
**Ergonomics of human-system
interaction —**

Part 393:
**Structured literature review of
visually induced motion sickness
during watching electronic images**



This document is a preview generated by EMS



COPYRIGHT PROTECTED DOCUMENT

© ISO 2020

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

	Page
Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Theories of visually induced motion sickness	2
5 Measurement of visually induced motion sickness	3
6 Effective factors of visually induced motion sickness	8
6.1 General.....	8
6.2 Effective factors: Visual image factors.....	8
6.2.1 General.....	8
6.2.2 Role of visual motion.....	9
6.2.3 Real and virtual motion.....	10
6.2.4 Constant rotation of global image motion.....	11
6.2.5 Change of velocity of global image motion.....	14
6.2.6 Cyclic rotation of global image motion.....	16
6.2.7 Cyclic translation of global image motion.....	17
6.2.8 Velocity effects of forward motion with complicated motion.....	18
6.2.9 Off-axis rotation of visual yaw rotation.....	20
6.2.10 Combination of different axes of visual motion.....	22
6.2.11 Anisotropy effects of back and forth translation.....	25
6.2.12 Spatial frequency of visual image.....	26
6.2.13 Spatial pattern of visual image.....	27
6.2.14 Independent visual background from visual motion.....	28
6.2.15 Chromaticity of visual image.....	29
6.2.16 Blur of visual image.....	30
6.2.17 Cognitive orientation cues of visual image.....	31
6.2.18 Stereoscopic image.....	32
6.2.19 Prediction signs for motion.....	38
6.3 Effective factors: Visual environmental factors.....	41
6.3.1 General.....	41
6.3.2 Image size in visual field.....	42
6.3.3 Perspective difference between capturing and rendering images.....	45
6.3.4 Time delay in HMD.....	46
6.3.5 Duration and repeated exposure to visual stimulus.....	48
6.3.6 Changes in illumination colour.....	49
6.3.7 Auditory stimulation.....	51
6.3.8 Odour simulation.....	52
6.4 Effective factors: Individual viewer factors.....	53
6.4.1 General.....	53
6.4.2 Gender.....	54
6.4.3 Gender – Menstrual cycle -.....	57
6.4.4 Age.....	58
6.4.5 Active/Passive viewing.....	59
6.4.6 Fixation.....	60
7 Susceptibility probability of motion sickness	62
8 Scaling of VIMS severity	63
9 Summary	65
Annex A (informative) Overview of the ISO 9241 series	66
Annex B (informative) Scaling symptoms severity induced by visual motion	67

Annex C (informative) Effective factors from the viewpoint of image production	69
Bibliography	78

This document is a preview generated by EVS

Foreword

ISO (the International Organization for Standardization) 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 organizations, 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 standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 159, *Ergonomics*, Subcommittee SC 4, *Ergonomics of human-system interaction*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

A list of all parts in the ISO 9241 series can be found on the ISO website.

Introduction

Recent advancements in moving image technology have enabled us to view and interact with images using various display devices and in various ways. Moreover, application fields are not limited to entertainment but also to other business scenarios with the expectation to expand to more ambitious applications.

In terms of the expansion of application fields and utility forms, the role of video images serving society has become increasingly important. Thus, it has become necessary to consider the ergonomic aspects of utilizing video images in view of further progressive expansions. In relation to ergonomic aspects, we need to consider not only the specifications of devices but also those affecting image safety, including those for reducing visually induced motion sickness, or VIMS. VIMS, which is similar to motion sickness, is usually recognized as simply being a minor annoyance from which those being affected would recover in the short term. However, some people experiencing this sickness suffer from vomiting or ataxia, and thus, are incapacitated.

Yet, the ambitious production of moving images and the use of those images should not be hindered by considerations to reduce VIMS. Major factors causing VIMS are considered to be visual motion of various kinds in moving image. In addition, visual motion in moving images conveys various types of information, for example, the psychology of characters captured by camera work producing various types of visual motion. For moving images shown to the public and those produced by professional staff, VIMS is presumed to be carefully considered based on empirical knowledge. Besides, adventurous trials can sometimes be necessary to drive forward ambitious moving image production and the use of those images. Moreover, in the absence of empirical knowledge, the uncharted territory of visual effects can come into existence through technical innovations. Although image safety is naturally important, these progressive approaches should not be fully restrained. The issue can be addressed by advancing moving image technology based on an understanding of the characteristics of VIMS. Thus, it is highly important to accumulate scientific knowledge on VIMS. This will encourage attempts to ambitiously produce moving images while considering image safety, which can be expected to lead to further development in the effective use of moving images.

With a view to international standardization for reducing the incidence of VIMS, this document attempts to summarize the scientific knowledge of VIMS by presenting an effective procedure for developing an advanced understanding of VIMS. This is achieved from the viewpoint of empirical knowledge on VIMS obtained during the production of moving images. This document categorizes related scientific knowledge on the ergonomic characteristics of VIMS, and clarifies the conditions under which VIMS can be induced and ways to reduce it. These actions are expected to develop the basis for ambitious moving image production and the use of these images. Furthermore, the work is expected to provide effective and basic data to allow VIMS to be studied together with a discussion of the guidelines focusing on VIMS.

While this document basically focuses on scientific knowledge of VIMS, postural ataxia or disorientation as an aftereffect of visual exposures especially to virtual environment, is another related issue and is even more important from the viewpoint of safety in daily life. However, this document cannot directly deal with the issue because of shortages of scientific reports on it. This should be further examined, and scientific knowledge of the characteristics should be accumulated.

This document does not include any guidelines. Moreover, this document is based on up-to-date data of the ergonomic characteristics of VIMS and can be revised as new scientific data become available.

Ergonomics of human-system interaction —

Part 393:

Structured literature review of visually induced motion sickness during watching electronic images

1 Scope

This document gives the scientific summaries of visually induced motion sickness resulting from images presented visually on or by electronic display devices. Electronic displays include flat panel displays, electronic projections on a flat screen, and head-mounted displays.

Different aspects of human-system interaction are covered in other parts of the ISO 9241 series (see [Annex A](#)).

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

visually induced motion sickness

VIMS

motion sickness-like symptoms induced by perceived motion within the visual environment, such as when watching movies and screen images of video games

Note 1 to entry: The symptoms may include *dizziness* (3.2), *vertigo* (3.3), sweating, odd feelings in the stomach, and nausea which can progress to vomiting.

3.2

dizziness

physical unsteadiness, lack of balance or light-headedness

3.3

vertigo

sensation of rotation or movement of oneself (subjective vertigo), or of rotation or movement of one's surroundings (objective vertigo), in any plane, caused by diseases of the inner ear, or by disturbances of the vestibular centres or pathways in the central nervous system

3.4

postural ataxia

inability to coordinate voluntary movements for maintaining posture, caused by dysfunction to sensory nerve inputs, motor nerve outputs, or the processing of them