A Multidimensional Concept of Mental Workload: A Systematic Review

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Abstract

The concept of mental workload is fully used and leads to various theoretical and methodological models. For this purpose, we are conducted in the same way as a systematic review for understanding the concept and a factor that identifies work and work situations that affect personal tasks, or mental workload field. A systematic review was obtained from scientific papers issued from 2010-to 2021. Mental workload is multidimensional, so that a conceptual definition of mental workload should therefore integrally encompass the most elementary dimensions of mental workload. In general, most factors affected mental workloads, including working environments, individual differences, temporal pressure, and task difficulty/compliance complexity. Techniques for assessing subjective workloads are popular in several studies because of their ease of use and sensitivity to workload fluctuations. The NASATLX scale is the most common subjective technique and is used in a wide range of fields. Subjective and objective measurements cannot even measure all kinds of factors that affect mental distress. The main difficulty facing researchers is establishing standardized measurements of mental workload and its normal range so that effective comparisons can be made between groups of subjects. These results can provide measurement development recommendations using three approaches: subjective, objective, and behavioral.

Keywords: *mental workload; measurement; workload factors*

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Introduction

Workloads are considered an important factor in assessing the usability of a system and are currently widely used in the industry to identify the cause of errors and improve performance (Jeffri dan Awang Rambli, 2021). The workload cannot be observed directly. Instead, it is an abstract property of human-machine interaction derived by multiple methods, including subjective reporting, psychophysiological measurements, and the performance itself (Vidulich & Tsang, 2012). Workload assessment in all practical contexts requires reliable and valid metrics. From a theoretical point of view, workloads are characterized in terms of the demands made by

the task on the operator's limited information processing resources (Matthews dkk, 2014). Mental workload is a complex, multidimensional, multifaceted configuration with no generally accepted definition. The term "what is a mental workload" has been raised by many researchers for over 20 years. However, due to its multidimensional and complex nature, there is not yet a single comprehensive definition of the concept (Jeffri dan Awang Rambli, 2021). On the other hand, if one accepts that the human mind (mental ability) has a limit on the speed at which information can be processed, the mental workload can be considered as a percentage of that ability being used at any given time. Despite this, mental workloads cannot be considered as a single component (Byrne dkk, 2014).

Mental workload has thus become a topic of increasing importance as modern technology imposes ever greater cognitive demands (Young dkk, 2015). There has been much debate about the issue of acceptable definitions of MWL for structuring the measurement process (Sharples and Megaw, 2015). One of the reasons to study mental workload is to establish a relationship with operator performance. Performance can be an indicator of mental workload, but performance failure can also increase workload awareness (Young dkk, 2015). It has been suggested that mental workload is strongly associated with human performance, and the current consensus is that both excessively high and excessively low mental workloads adversely affect performance (Marinescu dkk, 2018). Increasing work intensity creates a mental overload and reduces the amount of work. Therefore, in order to improve the well-being and safety of workers in the workplace, it is essential to study the factors of mental workload and how they interact (Galy dkk, 2012). The various mental workload assessment techniques that have been used over time are in two main categories: subjective (questionnaire and rating scale) and objective (stand-alone performance measurement, secondary task measurement, or physiological data), each having its advantages and disadvantages (Marinescu dkk, 2016).

Several factors in the work environment negatively impact an individual's performance and health. Such negative factors and situations have to be minimized in order that people can work without heavy workloads or pressure In order to minimize these negative factors and conditions, it is necessary to properly understand the characteristics of a particular profession. Determining total work exposure is an important step in designing a work environment or occupational characteristics that lead to the overall physical and mental exposure of employees. Of the overall

workload, the mental workload is a prominent variable in some professions that require a high level of attention, motivation, judgment, and evaluation (Ozkan dkk, 2015). Psychological stress assessment is an important aspect of professional task design and assessment. The excessive mental workload can lead to errors or delays in information processing, especially if the amount of information presented exceeds the processing power (DiDomenico dan Nussbaum, 2011). In the workplace, the mental workload can be assessed by assessing psychophysiological factors, task performance, and self-reported questionnaires or measures (Galy dkk, 2012).

Past research in this area has focused predominantly on assessing the influence of physical demands on cognitive performance but has yielded inconclusive results. While certain aspects of a mental task appear to have differential influences on mental workload indexes, the effects of concurrent physical demands have not been fully investigated. The extent to which different types of physical tasks affect performance and mental workload assessment has yet to be determined. While there are several assessment measures available that have been used extensively to assess mental workload (e.g. heart rate variability, eye movement, and NASA Task Load Index), there has been little investigation of the validity of current assessment tools during situations that require concurrent physical and mental demands (DiDomenico dan Nussbaum, 2011).

As Longo (2015) notes, various definitions have been suggested, but all include different workload variables based on different fields of application, beliefs, and even intuition. As a result, all these different, arbitrary conceptualizations only add to the confusion about the understanding of mental workload. Accordingly, the current literature urgently requires a critical reconsideration of the conceptualization of mental workload (Van Acker dkk, 2018). For that, we conducted a systematic review to understand the definition and how factors characterizing an individual, a task, or a work situation influenced mental workload. Specifically, the review set out to answer the following questions: What is the definition of mental workload based on an expert opinion? What kind of unrevealed factors are related to mental workload? What are the types of mental workload measurement instruments? What factors have not been measured in the instrument?

Method

The results of this review are reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to design the present study and report the review findings (Moher dkk, 2009; Shamseer dkk, 2015). All authors provided input during the systematic review, and the protocol was revised accordingly.

Eligibility Criteria

Inclusion and exclusion criteria were developed before commencing the selection of studies. A study that was eligible for inclusion included peer-reviewed journal articles, conference papers, books, and technical reports, written only in English and discussing the mental workload concept directly. Exclusion criteria were lack of information on mental workload and low relevance in the studies.

Information sources and database search

As input to the concept analysis methodology, first, a literature study is to be performed collecting all relevant sources. A literature search was conducted in January 2022, using MEDLINE (PubMed), ScienceDirect, PsycINFO (EBSCO), ACM Digital Library (ACM Journal), IEEE Xplore (Digital Library), International Prospective Register of Systematic Reviews (PROSPERO), and Cochrane Database of Systematic Reviews (EBSCO) databases. All studies published from 2010 to December 2021 were considered and no restriction was imposed regarding language or study design. A search strategy included combinations of key search terms related to the concept, factors, measurement, and types of studies along with relevant studies. The team then produced additional search terms that were added to the list, including adjustments made to accommodate each database. The final search strategies for the separate databases were discussed with two research librarians before commencing the search in January 2022. The text words from the MEDLINE search strategy were adapted to other databases according to the specific syntax required. In addition, a hand search of references cited in the studies and reviews was conducted to ensure literature saturation.

Search strategy

A search strategy included combinations of key search terms related to the concept, factors,

measurement, and types of studies along with relevant studies. In our case, a literature search using combinations of the following keywords: *mental* and *load, workload, effort, subjective, objective, measurement.* The team then produced additional search terms that were added to the list, including adjustments made to accommodate each database. The final search strategies for the separate databases were discussed with two research librarians before commencing the search on Feb 2nd, 2022. For the full search strategy applied to PubMed, see Supplementary materials. The search strategy was supplemented by reviewing the reference lists of included articles. Searches were restricted to English language publications of research articles. Books and posters were excluded.

Selection process

Only original articles published in peer-reviewed journals were considered. Studies were included that used at least one cognitive load measurement involving senior surgeons, surgical trainees, or medical students performing surgical procedures. Studies that did not assess mental workload related to the intraoperative phase and studies that measured physiological data without intent to infer a relationship with mental workload were excluded. Two authors screened the title and abstract for all search results independently and identified relevant articles based on the eligibility criteria. For these articles, the full text was read by both investigators independently, who then decided whether the study met the inclusion criteria for the systematic review. The reason for excluding articles after full-text reading was registered. Using standard forms created in the REDCap web-based platform21, two authors extracted specific data from each study included in the systematic review independently. In case of disagreement, a third author was consulted.

Study risk of bias assessment

Across studies, there is a risk of publication bias as the search was restricted to reports in English and did not include grey literature. For review, two authors independently evaluated the methodological quality of the studies identified using the Joanna Briggs Institute Critical Appraisal Tool (Tufanaru dkk, 2019). The initial screening of studies that can be included shows only a small portion of studies with well-defined criteria for the design of experiments and implementation of studies and analysis of data.

Result

A total of 551 articles were captured in the broad search strategy, involving eight different databases. From these, 391 met eligibility criteria during screening, and 21 met inclusion criteria after full-text review (Fig. 1). Pooling of data in a meta-analysis was not carried out owing to the heterogeneity regarding assessment methods and outcome measures.

Study design and setting

Fifteen (75 percent) were a review or systematic review and six (25 percent) a quantitative or cross-sectional. Most of the participants in this study were operators, drivers, and health worker.

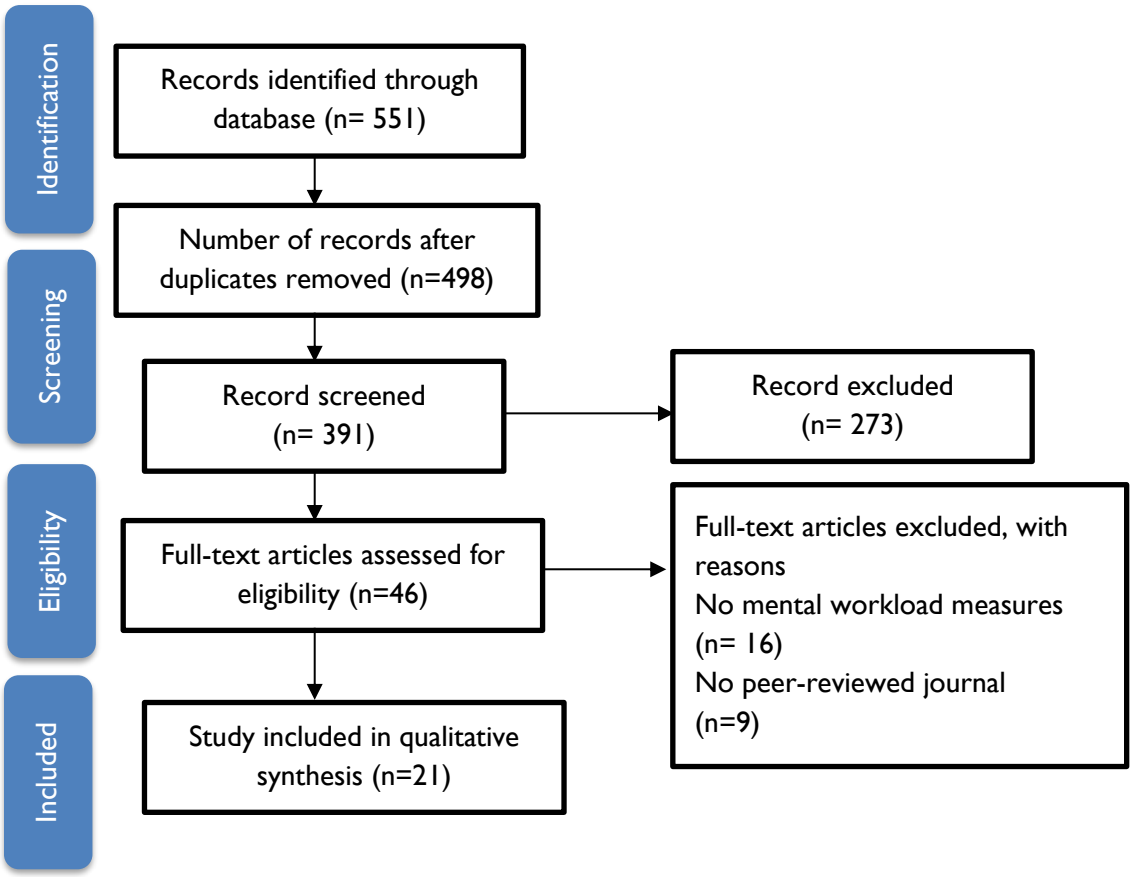

Figure 1. Flow Chart of Study Selection

Mental workload definitions

The concept of mental workload comes with a plurality of definitions, which depend mainly on the context of the study. Globally, it can be described as "how hard the brain is working to meet task demands"(Marchand dkk, 2021). Mental workload can be considered as the "demand placed on the user by the system". However, the mental workload depends on many parameters, notably on the intrinsic difficulty of the task performed but also on the subjective experience of the user. Thus, for the same task, two people will not have the same mental workload, depending on their initial capacities, their experience, their reaction to time pressure or fatigue (Marchand dkk, 2021).

Table 1. Overview the concept of mental workload

Researcher	Title	Definitions
Jeffri dan Awang Rambli (2021)	A review of augmented reality systems and their effects on mental workload and task performance	Interaction between the demands imposed by the task and the performance on the human's limited mental resources or an intervening variable, that modulates or indexes the tuning between the demands of the environment and the capabilities, and motivation of the human.
Byrne (2011)	Measurement of Mental Workload in Clinical Medicine: A Review Study	Mental workload is a concept that may be used as a method of assessment, to determine the effect of training, and perhaps also as a component of performance assessment.
Hertzum dan Holmegaard (2013)	Perceived Time as a Measure of Mental Workload: Effects of Time Constraints and Task Success	The mental workload can be conceptualized as the interaction between the structure of systems and tasks on the one hand, and the capabilities, motivation, and state of the human operator on the other "a function of the supply and demand of attentional or processing resources"
Wihardja dkk (2019)	Analysis of factors related to the mental workload of nurses during interaction through nursing care in the intensive care unit.	Mental workload is closely related to motivation that has been proven to be a fundamental value and internal stimulus that moves and instructs an individual toward responding to occurrences related to that individual
Galy dkk (2012)	What is the relationship between mental workload factors and cognitive load types?	Mental overload can be the result of a combination of task characteristics, such as time pressure and task difficulty, but its occurrence appears to depend on other characteristics, including alertness.
Braarud, P. Ø. (2020)	An efficient screening technique for acceptable mental workload based on the NASA Task Load Index—development and application to control room validation	The workload is well recognized as a multi-dimensional construct. However, for control room work, the results suggest that the main element of subjective workload can be represented by a singular item. The relatively high mean scores of mental demand, effort and time pressure compared with those of physical demand and frustration suggest that these three dimensions represented workload aspects that could be related to team performance issues.
Rusnock dan Borghetti (2018)	Workload profiles: A continuous measure of mental workload	The effort experienced by the operator when performing a task is affected by context and external factors. The context of the operator that affects the workload contains individual skills (physical and mental), training, experience, fatigue, stress, and character. External factors that affect workloads include environmental factors such as task volume, task issues, available times, and temperature and lighting.
Ozkan dkk (2015)	Effects of mental workloads on depression–anger symptoms and	Mental workload also includes mental stress encountered while performing a specific task that requires perception, calculation, and similar activities. Six

Researcher	Title	Definitions
	interpersonal sensitivities of accounting professionals.	dimensions of mental workload, are mental stress, physical stress, time limitation stress, effort, performance, and tension.
Bommer dan Fendley (2018)	A theoretical framework for evaluating mental workload resources in human systems design for manufacturing operations	The concept of MWL is related to the difference between the number of resources available to a person and the number of resources required for a task. High MWL values occur at points where task requests exceed the operator's capacity. Interaction between the operator and an assigned task is an important tool for creating awareness of where increased task requests can adversely affect human performance.
Van Acker dkk (2018)	Understanding mental workload: from a clarifying concept analysis toward an implementable framework	Mental workload is a subjectively experienced physiological processing state, revealing the interplay between one's limited and multidimensional cognitive resources and the cognitive work demands being exposed to
Longo (2015)	A defeasible reasoning framework for human mental workload representation and assessment.	Mental workload is believed to be multidimensionality, hypothetically, context-awareness, user-specificity, task-specificity, relationality, Preferentiality, subjectively, uncertainly, partially,
Galy dkk (2018)	Measuring mental workload with the NASA-TLX needs to examine each dimension rather than relying on the global score: an example with driving.	The operator's ability to meet task demands with his/her available resources
Mohammadi dkk (2016)	Evaluation of Mental Workload among ICU Ward's Nurses.	The mental workload in nurse's ICU context is related to mental demand, as work environments become more complex and new technologies are used by health care workers, the mental demand of these occupational groups is increased
Alexandre dkk (2016)	A dynamic closed-looped and A multidimensional model for Mental Workload evaluation	The mental workload can be seen as a multidimensional construction, since some variables are drivers, while others are mediators (cause-based analysis) or indicators (consequence-based analysis). The perception process is central in the model that guides the behavior of the operator. However, this dynamic and reflexive evaluation of the situation is complex and very difficult to measure. To improve our understanding of this black box "perception", we investigate the regulation loops.
Di Stasi dkk (2011)	Main sequence: An index for detecting mental workload variation in complex tasks	Mental workload (or cognitive load) is the term used to describe the mental cost of accomplishing task demands
Mandrick dkk (2016)	Why a Comprehensive Understanding of Mental Workload through the Measurement of Neurovascular Coupling Is a Key Issue for Neuroergonomics?	Mental workload is a set of mental and composite brain states that modulate human performance in different perceptual, cognitive, and/or sensorimotor skills. It is also considered a construct used to reflect the relation between the demands of the environment (input load), the human characteristics (capacities), and the task performances (output performance).
Fallahi dkk (2016)	Effects of mental workload on physiological and subjective responses during traffic density monitoring: A field study.	An operator of traffic control MWL or just workload "is the general term used to describe the mental cost of accomplishing task requirements"
Van der Kleij dkk (2018)	Change detection support for supervisory controllers of highly automated systems: Effects on performance, mental workload, and recovery of situation awareness following interruptions	Mental workload defined as the ratio between the task demands and the capacity of the operator working on the task. According to their definition, mental workload is high when the difference between task demands and capacity is small.

Researcher	Title	Definitions
Wickens dkk (2021)	Engineering Psychology and Human Performance	The demands of tasks, that require the limited information processing capability of the brain, in much of the same way that physical workload characterizes the energy demand upon the muscles

Factors related to Mental Workload

Generally, most factors affected mental workload including working environment, individual differences, time pressure, and task difficulty/task complexity. Task complexity (defined as a function of objective task characteristics) is one of the most essential factors affecting performance, most frequently energy regulation, such as the energy demands of the task.

Table 2.
Factor Influencing to Mental Workload

Factors	Description	Studies
Job factor	An assessment of the diversity of assignments, job identity, work time, work environment, and work feedback.	(Hertzum dan Holmegaard, 2013; Wihardja dkk, 2019) (Alexandre dkk, 2016; Jeffri dan Awang Rambli, 2021; Mohammadi dkk, 2016; Ozkan dkk, 2015; Rusnock dan Borghetti, 2018)
Organizational factor	Include an assessment of the complexity, formalization, and centralization of the workplace organization	(Longo, 2015; Mohammadi dkk, 2016; Van Acker dkk, 2018; Van der Kleij dkk, 2018)
Motivation	Intrinsic motivation includes subjective judgments regarding achievement, endeavor, and meaningfulness, while extrinsic motivation comprises subjective judgments regarding salary, work environment, supervision, and rew.	(Hertzum dan Holmegaard, 2013; Jeffri dan Awang Rambli, 2021; Longo, 2015; Wihardja dkk, 2019)
Task complexity	Task-specific factors, such as time limits, structural limitations, resource limitations, and required starting conditions should be built into the model logic by the modeler. Task success and task failures can also be captured, and can be based on numerous conditions including task time, task accuracy, probabilities, or complex model logic	(Bommer dan Fendley, 2018; Braarud, 2020; Galy dkk, 2018; Rusnock dan Borghetti, 2018)

Assessment tools

The workload measurement methods used in this study are shown in table 3. Most studies used only one tool to measure mental workload and the remaining applied two or more methods.

Table 3
Different methods used to asses mental workload

Measurement	No. of studies
Self-reported (*post hoc*)	
NASA Task Load Index (NASA-TLX)	14
Surgery Task Load Index (SURG-TLX)	2
Borg scale	1
Subjective Workload Assessment Technique (SWAT)	3
Improved Performance Research Integration Tool (IMPRINT)	2
Situation Awareness Rating Technique (SART)	2
Other validated questionnaires	5
Physiological parameters / Real Time	
Heart rate variability	3
Eye-tracking (blink rate)	2
Eye-tracking (pupil dilation)	3
Electroencephalography	4
Functional near-infrared spectroscopy	3
Skin conductance response	2

The most commonly used subjective (self-report) instrument was the NASA Task Load Index (NASA-TLX), used in 60% of studies. This is a multidimensional assessment tool that has been used in a wide variety of domains, such as healthcare, aviation and other high-risk industries. The overall workload is calculated by weighting, adding or averaging each domain rating. The NASA-TLX instrument can be administered verbally, using a paper and pencil version, or by a computer-based application. Subjective workload assessment technique (SWAT) only mentioned in 3

studies. The remaining studies used objective and real-time measurements of mental workload. The most commonly used real-time measure was heart rate variability (HRV) analysis.

Discussion

This systematic review attempted to collect all relevant studies to date dealing with the concept of mental workloads. The overview shows that several methods have been developed with different expert groups, procedures, techniques, task complexity, and training. Tools can be self-assessed or categorized in real time, depending on the type of implementation.

Definitions of Mental Workload

Mental workload concept resides in more specialized areas and is mostly used in the context of ergonomics, human factors, educational psychology and cognitive sciences. Mental workload is multidimensional, so that a conceptual definition of mental workload should therefore integrally encompass the most elementary dimensions of mental workload. According to Van Acker dkk (2018) scaffold a conceptual definition onto the following four proposed elementary dimensions of mental workload: cognitive work demands interacting with the human cognitive architecture, inducing cognitive physiological processing and a cognitive subjective experience. Meanwhile, according to Galy dkk (2018); Young dkk (2015) mentioned that mental workload is composed to two dimensions: task demands and the context in which the task is executed. Another researcher revealed six dimension of mental workload, these are: mental stress, physical stress, time limitation stress, effort, performance, tension (Ozkan dkk, 2015).

Based on table 1, numerous definitions and interpretations of mental workload have been mentioned, but many of them agree on the fact to consider two components, stress and strain. Stress concerns task demand and strain concerns impact on the individual (Fallahi dkk, 2016; Galy dkk, 2012; Longo, 2015; Ozkan dkk, 2015). Mental workload reflects the amount of attention resources required to perform a task as a function of task requirements, the environmental context in which the task is performed, and the individual's previous experience with the task (Galy dkk, 2018; Young dan Stanton, 2004). As stated by Cain (2007) “As such, mental workload is an interim measure and one that should provide insight into where increased task demands.” Therefore, it is not possible to define mental workload without also clearly characterizing mental

resources (Mandrick dkk, 2016).

Factors affected mental workload

Mental workload factor on the operator gives a different view. In such situations, the mental burden increases and the amount of information exceeds the processing capacity, which can cause the operator to delay information processing or become completely unresponsive to the information received. On the other hand, when the mental burden drops from a moderate level, it becomes boring and prone to making mistakes (Fallahi dkk, 2016; Longo, 2015).). In today's real-world, accountants are exposed to very high levels of psychological stress. Their work requires great care and attention, and should be error-free. The constant change of law, the maintenance of the company's daily accounting, the importance of timing and similar factors continue to increase the mental burden on accountants (Ozkan dkk, 2015). In line with nurses who working in Intensive Care Unit are experiencing a great amount of stress. These individuals have more responsibilities and time constraints increase their physical and mental workload (Wihardja dkk, 2019). Specifically, Mohammadi dkk (2016) mentioned another factor such as physical environment (noise, amount of space), family relations (distractions caused by family, lack of time to spend with family), and equipment (unavailability, misplacement).

According to a recent study, busy workplaces, poor quality medical supplies, and waiting to use the device for someone else's use are three barriers that are highly correlated with physical stress. This may be an explanation for the high physical demands of workers in the intensive care unit (Mohammadi dkk, 2016). When it comes to operator field, team performance became a comprehensive theme for human factors validation. The relatively high mean scores of mental demand, effort, and time pressure compared with those of physical demand and frustration suggest that these three dimensions represented workload aspects that could be related to team performance issues (Braarud, 2020). In ergonomics context, the mental workload required to meet both objective and subjective performance criteria. Performance standards may be imposed by external authorities or may represent an individual's internal goals. In the meantime, external support may be provided in the form of peer support and technical tools (Young dkk, 2015). Generally, most factors affected mental workload including working environment, individual differences, time pressure, and task difficulty/task complexity. Task complexity (defined as a

function of objective task characteristics) is one of the most essential factors affecting performance, most frequently energy regulation, such as the energy demands of the task (Di Stasi dkk, 2011).

Measurement

Subjective workload assessment techniques are popular due to their ease of use and sensitivity to workload variations in several studies. The NASA-TLX scale is the most popular subjective technique, and the scale has been used in a wide variety of domains (Grier, 2015). NASA-TLX instruments as a subjective measure alongside objective measurements of task performance which includes six subscales exploring the Mental Demand, Physical Demand, Temporal Demand, Own Performance, Effort, and Frustration Level (Braarud, 2020; Byrne dkk, 2014; Hertzum dan Holmegaard, 2013; Jeffri dan Awang Rambli, 2021; Ozkan dkk, 2015; Van Acker dkk, 2018). Subjective workload assessment technique (SWAT) instrument consists there are 3 dimensions that must be measured of mental workload: Time Load, Mental Effort Load and Psychological Stress Load (Galy dkk, 2012; Longo, 2015; Van der Kleij dkk, 2018).

Finally, a wide variety of measures starts from the knowledge that the mental processes entailing mental workload are physiological in essence. In (near) real-time, electroencephalography (EEG), event-related potentials (ERP) derived from EEG and functional near infrared spectroscopy (fNIRS), for instance, can provide estimations of the electrical activity or cerebral blood flow to derive MWL levels from (Antonenko dkk, 2010; Ayaz dkk, 2012; Mandrick dkk, 2016; Mehta dan Parasuraman, 2013). Other measures such as electro-dermal activity (also coined 'galvanic skin response'; (Boucsein, 2012), heart rate variability (Shakouri dkk, 2018) or pupillometry (Backs dkk, 2003; Hertzum dan Holmegaard, 2013) try to capture reactions of the autonomous nervous system to approximate MWL. (Van Acker dkk, 2018). Whereas, instrument to measure nurse's mental workload on Intensive Unit Care using a Questionnaire of Performance Obstacles of ICUs Nurses: Questionnaire developed by Gürses and Carayon, was used to identify performance obstacles associated with ICU nursing (Gurses dan Carayon, 2009; Mohammadi dkk, 2016).

Each typology of measurement technique has its own advantages and disadvantages and is suitable for different contexts to different extents. Several criteria exist and have been proposed as

guidelines for selecting and developing techniques: *Sensitivity*: the methodology must have a high reliability in terms of sensitivity to changes in resource demand or task difficulty and in terms of discrimination capacity between significant variations in workload. *Diagnosticity*: the method should be highly diagnostic in that it must be capable of indicating the sources that cause variations in workload and of quantifying the contributions by type or resource demand. *Intrusiveness*: the methodology should not be intrusive or interfere with the performance of the task of the operator, becoming a source of workload itself (this property is referred to as *obtrusiveness*. *Requirements*: the methodology should require the minimum possible equipment to avoid influencing the operator's performance. *Acceptability*: the method should have a high level of operator acceptance, showing at least face validity. Face validity refers to what a concept superficially appears to measure, mainly testing whether it looks valid. It is in contrast with content validity – a more strict property that requires the use of recognized tests or subject experts for evaluating whether the items evaluated assess defined content. This includes statistical tests which are in general more rigorous than methodologies applied in face validity tests. View all notes without being onerous. *Selectivity*: the method should be selectively sensitive to differences in resource demand and not to changes in factors unrelated to MWL. *Bandwidth and reliability*: the assessment procedure should be reliable both within and across tests and it should be capable of rapidly detecting transient changes in workload levels (Ding dkk, 2020; Longo, 2015).

Accordingly, it is difficult to both define acceptable levels of workload and establish meaningful limits for screening purposes and for determining unacceptable workload. The six subscales of NASA-TLX are too time consuming for use in scenario breaks or in on-line evaluation, especially in applied settings in which workload can be one of several performance dimensions measured. It is important that measurements can be completed within a short time frame to limit the intrusiveness on the team's work. (Braarud, 2020). Objective measures of workload are more difficult to define, as theoretical approaches to the problem emphasize that workload has multiple aspects that may be measured separately. These aspects are often linked to specific neurological processes. For example, it is recognized that it is possible to a watch a monitor (visual task) while also listening to a conversation (auditory task). It is also possible to watch a monitor (sensory) and run through possible diagnoses (cognitive). However, it is difficult or impossible to listen to two conversations (auditory-auditory), watch two different monitors (visual-visual), or run

through diagnoses and calculate a drug dose at the same time (cognitive-cognitive). Effective measures of mental workload should be able to discriminate between mental workload produced by different types of tasks (diagnosticity) and different levels of difficulty (sensitivity). It is generally accepted that decreases in HRV (measured here using SDNN) reflect increases in mental workload when physical workload is negligible or consistent (DiDomenico dan Nussbaum, 2011).

Conclusion

This study provides a number of conclusions, several experts put forward different definitions of mental workload, and so are the factors that influence it. even each type of work has different factors according to the conditions and situations of the difficulty of the work. The most popular approaches to measuring mental workload are subjective and objective. Subjective and objective measurements are not even able to measure all types of factors that affect mental load. The principle difficulty faced by researchers is the establishment of standardized measures of mental workload and their normal ranges so that valid comparisons can be made between subject groups. In summary, the execution of a mental task with a concurrent physical task was altered by the magnitude of the physical demands required. Performing the physical tasks within this experiment required attentional resources and at times decreased cognitive performance, due in part to the tasks not being completely automatic, even for the highly controlled elbow flexion and knee extension. It is also recommended that multiple measures be used, and that primary workload be included. This is both because currently available methods are not adequate to use in isolation, and because workload can vary in unexpected way.

Limitations and future research directions

We cannot exclude that there are limitations to our review. The nature of this review is explorative, that is, our goal was to discover concept, factors and measurement of mental workload. Therefore, while we conducted the review with greatest attention to detail, we can never exclude the possibility of omitting a specific group of demands.

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