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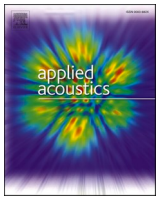
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Evaluating soundscape in the Italian language: Validation of the translation of the English standardized perceptual attributes of the ISO/TS 12913-2:2018 and comparison with other Romance languages

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ABSTRACT

The Soundscape Attributes Translation Project (SATP) has successfully translated English standardized perceptual attributes of the ISO/TS 12913–2:2018 into various languages. This paper validates the Italian translation of the widespread use of the soundscape circumplex model attributes for using standardized listening experiments protocol. The Italian translation of the ISO soundscape circumplex model was compared with the original English version. Furthermore, a comparison with other Romance languages (i.e., Portuguese, Spanish, French) that have already concluded the validation was carried out. The study was conducted following three phases: (i) a consensus on the final eight attributes of the Italian language was achieved, (ii) the recruitment of 30 naïve normal-hearing Italian listeners and the preparation of the set-up for the listening tests was fostered, (iii) listening tests based on the 27 binaural recordings provided by the SATP project to examine the differences in subjective evaluations of the same sound environment were administrated in the Audio Space Lab of Politecnico di Torino. The main findings of the listening tests consisted in the validation of the Italian translations against English, in the comparison of the perceived loudness in the Italian and English listening tests that showed no significant differences, and in the satisfactory match of Italian translations in comparison with other Romance languages. Although slight differences probably due to cultural aspects were found, these outcomes are helpful to properly develop the Italian version of the ISO 12913-2 and to pursue accurate and replicable soundscape studies.

1. Introduction

The need to go beyond linguistic boundaries and the complexity of the translation of the soundscape affective attributes in different languages has now shown a broad interest in the scientific community which has produced several papers [1–14] under the Soundscape Attributes Translation Projects (SATP) umbrella [15]. The project has promoted a global partnership that has developed soundscape attributes in multiple languages highlighting the limits of the linguistic translations. Furthermore, the SATP has the scope of considering a cultural adaptation to reach equivalence between the original source and target versions, and to maintain the content validity of an instrument (e.g., a questionnaire) at a conceptual level across different cultures [16]. The cultural adaptation process should be designed to maximize the attainment of semantic, idiomatic, experiential, and conceptual equivalence between the source and target questionnaires [17]. This is based on the fundamental meaning of soundscape defined as an "acoustic environment as perceived or experienced and understood by people, in context" [18]. The objective of this paper is to contribute to this framework and assess the validity of the widespread use of the soundscape circumplex model attributes by validating the Italian translations. Moreover, it considers also a comparison with other Romance languages (i.e., Portuguese, Spanish, French) that have already concluded the validation [8–10].

Several previous studies have reported the use of the soundscape Perceived Affective Qualities (PAQ) model or the "soundscape circumplex" in Italian language using specific questionnaires administered during soundwalks in Italian cities [19–25]. However, none of these

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translations has been previously validated towards the English attributes, namely *Eventful, Vibrant, Pleasant, Calm, Uneventful, Monotonous, Annoying, and Chaotic*. The current study aims to validate the potential use of soundscape descriptors present in the ISO 12913 standard in the Italian context making use of a listening test according to the standardized SATP protocol [26]-[27].

The eight PAQs that serve as subjective measurements of the acoustic environment have been derived from the two-dimensional model generated through Principal Component Analysis (PCA) in the reference work of Axelsson et al. [28]. Given that the eight PAQs were initially formulated in Swedish and later translated into English, concern arose about the accuracy of the original translation. It is now evident from the SATP initiative [15] that significant differences in the translation could be due to sociocultural variations in evaluating soundscapes regarding their PAQs [29–32].

The SATP was started as an international network of over 50 researchers whose primary goal was to translate and validate the eight soundscape attributes in other languages [1–14]. Most of these works adopted a two-stage research framework with Stage 1, qualitative data collection, conducted to gain preliminary translations, and then Stage 2, which involved validation through listening tests according to the standardized SATP protocol.

This paper contributes also to a comparison among translations in the Romance languages (i.e., Italian, Portuguese, Spanish, and French), which have already concluded their investigations and reported their findings in [8–10]. The Portuguese and Brazilian Working Groups conducted a cross-national investigation on the translation of PAQs in Portuguese [8]. They focused on both the translation and validation stages (Stage 1 and Stage 2). In Stage 1 the translation method used a mixed-method approach that involved expert panels and online questionnaires, while in Stage 2 the method was based on the standardized SATP listening test data collection. The study revealed differences between the perception of European Portuguese and Brazilian Portuguese speakers (i.e. Portuguese-speaking countries). They highlighted the need for further investigations regarding Vibrant, Monotonous, Annoying, and Chaotic PAQs, which did not correlate as in the original English model, while the Pleasant and Calm PAQs have been confirmed as in their initial translations. These findings have shown an important cultural component affecting the positive or negative meaning of the translated words in two different geographical contexts that make use of the same language. Additionally, the Uneventful term showed inconsistencies that were attributed not only to the Portuguese language, but also to the original English term and its initial translation from Swedish. Therefore, a suggestion on a possible revision of the English term was made.

The Spanish translation of the eight PAQs focused on Stage 1 and 2 [9]. Stage 1 has been performed through an iterative process between project teams from Chile and Spain and references from previous literature. The results of this stage brought to two Spanish words for each PAQs component. Stage 2 was performed according to SATP common instructions and listening tests given to all partners in the project. The results aligned reasonably well with the English circumplex, although suggestions were made to revise the "vibrant/monotonous" and "eventful/uneventful" axes.

The Working Groups in France and Quebec also have focused on a cross-national comparison of the translation of PAQs into French language [10]. They focused on Stage 1 providing a more in-depth historical reconstruction of the translated attributes used in two different geographical contexts (Quebec and France) that spans over 8 and 18 years of research, respectively. The results have shown a convergence in the standardization for most of the attributes, both concerning the terms used and the issues raised regarding the French language [10]. Although most of the translations of the PAQs (pleasant, calm, chaotic, and monotonous) utilized by the Quebec team were cognate versions of their English counterparts, an important point emerged regarding the assessment of the term "vibrant", which was closely correlated with "eventful", a pattern that was observed in both English and French. The study highlights that standardization might be limiting and encourages the exploration of new methods to address the complexity of experiences in relation to associated meanings and values or space use. These should be explored at both individual and group levels.

Italian (ISO 639-2:ita) is one of the most widely spoken European languages, it is estimated to have 67 million speakers globally and is the official language in 6 countries [33]. Among other Romance languages (e.g., Portuguese, Spanish, French) [34], it is the least divergent language from Latin [35]. Despite its widespread use, the availability of soundscape data collection protocols in Italian is limited to the context of soundscape literature. To the authors' knowledge, this is evident from the limited examples of protocols used directly in Italian, as referenced in [15,19–25]. This context highlights further research and development in this area, particularly in Italian-speaking countries, to ensure that the language is represented in the soundscape research community and to support policymakers in evaluations towards sustainable urban design and noise action planning [36]. Table 1 shows all the Italian translations of the English PAQs that were found in the referenced bibliography of Italian soundscape studies [15,19–25].

In this framework, this paper aims to investigate the validity of the Italian translation of the ISO protocol for soundscape evaluations. The purpose is to enrich the scientific database created in the SATP project and support the standardization of the soundscape evaluation process in the Italian language-speaking communities. Moreover, it aims to highlight similarities and differences among the languages of the same family i.e. Romance languages (Italian, Portuguese, Spanish, and French).

2. Materials and methods

From a methodological point of view, this work followed three phases, as summarized in Fig. 1 and briefly introduced below. Further details are given in the subsequent paragraphs of this section.

Phase 1 was aimed at selecting and formalizing the attributes translation from English to Italian language. Several studies adopted a linguistic translation of the attributes for the development of soundwalks [19–25], however, the set of translations was still not validated and some attributes varied from one study to another based on the sensitivity of the researchers. Therefore, in this phase all documented translations in previous literature for each English attribute were collected and, thanks to the involvement of a panel of three Italian mother-tongue experts (two females and one male), the final set of eight attributes was formalized. All the possible translations from the English PAQs (Table 1) were analyzed by the panel of Italian mother tongue experts, who underwent a first step of translations screening to remove the translations that could be misleading. In such a way, a maximum number of two terms were considered per each attribute (Table 2) and the final step of selection could start. The panel judged each attribute using a discrete scale from 1 (highly unclear) to 5 (highly clear), and then a comparison of the results was done. The attributes with the highest scores were selected and included in the final set to be validated

Table 1
Italian translations of the English attributes based on the available soundscape studies.

English soundscape attributes according to ISO/TS 12913-2 [26]	**Italian attributes from bibliographic research** [15,19–25]		
Eventful	Dinamico	Vario	Stimolante
Vibrant	Vivace	Stimolante	
Pleasant	Piacevole	Confortevole	
Calm	Calmo	Tranquillo	Riposante
Uneventful	Stabile	Stazionario	Noioso
Monotonous	Monotono	Noioso	
Annoying	Spiacevole	Irritante	Disturbante
Chaotic	Caotico	Confuso	

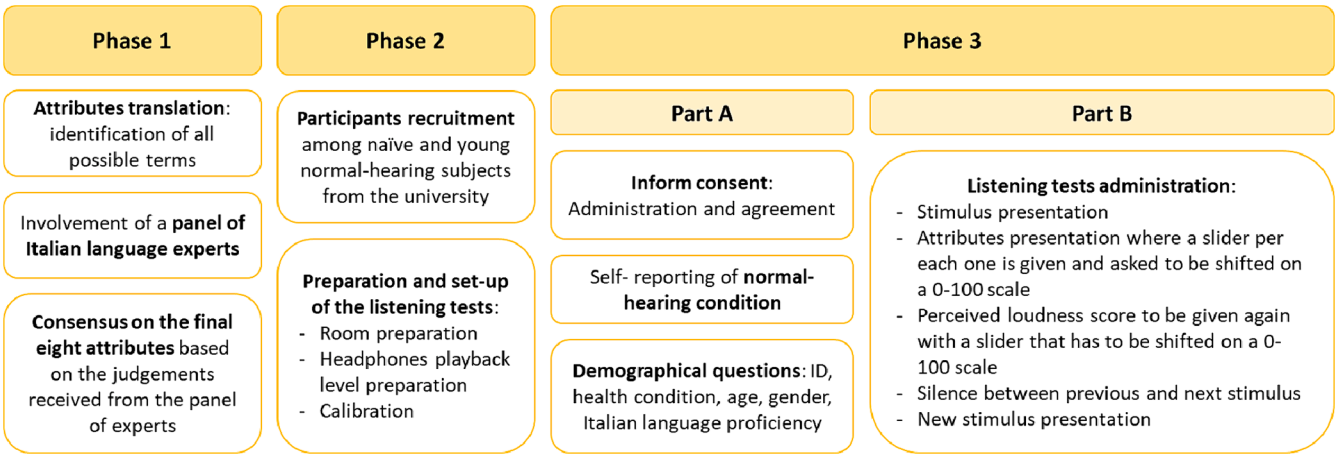


Fig. 1. The 3-phase methodological approach: Phase 1 – Attributes translation selection, Phase 2 – Listener recruitment and set-up calibration, and Phase 3 – Listening tests presentation and Italian attributes validation.

Table 2
Soundscape attributes for English and Romance languages [8–10]. Spanish, Portuguese and French were considered in comparison to Italian.

Soundscape attributes according to ISO 12913-2	Romance languages			
English	**Spanish**	**Portuguese**	**French**	**Italian**
Eventful	Con actividad –	Agitado OR Movimentado	Animé OR Mouvementé	Dinamico OR Stimolante
Vibrant	Estimulante –	Animado –	Stimulant OR Dynamique	Vivace –
Pleasant	Agradable –	Agradável OR Prazeroso	Plaisant OR Agréable	Piacevole –
Calm	Calmado –	Tranquilo OR Calmo	Calme OR Tranquille	Calmo OR Riposante
Uneventful	Sin actividad –	Sem acontecimentos OR Estático	Inerte OR Amorphe	Statico OR Noioso
Monotonous	Monótono –	Monótono OR Entediante	Ennuyeux OR Monotone	Monotono –
Annoying	Desagradable –	Irritante OR Desagradável	Gênant OR Dérangeant	Disturbante –
Chaotic	Caótico –	Caótico –	Agité OR Chaotique	Caotico –

within the subsequent phases.

Phase 2 was dedicated to the participants' recruitment and the listening test set-up calibration. The main criteria used in the listeners recruitment were based on the selection of participants among PhD university students or young researchers (i) who were below 35 years of age, (ii) with self-reported normal-hearing conditions and (iii) naïve concerning acoustics-related research. Then, the listening tests were prepared locating the set-up in the Audio Space Lab of Politecnico di Torino which was used as a testing room [37]. The room was equipped with a TV screen that was used in this experiment to present the attributes and collect the ratings through an ad-hoc user interface.

Phase 3 consisted of the listening tests administration stage (corresponding to SATP Stage 2). Using the ad-hoc designed user interface for the presentation and data collection of the tests, each participant was asked to fill in the first part of the questionnaire with demographical information that included the reporting of an ID assigned by the experimenter to make the test anonymous, actual health condition (e.g., having or having had a recent cold), age, gender, Italian language proficiency (i.e., mother tongue, advanced levels C2 or C1, intermediate levels B2 or B1). After this initial part, the questionnaire was administered presenting 27 recordings to each listener in a randomized order.

2.1. Soundscape attributes translations (phase 1)

As mentioned, phase 1 of the present study was dedicated to the selection of the final attributes for the Italian language to be used for soundscape evaluations. This process was done in parallel with English but also analyzing the outcomes for other Romance languages that underwent the validation within the Soundscape Attribute Translation Project. Table 2 summarizes the eight attributes in English according to ISO 12913-2, and then the translations in Spanish, Portuguese, French and Italian. The possible translations both from the published papers on the validation procedure referenced as [8–10] and [19–25], and from the public database where all the data collected for the SATP are contained [38]. In Table 2, all possible terms that the different groups identified per each attribute were included. Indeed, the literature review presented in Section 1 has shown a variety of possible translations that did not converge into a unique and comparable model [8–10,19–25,38]. This has been made in past studies using different terms without a formal agreement in the scientific community, which is actually the main scope of the overall SATP.

As far as the Italian language is concerned, the main criterion adopted by the panel to either select or reject a term when two were present, was to evaluate whether one of the two had an intrinsic positive or negative meaning. This could bring to a biased evaluation in a listener, therefore the panel of Italian mother tongue experts preferred to include in the translation only those attributes that were not strongly affected by an intrinsic judgement. Fig. 2 shows the final translations that were selected.

2.2. Participants recruitment (phase 2)

Laboratory measurements were carried out in Autumn 2021, involving a group of 30 participants (i.e., 14 male and 16 female

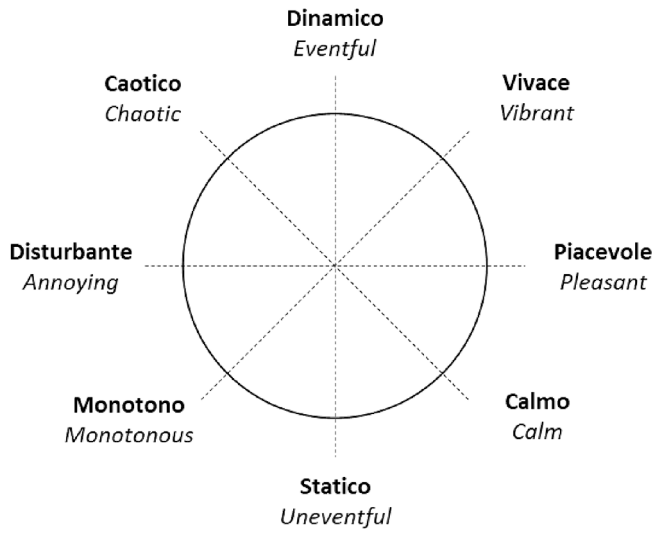


Fig. 2. Circumplex model of the soundscape attributes with the identification of the Italian and respective English terminology.

subjects) on a voluntary base. The sample size agreed with the number of involved participants in similar studies that, within the SATP, validated the translation of English attributes into other languages [38]. They answered a general call-for-participation spread among PhD students and young researchers at Politecnico di Torino. The mean age of the subjects was 27.5 years (±3.8 years), which was consistent among genders (i.e., female mean age was 27.8 ± 4.1 years; male mean age was 27.2 ± 3.7 years). Subjects were all Italian mother tongue and naïve with respect to acoustics-related research. All participants were asked to report any history of hearing loss and were only included in the final sample whether they reported to be normal hearing and without an ongoing cold, which may have affected the listening task. Before starting the listening test, subjects (i) were instructed by an experimenter on the procedure, (ii) were explained the objectives of the overall study from an ethical point of view and (iii) agreed in the anonymous collection of the results for scientific purposes (e.g., publication on national and international journals, participation into conferences).

2.3. Listening test set-up and acoustic stimuli (phase 2)

Within the SATP agreement, University College in London (UCL) provided a guideline of standardization for the administration of the listening tests. This allowed for the presentation of the acoustic stimuli in a homogeneous way across the different research groups involved in the SATP project.

A Windows PC connected to a TASCAM audio card and output channel to the Sennheiser HD650 open headphones was used. The headphones were calibrated based on the procedure shared by the University College London to have a standardized methodology among the Institutions involved in the SATP experience [38,39]. Particularly, a sensitivity calibration considering a 1 kHz RMS value and then a frequency compensation, i.e., equalization, for the other frequencies in the audible range were performed.

The audio recordings containing different acoustic features that had to be evaluated by means of the soundscape attributes were provided by the UCL who led the SATP [38,39]. Each recording has a length of 30 s. Recordings are related to everyday acoustic scenarios (e.g., park, trafficked street, construction area, busy shopping street) and contain specific characteristics of sounds – such as mechanical, natural, and related to human activities – that were captured in 2019 in London [39]. For the sake of clarity and ease of reading of the results, a brief description of each audio recording is given in Table 3, which also shows the associated label, the location of registration, and the dominant sounds that are present.

2.4. Listening test procedure (phase 3)

Listening tests were performed in the Audio Space Lab of Politecnico di Torino, which is a quiet room with low reverberation time (<0.3 s at mid-frequencies) and background noise level (<37 dBA). Before starting the actual presentation of the stimuli, a familiarization test was performed by allowing each participant to listen to one test stimulus and rate it on the eight attributes scale. Immediately after this familiarization step, the actual experiment started, and the stimuli related to 27 recordings [39] were presented separately.

The administration procedure was automatized with a Matlab routine implemented on Matlab App that was presented on the Windows PC, and an experimenter was always present in the room at a control position outside the sight of the listener. Recordings were administrated in a random order to all the listeners. Each listener was asked to listen to each recording entirely (i.e., for 30 s) and then to rate the attributes' scales. The listener could listen to the recording more than once. In between two subsequent recordings, a 30 s pause was presented. Each test duration was less than 20 min long.

After having listened to each sample, the listener was asked to rate each attribute that appeared on the TV screen answering, "For each of the 8 scales below, to what extent do you agree or disagree that the present surrounding sound environment is…". Making use of moving a slider (with a default position of the slider on 50), the listener could answer on a scale that ranged from 0 to 100 perceptually representing a scale ranging from "strongly disagree" (left) to "strongly agree" (right). The final question presented to the listeners was related to the rating of the perceived loudness to be associated with each recording, which had to be evaluated using the same scale and slider typology in the 0–100 range.

3. Results

The data collected from the listening tests have been analyzed aiming to present 1) a validation of the Italian translations against English of the soundscape attributes, 2) a comparison of the perceived loudness in the Italian listening test and English listening tests, 3) a comparison of the attributes ratings overall the Romance languages (i.e. Italian, Portuguese, Spanish and French).

3.1. Validation of the Italian translations against English attributes

As far as the mean and standard deviations obtained for each attribute in each recording, the results from the 30 involved participants are presented in Table 4. These values have been further compared with the English results (Fig. 3).

Oberman et al. [38] published the outcomes of the validation process of the English soundscape attributes in a public repository. These ratings, on which mean values and standard deviations were calculated, were compared against those obtained for the Italian translations. Fig. 3 shows the radar plots of the mean ratings for Italian (in blue) and English (in yellow).

Overall, as represented in the latter plot in which an average across all the recordings is reported, it is highlighted that there is a general agreement in the ratings that match well for the two languages. Visually inspecting the single outcomes obtained for each recording, a good match is also present (note that each pace refers to 10 points in the rating scale).

Another analysis to compare the Italian results against the English ones consisted of the application of the equations to obtain the Eventfulness and Pleasantness scores, in agreement with ISO/TS 12919-3:2019 [27]. Formulas A.1 and A.2 shown in the cited standard, which are included in Annex A of the standard and that refer to the analysis of data related to Method A, allow to obtain the scores that are

Table 3
Audio recordings description. Each recording is provided with its label (ID), location of registration, dominant sound(s) category and specific sound(s) present.

Recording details		Human sounds						Natural sounds			Traffic noise		Noise from equipment			
ID	Location	Music	People talking	People laughing	People walking	Children playing	Children crying	Birds	Water	Nature	Cars/ road	Horns/ sirens	Machines	Hammers	Metallic noises	Construction
CG01	Covent Garden	X	X	X												
CG04	James Street		X													
CG07	Covent Garden		X													
CT301	Camden Town Station												X			
E01b	Hertford Union Canal								X		X					
E02	Hertford Union Canal								X		X					
E05	Victoria Park		X	X				X								
E09	Wharf Road Gardens	X	X	X			X	X								
E10	Granary Square		X			X	X		X							
E11b	A12, pedestrian overpass										X	X	X			
E12b	Copper Street												X	X		
HR01	Highgate Road											X	X	X	X	X
KT01	Ospringe Road												X			
LS06	Leicester Square	X	X	X												
N1	Alexandra Park							X			X					
OS01c	Charring Cross Road		X									X				
OS01d	Charring Cross Road	X	X													
RPJ01	Regent's Park		X					X								
VP01b	Victoria Park							X		X						
W01	Regent's Canal												X			
W06	Regent's Canal								X							
W09	Sheldon Square												X			
W11a	Regent's Canal		X		X						X					
W15	Blomfield Road										X					
W16	Aberdeen Place										X				X	
W22	Regent's Canal		X	X				X								
W23a	Regent's Canal		X	X												

Table 4
Mean and standard deviation (St.Dev.) for the Italian ratings for each attribute and each recording.

Recording		**Dinamico** *Eventful*	**Vivace** *Vibrant*	**Piacevole** *Pleasant*	**Calmo** *Calm*	**Statico** *Uneventful*	**Monotono** *Monotonous*	**Disturbante** *Annoying*	**Caotico** *Chaotic*
CG01	Mean	63.0	68.9	73.7	65.9	27.6	25.9	21.3	38.6
	St.Dev.	*16.0*	*16.7*	*14.0*	*20.7*	*15.9*	*20.4*	*20.1*	*24.5*
CG04	Mean	49.7	54.2	50.1	52.3	48.1	54.2	31.4	51.2
	St.Dev.	*18.0*	*15.9*	*17.8*	*17.2*	*20.0*	*23.0*	*20.3*	*17.5*
CG07	Mean	50.0	41.0	51.0	60.7	41.6	46.7	37.4	47.3
	St.Dev.	*22.3*	*19.4*	*19.3*	*16.7*	*21.1*	*19.1*	*24.6*	*20.9*
CT301	Mean	49.1	33.9	8.6	9.7	40.0	66.2	87.9	65.1
	St.Dev.	*24.8*	*32.1*	*12.2*	*10.4*	*29.0*	*20.4*	*18.1*	*28.6*
E01b	Mean	22.5	21.8	24.9	47.0	71.6	84.7	52.7	33.6
	St.Dev.	*19.5*	*19.6*	*19.2*	*24.2*	*25.9*	*15.1*	*22.2*	*20.2*
E02	Mean	31.5	33.1	51.1	59.4	58.1	70.1	33.3	26.0
	St.Dev.	*23.8*	*22.0*	*25.0*	*21.5*	*24.1*	*14.9*	*26.1*	*21.9*
E05	Mean	45.2	44.7	70.8	70.1	48.7	42.6	17.0	23.6
	St.Dev.	*21.5*	*22.8*	*17.8*	*18.4*	*19.9*	*20.7*	*16.0*	*18.8*
E09	Mean	59.2	56.6	47.6	41.3	32.0	32.1	44.9	60.9
	St.Dev.	*18.4*	*13.8*	*17.5*	*16.0*	*19.3*	*21.7*	*20.4*	*15.6*
E10	Mean	61.9	66.4	46.0	30.7	30.9	30.0	53.8	66.8
	St.Dev.	*20.7*	*16.9*	*24.1*	*21.5*	*23.7*	*23.7*	*22.1*	*16.6*
E11b	Mean	68.9	32.3	8.7	12.3	21.9	29.1	90.4	85.6
	St.Dev.	*21.1*	*24.4*	*12.8*	*15.8*	*17.3*	*19.7*	*12.0*	*16.5*
E12b	Mean	48.5	36.2	8.8	10.6	39.3	52.4	87.8	75.6
	St.Dev.	*26.6*	*29.9*	*12.7*	*13.1*	*28.1*	*30.0*	*15.6*	*23.3*
HR01	Mean	63.3	32.8	17.4	16.3	22.6	29.1	75.9	76.4
	St.Dev.	*20.1*	*23.5*	*18.6*	*18.1*	*23.5*	*22.9*	*21.7*	*22.5*
KT01	Mean	11.3	12.4	29.6	62.3	80.6	89.3	42.0	23.2
	St.Dev.	*15.8*	*12.2*	*22.7*	*22.6*	*25.5*	*11.2*	*22.8*	*22.0*
LS06	Mean	55.9	61.1	65.3	56.7	30.6	26.6	29.3	47.7
	St.Dev.	*18.9*	*17.9*	*21.5*	*18.9*	*15.9*	*17.0*	*21.7*	*20.8*
N1	Mean	49.2	63.5	73.8	71.8	42.3	42.2	17.6	26.3
	St.Dev.	*20.2*	*16.2*	*17.0*	*15.0*	*21.1*	*20.5*	*16.7*	*20.4*
OS01c	Mean	65.4	52.8	23.5	15.7	21.9	25.4	76.1	79.0
	St.Dev.	*17.3*	*24.1*	*16.7*	*14.1*	*18.1*	*16.7*	*15.6*	*14.2*
OS01d	Mean	80.5	85.0	56.6	12.5	10.5	18.5	46.6	72.4
	St.Dev.	*17.4*	*13.3*	*21.3*	*14.3*	*11.0*	*21.7*	*26.7*	*17.4*
RPJ01	Mean	41.1	53.5	66.6	71.6	46.7	46.2	22.7	25.2
	St.Dev.	*21.0*	*23.2*	*20.3*	*18.1*	*20.4*	*20.6*	*20.1*	*19.8*
VP01b	Mean	31.7	37.2	78.4	87.2	58.2	54.4	10.5	9.9
	St.Dev.	*17.7*	*22.4*	*22.0*	*15.6*	*22.6*	*21.7*	*16.3*	*11.6*
W01	Mean	40.8	28.0	19.9	29.1	43.9	66.6	70.8	58.3
	St.Dev.	*23.1*	*20.3*	*20.8*	*21.6*	*24.5*	*20.9*	*24.7*	*22.2*
W06	Mean	26.6	31.8	63.4	77.5	65.2	71.3	19.6	15.8
	St.Dev.	*19.5*	*16.5*	*16.9*	*13.1*	*21.1*	*20.4*	*16.0*	*15.3*
W09	Mean	12.1	20.4	7.2	16.2	80.9	91.1	88.9	58.2
	St.Dev.	*13.4*	*21.4*	*14.1*	*19.3*	*20.1*	*8.5*	*14.8*	*25.6*
W11a	Mean	46.4	42.8	43.9	56.8	43.0	51.9	35.1	42.0
	St.Dev.	*21.2*	*18.7*	*16.6*	*14.2*	*16.2*	*18.3*	*22.0*	*22.2*
W15	Mean	51.7	25.1	38.3	54.3	37.4	44.9	35.4	36.0
	St.Dev.	*26.1*	*18.3*	*20.8*	*16.6*	*21.2*	*24.8*	*18.3*	*21.3*
W16	Mean	18.2	17.0	50.5	79.2	76.1	83.1	21.0	15.2
	St.Dev.	*18.6*	*17.5*	*23.3*	*16.3*	*19.8*	*12.2*	*23.4*	*15.5*
W22	Mean	49.0	39.0	72.5	76.4	46.5	47.6	20.8	29.5
	St.Dev.	*20.4*	*16.9*	*16.7*	*16.1*	*22.7*	*20.6*	*18.8*	*20.6*
W23a	Mean	39.5	34.8	48.3	62.2	46.9	50.2	27.7	30.3
	St.Dev.	*22.1*	*20.3*	*16.6*	*18.2*	*20.4*	*22.5*	*18.6*	*19.6*
Total	**Mean**	**45.6**	**41.7**	**44.3**	**48.4**	**44.9**	**50.8**	**44.4**	**45.2**
	St.Dev.	***26.4***	***26.4***	***29.1***	***30.0***	***27.7***	***28.5***	***32.1***	***29.4***

plotted in Fig. 4 both for Italian (in blue) and for English (in yellow). These formulas are used to weigh the ratings obtained in the two-dimensional circumplex model by adjusting them concerning the 45° rotation. In the figure, each dot refers to a specific recording. Fig. 5 is similar to the previous one but represents the differences between the scores for Italian and English. Here the Italian scores were subtracted from the English ones. This analysis shows that the Italian sample rated the recordings, on average, more pleasant and eventful than the English sample (i.e. the differences are slightly shifted towards the positive quadrant). Anyway, this is a tendency, but no significant differences were found between the two languages and no significant changes in the quadrant in the circumplex were found.

From a statistical point of view, a two-steps analysis was followed. First, the Euclidean Distance was calculated for all the Pleasantness and Eventfulness scores of all the 27 recordings considering Italian and English. Considering a cut-off value equal to or higher than 0.15, only three recordings resulted in larger differences between the translations. Recordings CG07, LS06 and OS01c resulted in Euclidean Distances of 0.16, 0.18 and 0.16, respectively. Such larger differences may depend on the subjective perception of noises that is partly influenced by the different cultural backgrounds. Indeed, the minimal differences found in the comparisons could be attributed to the sociocultural variations in evaluating soundscapes as indicated in [29]-[32]. Similarly, as a further example, past investigations found a correlation between pleasantness

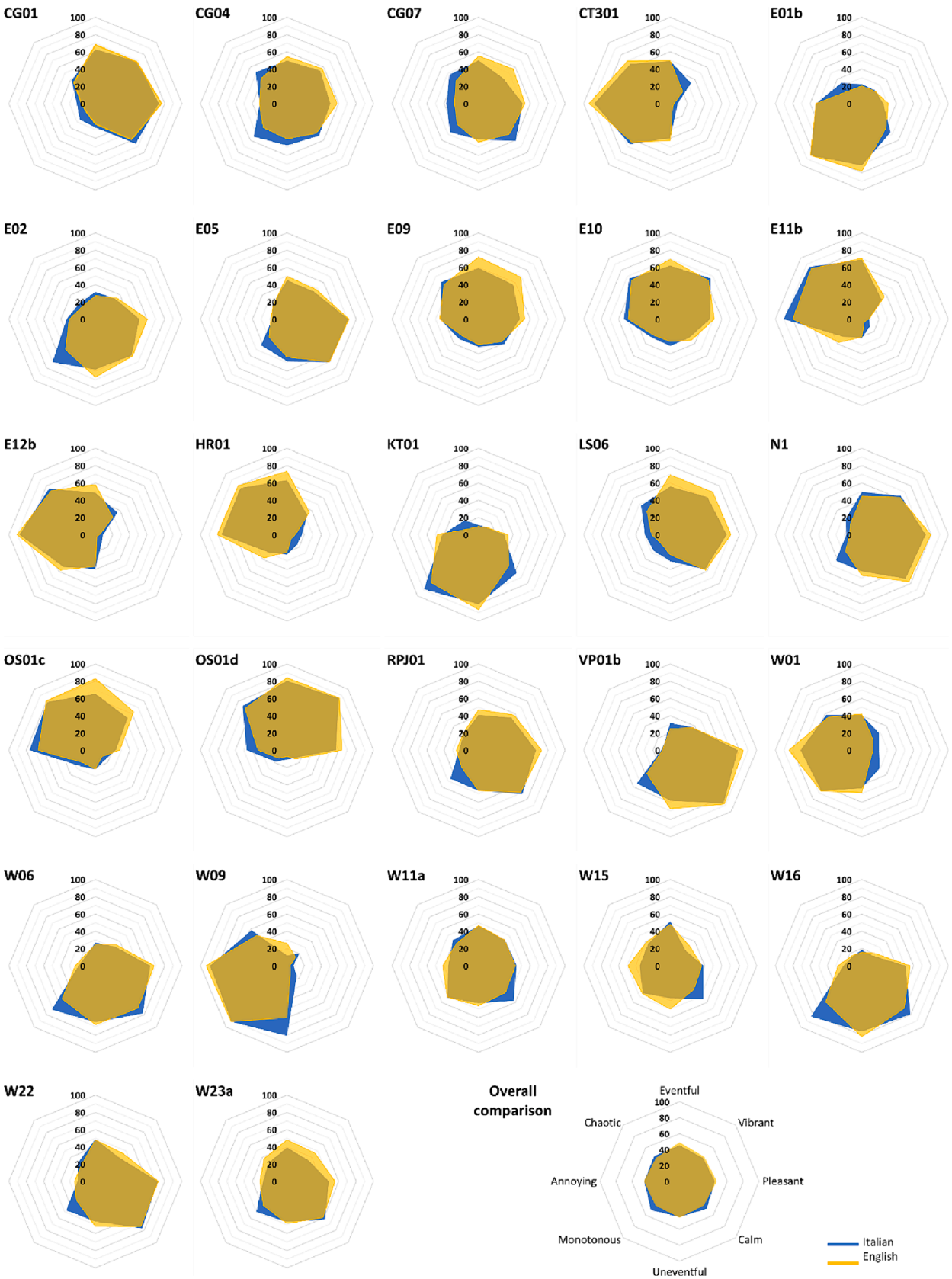


Fig. 3. Average ratings for each of the eight attributes and separately considering each of the 27 recordings (i.e., each plot is associated with the code of the recording on the top left area). Radar plots differ per language, which are layered from the bottom to the top as follows: Italian in blue, English in yellow. Labels related to the different attributes are shown only in the last radar plot (i.e., named "Overall comparison"), showing the mean overlap of all 27 audio files combined per language. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

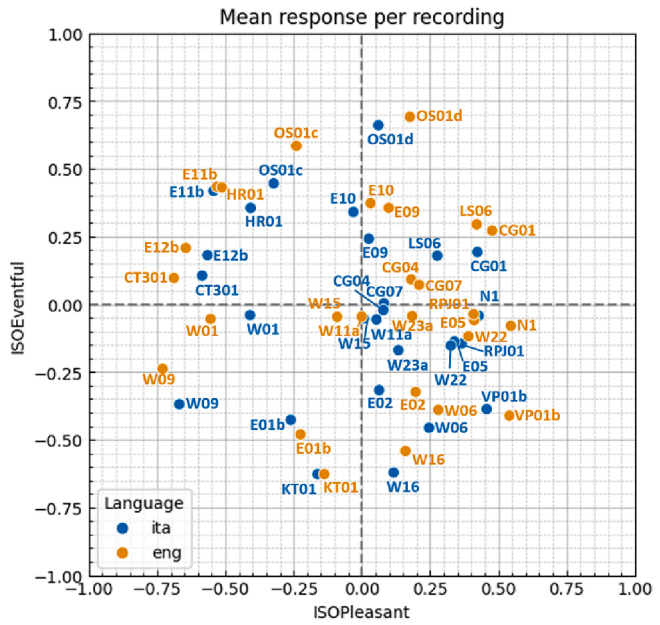


Fig. 4. Plot of mean values for the "Eventfulness – Pleasantness" attributes for Italian (blue) and English (yellow), separately. Each dot is the average score given for each of the 27 recordings. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

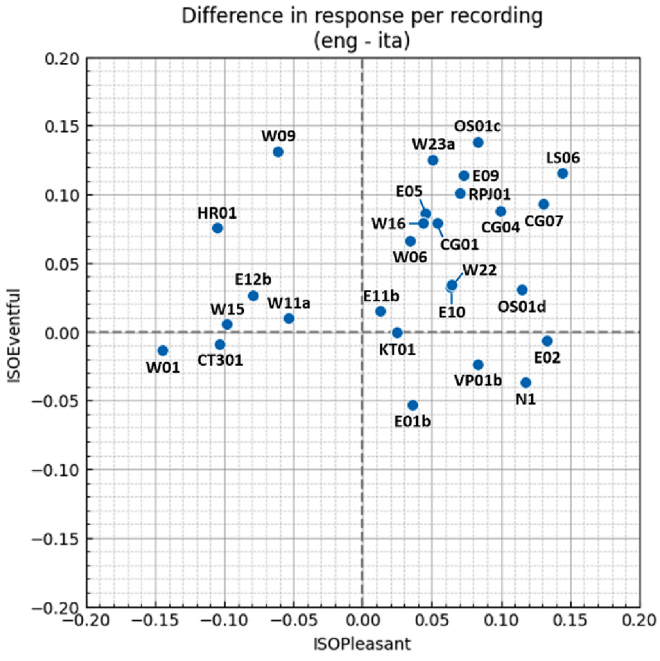


Fig. 5. Plot of the average differences between Italian and English on the "Eventfulness – Pleasantness" attributes. Each dot is the subtraction of the average score for each of the 27 recordings in Italian from the correspondent average in English.

and natural sounds only for European respondents but not for Chinese [40].

Second, to assess whether the specific differences between samples were significant or not, a two independent-samples *t*-test was applied to the data. The Italian sample (M = −0.018, SD = 0.342) rated the audio files as similarly pleasant compared to the English sample (M = 0.013, SD = 0.401). The difference in Pleasantness was not significant, t(52) = 0.092, p = 0.763. The Italian sample (M = −0.033, SD = 0.331) also rated the audio files as similarly eventful compared to the English sample (M = 0.015, SD = 0.346). The difference in Eventfulness was also statistically non-significant, t(52) = 0.275, p = 0.602.

3.2. Outcomes on the perceived loudness in Italian against English

Fig. 6 shows the distribution of mean ratings related to the perceived loudness in Italian (blue) and English (yellow), with the respective standard deviations. No significant differences were found; thus, this insight validates the appropriateness of the selected attributes in Italian with respect to those proposed for English in the ISO/TS 12919-3:2019 [27].

3.3. Italian against other Romance languages outcomes

A further investigation of this study was focused on a comparison of the ratings provided concerning each recording based on the different Romance languages. Similarly to the analysis proposed for the Italian ratings against the English ones, Fig. 7 shows the radar plots of the mean ratings for Italian against the other validated Romance languages (i.e., Portuguese, Spanish, and French). Again, an overall observation, which is represented in the latter plot with an average across all the recordings, shows that there is general agreement in the ratings in the different languages.

It might be argued that some recordings present differences in the ratings across the different languages, such as recordings CT301, W06, W09 and W15, with the Italian language shifted towards evaluations with higher scores near to uneventful, monotonous and calm dimensions. To the authors knowledge, there are no studies that show evidence on the cultural perceptual differences of the machines, water and cars sounds (i.e., the dominant sound in the above highlighted recordings) between the Italian culture the other three. However, intrinsic differences related to semantic and cultural features should be deepened in future studies, maybe considering a multi-language approach that involves also linguistics and culture experts. Overall, visually inspecting the single outcomes for each recording, a good match is present, and no significant differences are evident in the radar distribution of ratings for each attribute in each recording.

4. Discussion

The objective of the present study was to assess the validity of the Italian translations from English of the eight attributes used within soundscape research. The findings obtained through listening tests on a set of 30 Italian mother tongue naïve normal-hearing listeners, support the hypothesis that the Italian translations of soundscape attributes successfully served their intended purpose of being used in a manner like the English attributes.

Indeed, no statistically significant differences were found considering the attributes' ratings for each of the 27 recordings considered. This was also reflected in the Pleasantness and Eventfulness insights through the application of the ISO/TS 12913-3:2019 [27] formulas, as a general shift to more pleasant and eventful perception was obtained after subtracting the Italian scores from the English ones, but no statistically significant results emerged. Although further investigations are needed to deepen such cross-language difference, this result can be explained by the different cultural backgrounds of the two countries. Aletta et al. [40] found a higher correlation between pleasantness and natural sounds for European respondents than for Chinese ones, and Europeans associated a vibrant soundscape with human-generated sounds while Chinese respondents with natural sounds. Jeon and al. [30] showed similarities in the assessment of the pleasantness of soundscapes of urban parks across France, Korea, and Sweden, and found that socio-cultural differences are responsible for the differences in the soundscape eventfulness scores. Deng et al. [41] found that

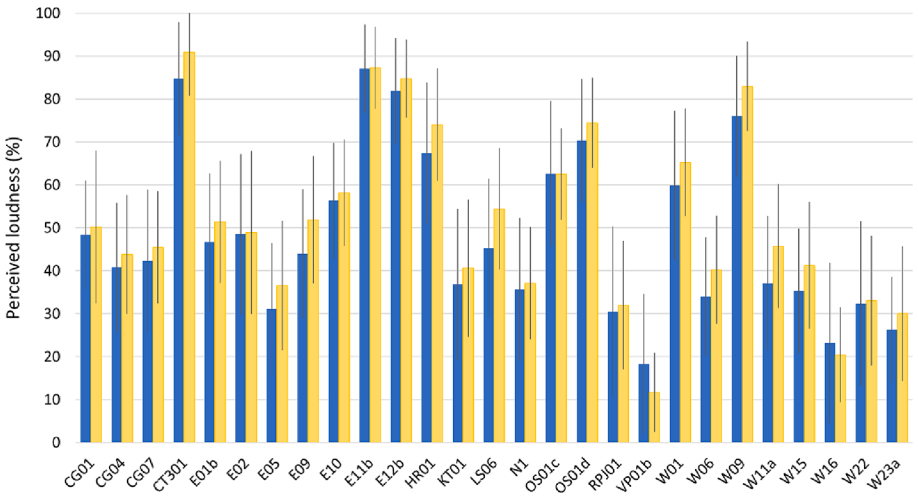


Fig. 6. Average ratings of the perceived loudness for each of the 27 recordings. Histograms represent the results for Italian in blue and for English in yellow. Error bars represent the standard deviations. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Chinese people gave more importance to the eventfulness dimension as opposed to the Croatian respondents in the case of a soundscape assessment of public spaces.

In general, the outcomes of the present study an encouraging starting point to assess objectively valid soundscape studies that can be comparable across languages, as also other validated translations have obtained similar conclusions for the Dutch language [14]. However, it is important to underline that future investigations should include further typologies of listeners than the one that can be classified as "WEIRD" (Western, Educated, Industrialized, Rich, and Democratic). Indeed, besides the language of origin, background and experiences of other listeners still may influence the variability of results.

When comparing the outcomes for the Italian language to those obtained for Portuguese [8], Spanish [9] and French [10], i.e., for other Romance languages, a visual inspection of the distribution of the ratings of the eight attributes for each recording did not put in light great differences across the four languages. However, some slight mismatches are present. Further research is needed to investigate on differences at a linguistic level for the specific conditions obtained especially in the recordings with major differences, as a deeper investigation may explain some still uncovered aspects like in other experiences of multilingual validation of speech material [42]. The collected data at this phase of the research are not sufficient to give a proper understanding of the differences found between different languages translations. It might be a step forward to consider a common investigation including the four Romance languages and on site soundwalks with more in-depth free-format interviews. As it was highlighted by the Quebec and French SATP working groups, the risk of simplification of a complex and multidimensional sensorial experience could lead to a loss of information that might be otherwise collected by adding also free-questions and exploration of other perspectives related to space use, values, and meanings associated to sounds [10]. Losing part of the "context" meaning while performing listening tests in a laboratory could also be a further aspect to explore. All the working groups had different "immersive" environmental conditions (e.g. anechoic chambers and experimental labs [9]) with effects that could not be properly quantified from a metrological perspective.

Moreover, from a general point of view, the SATP provided a standardized methodology for the translations' validation, but then each individual research group that participated in the project had the autonomy to acquire translations for the soundscape attributes in the preferred manner, resulting in possible substantial differences across the adopted methodologies. For the Italian translation, a first phase of validation consisted in the selection of most appropriate terms involving a panel of mother tongue experts as well as it happened for other groups such as the Indonesian [3], the German [11] and the Dutch [14] ones. Other research groups followed a phase 1 more elaborated methodology, by the involvement of focus groups but also organizing ad hoc soundwalks and pilot listening experiments to validate the selected translations. The Malaysian translation [6] was based on five steps (1a-Semantic translation; 1b-Focus Group discussion; 1c-Experiential evaluation online questionnaires; 1d-Committee Review and 1e-Quantitative evaluation); the Portuguese translation was based on a two step-approach (1a-Qualitative analyses based on bibliographic research and panel of experts and 1b-Quantitative analyses online questionnaires and individual environment assessment) [8]; the Japanese [12] translations were based on four step-approach (1a-Qualitative selection based on bibliographic research; 1b-Quantitative assessment experiment in a class; 1c-Quantitative assessment of parks through videos and binaural recordings in laboratory; 1d- Quantitative assessment through soundwalks in real environments). Another approach adopted within the SATP was the one of comparing the terms in two equal languages but spoken in different world areas and that may lead to internal cultural differences. As an example, this approach was adopted by the Greek research group [5].

From the point of view of the Italian translation approach, the adoption of a quantitative framework methodology has significantly supported the achievement of a robust validation within the SATP project goals. Indeed, the experimental validation step included in phase 3 of the presented methodology, allows building up a strong baseline of materials to be confidently adopted and replicated in future soundscape studies. These conclusions are also supported by the perceptual ratings regarding the perceived Loudness, which are compatible with those obtained by the English SATP group. As reported in [13], the attributes related to sound quality, such as quietness or loudness, could provide insights into how cultural or linguistic differences influence the perception of sound quality. They showed, for example, the negative correlation between Loudness and Chaotic for the Japanese group. A higher level of perceived loudness might contribute to a sense of organization or structure in the soundscape for this specific group, counteracting the perception of chaos, i.e., the perception of chaotic attributes decreases.

It should be highlighted, as underlined by other studies such as in the Dutch translation project [14], that further investigations are needed to account for demographic factors (e.g., gender and age, linguistic issues, cultural backgrounds) and for social factors and noise sensitivity. This would allow for investigating from a more comprehensive point of view into the actual subjective perception of the sound environment.

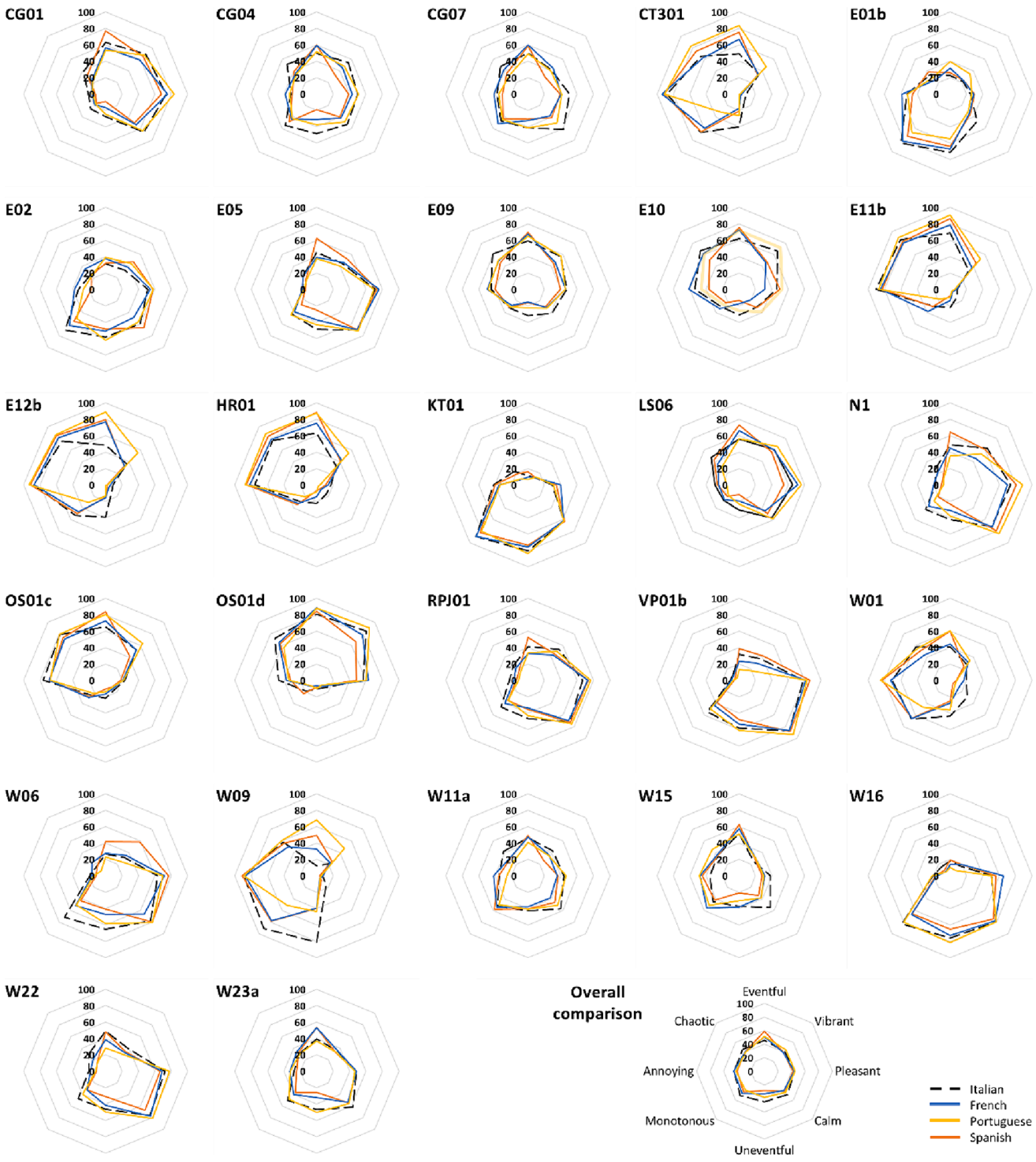


Fig. 7. Average ratings the eight attributes in the different Romance languages for every 27 recordings (i.e., each plot is associated with the code of the recording on the top left area). Radar plots differ per language, i.e., Italian in black dashed line, French in blue, Spanish in orange, Portuguese in yellow. Labels related to the different attributes are shown in the last radar plot (i.e., named "Overall comparison"), showing the mean overlap of all 27 audio files combined per each language. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

5. Conclusions

Considering the overall objective of the Soundscape Attributes Translation Project (SATP), the establishment of a common language for soundscape research turned out to be an urgent need. This work contributed to the validation of the translation of the eight attributes to describe soundscapes from English to Italian. The need for this validation was evident, as past soundscape studies in Italian [19–25] made use of different translations of the English terms without converging into an agreed panel of attributes. Indeed, after selecting the final eight translations, the data related to the Italian sample and the English sample were compared and resulted in a high similarity when rating all the 27 recordings that represented everyday scenarios with different acoustic features. The validated attributes are *Dinamico* (Eventful), *Vivace* (Vibrant), *Piacevole* (Pleasant), *Calmo* (Calm), *Statico* (Uneventful), *Monotono* (Monotonous), *Disturbante* (Annoying), and *Caotico* (Chaotic).

The presented outcomes are encouraging and suggest that the application and use of these attributes for future soundscape research are robust. Future studies on soundscape evaluation should consider performing pilot tests involving also different participants than those involved in the present work, i.e., PhD students. In fact, representing a wider typology of listeners than the one that can be classified as WEIRD, can be beneficial to corroborate the presented findings. From a cross-language point of view, when comparing the Italian outcomes to those obtained for other Romance languages (in particular, Spanish, French and Portuguese), it results that a good general match is present, although some slight differences under certain acoustic features can be found. These differences might be related to intrinsic semantic and cultural reasons [43]; therefore, future studies should also include linguistic and cultural experts to deepen the actual reason for such cross-language differences.

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CRediT authorship contribution statement

Giuseppina Emma Puglisi: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Resources, Investigation, Formal analysis, Data curation, Conceptualization. **Louena Shtrepi:** Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Investigation, Conceptualization. **Marco Carlo Masoero:** Writing – review & editing, Supervision. **Arianna Astolfi:** Writing – review & editing, Supervision, Conceptualization.

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.

Data availability

Data will be made available on request.

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