et al. [33] can be considered an appropriate translation and CCA methodology for soundscape research, as it gathers several of the desired features proposed in the literature. It uses a combined technique of the committee approach, back-translation method and a pretest procedure, while it requires four bilinguals for its implementation.

(2) Additional guidelines (that were not in the methodology by Cha et al. [33]) have been found in the literature to improve translation efficacy and were applied in this research. Some of these are: translators should be bicultural, translators should have some knowledge of the content of the instrument being assessed, translators should not be (only) chosen from a population of highly educated persons (e.g. academics), target population input is important.
(3) Application of translation and CCA methodologies (such the one by Cha et al. [33]), require the utilization of bilinguals. However, in the methodologies, it is not clearly indicated who may or may not be considered a bilingual. In the context of this study, a categorization of bilinguals was proposed and applied, which classifies them in three different grades (grade 1–3).

Regarding the second set of research questions, the main conclusions, findings and implications are:

(1) The most striking result to emerge from the data was that the PCA results of the translation group utilizing biculturals translators were significantly closer to the PCA results of English participants. Our findings corroborate with results from other scientific fields and highlight the importance of utilizing biculturals in the application of translation and CCA methodologies.
(2) In addition to the above, according to the results, utilization of bilinguals for translation and CCA methodologies in some cases is not sufficient in order to provide the optimum outcome. It has to be noted that the use of bilinguals is very common in the application of translation process in the field of soundscape research.
(3) Insufficient translation may be mistaken for a cross-cultural difference. Therefore, the optimum application and validation of an appropriate translation and CCA methodology is essential.
(4) PCA was used in this study as a validation methodology for comparison of different translation results. We think that our findings might be useful also for other scientific fields for the application of PCA as a validation method for different translations.
(5) The process of back translation especially in cases where there are not corresponding words in the target language can be effective.
(6) Analysis of results according to clustering of sound stimuli based on their context (technological, human, nature) can reveal useful information.

Taken together, the results of this work highlight the complexity of convening the correct meaning of the soundscape attributes across languages and call for more research on methodological approaches to translation tasks in soundscape studies. This will hopefully inform the standardization process that is currently in progress in soundscape studies and lead to further advancements in the discipline.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Please see Table A1.

Table A1
Categorization of bilinguals of the study according to Hamers and Blanc [59].

Gr	Member	Dimensions of bilinguality					
		Competence in both languages	Cognitive organisation	Age of acquisition	Presence of L2 community in environment	Relative status of the two languages	Group membership and cultural identity
1	1 DT	balanced	compound	childhood, simultaneous	endogenous	additive	bicultural
	2 DT	balanced	compound	childhood, simultaneous	endogenous	additive	bicultural
	3 DT	balanced	compound	childhood, simultaneous	endogenous	additive	bicultural
	4 BT	balanced	compound	childhood, simultaneous	endogenous	additive	bicultural
2	1 DT	balanced	compound	childhood, simultaneous	endogenous	additive	bicultural
	2 DT	balanced	compound	adolescent bilinguality	exogenous	additive	L_1 monocultural
	3 DT	balanced	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
	4 BT	balanced	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
3	1 DT	balanced	compound	adolescent bilinguality	exogenous	additive	L_1 monocultural
	2 DT	balanced	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
	3 DT	dominant	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
	4 BT	dominant	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
4	1 DT	dominant	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
	2 DT	dominant	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
	3 DT	dominant	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural
	4 BT	dominant	coordinate	adolescent bilinguality	exogenous	additive	L_1 monocultural

Note. DT: direct translation group member, BT: back translation group member.

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