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Ergonomics of the physical environment - Subjective judgement scales for assessing physical environments (ISO/DIS 10551:2017)

Ergonomie des Umgebungsklimas - Subjektive Bewertungsskalen für die Beurteilung des Umgebungsklimas (ISO/DIS 10551:2017)

Ergonomie de l'environnement physique - Échelles de jugements subjectifs pour l'évaluation des environnements physiques (ISO/DIS 10551:2017)

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Ergonomics of the physical environment — Subjective judgement scales for assessing physical environments

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Foreword

ISO (the International Organization for Standardisation) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organisations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardisation.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10551 was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC5, *Ergonomics of the physical environment*.

The standard includes seven informative annexes (annex A to annex G).

Introduction

By using this international standard you can construct subjective scales that can be used to ask people how they feel about their physical environment. That is whether they find it too hot, whether there is any noise and if it is annoying, if the light is too bright, is it 'smelly' and so on. By constructing the scales and using them correctly you can see, in a cost effective way, how people find the environment. The information can be applied to report on the environmental quality and to work out how to improve the environment.

People are exposed to a range of physical environments which can affect their health and safety, comfort and performance. An important method for assessing physical environments, particularly when considering psychological constructs such as comfort or satisfaction, is to use subjective scales. The type of scale used and how it is administered are important in influencing the subjective responses of people. There are principles for constructing scales and procedures for administering them that will reduce bias and ensure validity and reliability of response. There are also generic types of scale that can be used across environmental stimuli, for example scales on which people rate sensation or comfort or acceptability or preference and so on.

This International Standard provides a description of principles of scale construction and procedures for use. It also provides examples of commonly used scales across environmental components. The standard does not standardize any particular scale but it provides the principles upon which appropriate scales can be constructed. It is needed to provide consistency in the production of valid and reliable scales. It will be particularly useful to people who wish to conduct an environmental survey, for example to assess post occupant satisfaction of new or existing buildings or other spaces, environments where dissatisfaction occurs and a diagnosis of the problems is required and for people who are investigating the relationship between conditions in the physical environment and human perception. A consistent approach to subjective scale construction and use will also allow a meaningful comparison of data obtained from investigations internationally.

The present International Standard forms part of a series of standards on the assessment of comfort, stress and strain in physical environments.

This series is concerned in particular with:

1) establishing specifications on methods for measuring and estimating the characteristic physical parameters of environments;

2) establishing methods for assessing stress in environments.

This International Standard proposes a set of specifications on direct expert assessment of comfort/discomfort expressed by persons subjected to various degrees of stress during periods spent in physical environments. The data provided by this assessment can be used on its own or to supplement physical and physiological methods of assessing loads. The methods belong to a psychological approach consisting in gathering, as appropriate, the onsite opinions of persons exposed to the conditions under consideration (diagnosis) and thus may complement data provided by predictive approaches described elsewhere in this series.

The information provided in this standard can be used to construct valid subjective scales for use in determining how people feel in their physical environment. The standard does not give guidance on questionnaire design and application although the scales may be used in the construction of questionnaires.

If persons exposed to environments are to be asked about their corresponding experiences or information requested on their cultural attitude in order to obtain the most appropriate subjective judgement scales, favourable relationships should first be established between these persons and the organization responsible, through the persons conducting the ergonomic investigation.

The environments which lend themselves to the application of subjective judgement scales relate to conditions which differ to a moderate degree from comfortable conditions. Under extreme conditions, physical

and physiological assessment methods of the environmental load should be preferred, provided that their results can be used as criteria for a decision. In particular, tolerance Iimits for load cannot be confidently based on subjective judgements and have to be decided in view of accepted health risk criteria. The decision of whether a person is exposed to an extreme environment should not be left to the person exposed as their judgement may be impaired by the conditions.

The opinions held by persons about their environment have a value in themselves. lt is up to the ergonomist whether or not to take them into account. The reputation of these data for lack of reliability does not justify dismissing them out of hand. The aim of this International Standard is precisely to improve their reliability by specifying the appropriate tools to use in collecting them and the requirement for using them.

Ergonomics of the physical environment — Subjective judgement scales for assessing physical environments

1 Scope

This International Standard presents principles and examples of practical application for the construction of subjective scales for use in the assessment and evaluation of the physical environment.

This international standard considers scales of perception; comfort; preference; acceptability; expression form and tolerance It does not consider other scales such as those related to the effects of the environment on the ability to read displays or signs, on manual performance or on psychological conditions such as mood etc.

This international standard does not consider scales related to pain or scales related to stimuli that could lead to injury.

Environmental components considered include thermal, visual, air quality, acoustic and vibration.

This International Standard does not standardise particular scales, it provides the principles that will allow users to construct appropriate scales for their application.

This International Standard does not present principles of surveys (see Note 1) or questionnaire design.

However, the scales that are developed using this standard may be incorporated into surveys or questionnaires.

NOTE 1 Environmental surveys are described in ISO 28802, (2012). ISO 28802, (2012) includes scales that are complementary to, and based upon, the principles of scale construction that are described in this international standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 28802, *Ergonomics of the physical environment — Assessment of environments by means of an environmental survey involving physical measurements of the environment and subjective responses of people*

3 Subjective judgement scales for physical environments: Principles of scale construction and use

There are a number of subjective judgement scales for physical environments. They differ in whether emphasis is placed on some aspect of judgement: perceptual or affective (evaluative and preferential). Global (encompassing the whole environment or organism) or localized, present or past, instantaneous or extended over a period of time. They also differ as to the object of judgement: environment or person, the whole or its component parts, permanent or temporary situation.

The present International Standard retains judgements that people make about their own state as a whole. It distinguishes between perception, present affective assessment (comfort/discomfort) and future preference.

NOTE 2 This International Standard also suggests supplementing the perceptual, evaluative and preferential judgement scales by a statement of acceptability and a scale of tolerance of environments

In most instances, the exposure to an environment lasts for several hours. Therefore, it is useful to gather the person's opinions throughout, by repeating the expression of the judgements at regular intervals, using exactly the same scales.

NOTE 3 The procedure of obtaining synthetic judgements by hypothetically integrating spot impressions over an extended period of time should be avoided.

By repeatedly applying the same scales, the evolution with time of the comfort or strain experienced may be assessed and an integrated judgement obtained over the whole time of exposure by appropriate computation of the data (e.g. overall mean, overall change, variation etc).

Basic difficulties are encountered in any area which involves the use of language. In this regard, bias and variability in the data can result from inconsistencies and inappropriateness of accompanying instructions. Therefore, it becomes crucial to standardized preparatory instructions which explain the study, as well as the wording of the judgement scales. Of special importance is the terminology used to denote the degrees on the judgement scales. This International Standard specifies the principles used to develop subjective scales. The actual descriptors used may be influenced by language structure and shall be established with subject experts from national member bodies.

NOTE 4 International usage and acceptance of the scales in this International Standard will result in the fixing of suitable wording of the degrees on the scales in various languages.

Other judgement scales are in use concerning the state of various parts of the body (e.g. head, torso,

hands, feet), the total environment or various components of it, other aspects of the experience of the person or evaluations conducted over a certain period of time, including periods during which conditions have not been measured. Other scales, e.g. a bipolar affective evaluation scale, have been structured differently on the model of perception; such a scale is useful for taking into account pleasure and is more sensitive than the unipolar discomfort scale in the region near to comfort.

This International Standard is limited to the five scales described in clauses 4 and 5. The gathering of subjective judgement should first be concerned with localized sensations (parts of the body) and in constant conditions, given the current interest and application of these data. The second concern should be for data gathered under transient conditions, which are extremely important but are not yet sufficiently well known.

4 Perceptual, evaluation and preferential judgement scales

4.1 Instructions for using the judgement scales

It is important to distinguish between more objective ratings such as sensation, and affective or evaluative ratings such as comfort and pleasure. In everyday languages, however, these dimensions are often confounded, and distinctions are not made. In addition, the richness of the semantics for describing environments and responses to them will depend on individuals, their experiences, their language and their culture. When investigating physical environments, therefore, it is sometimes useful to first investigate the psychological dimension (or constructs) which individuals and groups use to describe their world[3].

Two commonly used approaches are semantic differential techniques and personal construct theory methods. The methods invoke factor analysis or multidimensional scaling techniques to build a psychological model of the way in which physical environments are perceived and 'modelled' (represented in psychological space) by the person. Similar stimuli on a particular dimension (or

all combinations of dimensions) will be placed closed together in the multidimensional model of psychological space.

The form and method of administering the scales are important. For example, a continuous form of the scale would be to draw a line through all points on the scale where subjective terms are placed. This would allow a person exposed to the environment to choose values between ratings (e.g. between cool and cold, a rating of -1.6 on a thermal sensation scale.). In an analysis of the results, this would enable parametric statistics to be used. However, maybe the investigator does not consider that the data are 'strong enough' for this and is prepared only to use ordinal data (ranks) and nonparametric statistics. These and other points are of importance and for further information the reader is referred to a text on the design and analysis of surveys and on the use of subjective assessment methods (see Bibliography).

The psychological interaction when the scale is administered may also influence the results. Usually, the subjects are given the scale and are asked to tick the place which represent 'how they feel now', for example. It is important to avoid ambiguity, which may lead to a person providing his or her own interpretation, for example, what the environment is generally like or how other people may perceive it. Other issues include range effects-the range provided, (e.g.for example, hot to cold) influences the subject's judgement as do leading questions: (e.g. 'you are uncomfortable aren't you?'). The following important issues should be considered when constructing questionnaires: question specificity, language, clarity, leading questions, prestige, bias, embarrassing questions, hypothetical questions and impersonal questions. Other issues include whether knowledge of the results is given- for example, if responses are requested over time, is the subject informed of previous ratings that he or she made, and whether the ratings are given in the presence of others. In some circumstances, people may avoid extremes such as end points on scales or be influenced by the range presented.

Although subjective measurement techniques can be useful for measuring extreme environments, they should not be used as a primary measure in health and safety. In these conditions, the ability of a person to make a 'rational' subjective judgement may be impaired. While a subject must always be allowed to withdraw from an investigation, he or she does not have the overriding right to remain in it. It is the investigator's judgement as to whether he or she should remain exposed (based on physiological responses, etc.) even if the subject is willing (enthusiastic) to do so.

The three judgement scales should be applied in the following order: perceptual scale, evaluative scale, scale of preference. The combination of possible replies provides all the required information.

The following introductory questions should be posed:

— before applying the perceptual scale: "How are you feeling (at this precise moment)?" (followed by the replies from the scale);

— after the response given on the perceptual scale, and immediately before applying the evaluative scale: "Do you find this... ?" (followed by the replies from the scale);

— after the response given on the evaluative scale, and immediately before the application of the preference scale: "Please state how you would prefer to be now" (followed by the replies from the scale).

A 7-degree scale should be applied in the case of environments judged to be close to neutrality; a 9-degree scale should be applied in the case of environments judged to be more intense.

NOTE 5 It is recommended that the full scales be presented, even in cases of surroundings located only in a limited range of conditions. The wording of all the degrees of a scale provides a frame of reference useful to those asked to verbalize their instantaneous experience.

There is utility to the investigator to consider a large number of environmental impacts and a variety of scales. However, the desire for data must be balanced with the willingness of the participants to provide accurate perceptions, and management's tolerance for the use of the time required. The survey may be most acceptable if it is focused on legitimate environmental concerns specific to the environment in question. The scales used and ergonomic aspect assessed must get to the point and provide actionable data.

4.2 Scale of perception of the personal state

4.2.1 Structure of the scale

Scales can be unipolar or bipolar.

For a unipolar scale a 4-degree one-pole scale, which can be extended to 5 degrees, with a point of origin indicating the absence of the effect, and 3 (or 4) degrees of increasing intensity of the effect.

Point of	Degrees of	
0	1 2 3 (4)	Unique pole
origin	intensity	

For bipolar scales, a symmetrical 7-degree two-pole scale, which can be extended to 9 degrees, comprising a central indifference point and two times 3 (or 4) degrees of increasing intensity.

	Degrees	Point	Degrees	
Pole A	(- 4) – 3 – 2 - 1	0	+ 1 + 2 + 3 (+ 4)	Pole B
	of intensity	of indifference	of intensity	

4.2.2 Wording of the degrees

The poles A and B are at either end of the scale. The central point of indifference corresponds to absence of sensation. The wording of the degrees will depend on the vocabulary choices in each language. The selection of the terms should be carried out carefully and tested beforehand on a representative number of persons who are native speakers of the given language.

The following wordings should be taken as an illustration:

— for languages which have several (at least two) distinct terms to denote different degrees of intensity these terms will be used along the lines of English wording;

— for languages which do not have two terms for denoting different degrees of intensity for each of the poles, a single term will be used for each pole and its intensity modulated by the use of adverbs along the lines of French wording.

Note Table A.1 and Table C.1 give examples for each case.

4.3 Evaluative scale

4.3.1 Structure of the scale

A 4-degree one-pole scale, which can be extended to 5 degrees, with a point of origin indicating the absence of the effect, and 3 (or 4) degrees of increasing intensity of the effect.

Point of	Degrees of	
0	1 2 3 (4)	Unique pole
origin	intensity	

4.3.2 Wording of the points

The unique pole devoted to the evaluation of the load denotes a negative effect: DISPLEASURE,

