A Review of the Relationship between Mental Load and Work Performance

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Abstract. With the rapid development of network technology and information tools, enterprises have been embarking on digital transformation one after another. The mental load of employees has gradually taken the leading position. Therefore, understanding the relationship between mental load and work performance is of great significance for maximizing the role of knowledge workers to improve their work performance. This article will first conduct a comprehensive and systematic review of relevant domestic and foreign literature by using the systematic literature review method. Secondly, it will systematically summarize around three parts: the concept and connotation of mental load, theoretical basis, and the effect on work performance. Finally, on the basis of the above two aspects, it will conduct a literature review and put forward future research prospects.

Keywords: Mental load; Cognitive resources; Employee performance

1 Introduction

The measurement and assessment of workload have always been regarded as an important reference for organizations to optimize job design. In recent years, with the development of information tools, enterprises have gradually embarked on the digital track. This has led to the transformation of the type of employees required by enterprises into knowledge workers, and has placed higher demands on employees' cognitive abilities, as well as their capabilities in compiling, organizing, selecting and deciding information[1]. Employees have gradually completed the identity transformation from information receivers to information processors, and their workload has gradually shifted from being mainly physical to mainly mental. As the digitalization of enterprises deepens, understanding the relationship between mental load and job performance is of increasingly significant importance for organizations to optimize job design and thereby enhance employees' job performance.

Workload refers to the amount of work a person bears within a unit of time, including both physical and mental loads. By searching for the theme of "workload" within China National Knowledge Infrastructure (CNKI), there are a total of 2,591 journal articles. Narrowing down the theme to "psychological workload" for the search,

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it can be found that there are 834 articles, accounting for 32.18%.As can be seen from Figure 1, the number of papers published on psychological load has been over 30 each year in the past decade. It can be observed that psychological load has always been a hot topic of academic concern.

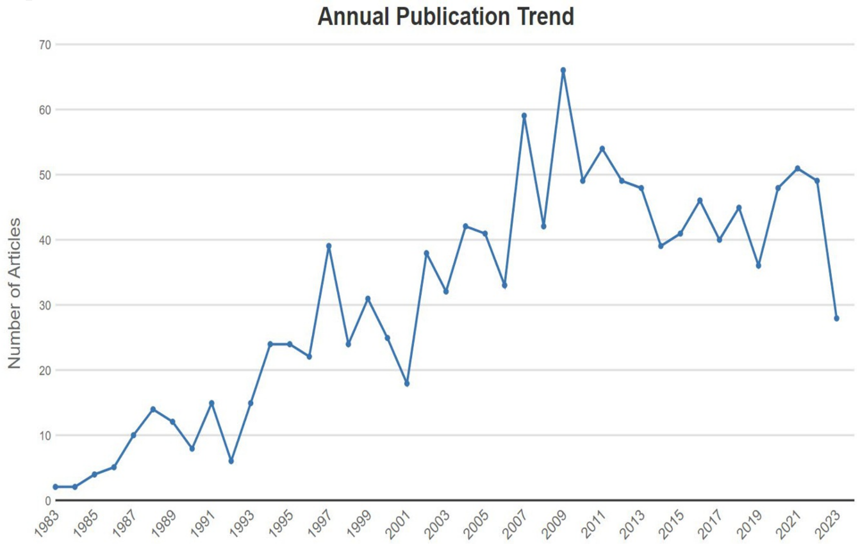

Fig. 1. Annual Trend Chart of the number of articles published on the theme of "Psychological Load".

Furthermore, when searching for "mental load" as the key term, it can be found that there are a total of 262 articles. By exporting them and using the VOSviewer tool to visually present the research focuses of the papers, it can be discovered that the research perspective on mental load is gradually shifting from an ergonomic perspective to an application perspective such as human-computer interaction combined with brain waves. Moreover, the research scope is mostly focused on traffic safety scenarios such as pilots, traffic attendants, and drivers.

Overall, research on mental load has made considerable progress and is showing an accelerating upward trend. At present, the research is still fragmented, scattered and lacks a unified overall analysis framework. In view of this, this study will be carried out in the following three aspects: (1) Use the systematic literature review method to comprehensively and systematically sort out and summarize the relevant domestic and foreign literature. (2) Systematically summarize around three parts: the concept and connotation of mental load, its theoretical basis, and the results of its impact on work performance. (3) Based on the above two aspects and in combination with the Chinese context, make prospects for future research.

2 Research Design

The systematic literature review method is a literature review approach that assesses existing literature through a replicable, scientific, and transparent process to reduce biases caused by subjective inclusion or exclusion of literature [2]. This paper adopts the following four steps for literature analysis, as shown in Figure 2; (1) Define the research question; (2) Determine the criteria for literature retrieval and literature screening; (3) Literature retrieval and screening; (4) Literature analysis.

To systematically and clearly explain the research in the field of mental load, this paper raises four questions:

(1) Determine the conceptual connotation of mental load.

(2) What are the methods for measuring and evaluating mental load? What are the respective advantages and disadvantages?

(3) What is the theoretical basis for the impact of mental load on job performance?

(4) What is the relationship between the size of mental load and the level of work performance?

Secondly, it is determined that the literature retrieval criteria of this paper are as follows: Search for the main English literature from the Web of Science with "mental workload" as the title word, and use Baidu Academic website to track and supplement the literature; Search for Chinese literature from China National Knowledge Infrastructure (CNKI) with the keywords "mental load" and "psychological load". The criteria for literature screening are: excluding articles whose actual content is not related to mental load. Exclude book reviews, editorials, call for papers and other documents; The selected literature types are empirical articles and review articles.

In terms of literature retrieval and screening, mental workload was first used as the subject term. According to the screening criteria, a total of 50 literatures were obtained by limiting the Web of Science Core collection and publication time. After reading the titles and screening the abstracts, 6 literatures were obtained. After that, I conducted a snowballing search on the Baidu Scholar website for important documents and read and screened them according to the screening criteria. Then, I supplemented four English documents. Regarding the retrieval and screening of Chinese literature, "mental load" and "psychological load" were used as key terms to search for literature in the academic journals limited by China National Knowledge Infrastructure (CNKI) and the CSSCI database. A total of 220 documents were obtained. Based on the screening criteria, 14 Chinese literatures were finally obtained. Finally, a systematic literature review method was used to analyze and comment on the concept of mental load, the development of measurement methods, theoretical basis and formation mechanism.

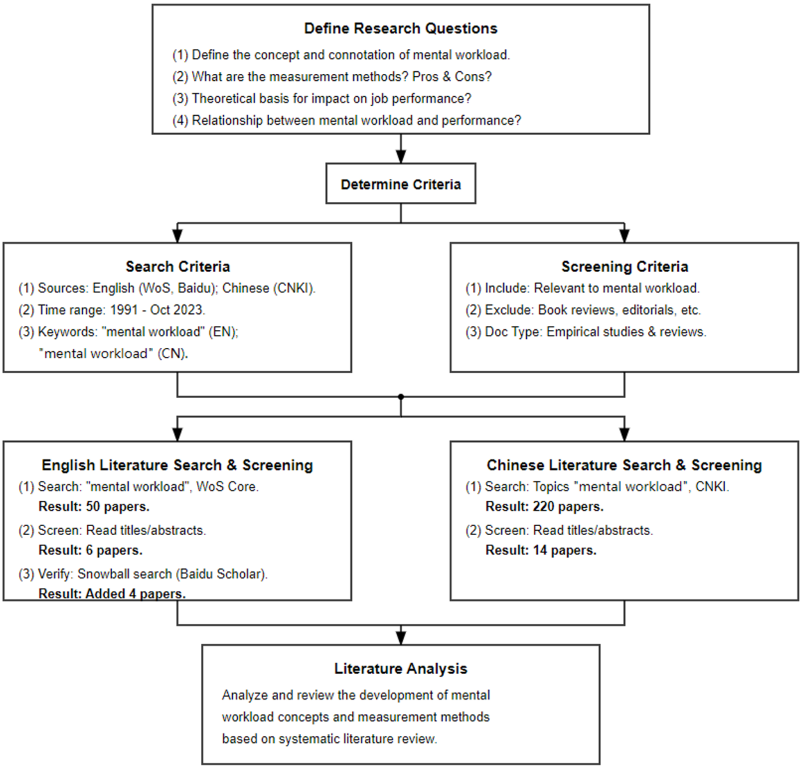

Fig. 2. Literature retrieval, screening process and results.

3 Mental Load

3.1 The Origin and Definition of Mental Load

Mental load was initially used as a concept corresponding to physical load, to describe the pressure people face when engaging in mental work, but mental load has not been strictly defined. At the North Atlantic Treaty Organization's academic symposium on mental stress, participants sought a generally accepted definition of mental stress, but soon found it difficult to categorize mental stress into a single definition[3]. Ultimately, they concluded that mental load encompasses numerous other factors such as task requirements, time pressure, the operator's ability and behavioral performance, and is a multi-dimensional concept. This conclusion has been widely accepted. A large number of scholars have carried out subsequent research and practice on this basis and provided their definitions of psychological load,as shown in Table 1.

Representative examples include: Hancock believes that mental load is the product of cognitive resources generated to meet task demands. If cognitive demands exceed production capacity, skilled operators can adjust their strategies to compensate; otherwise, job performance is bound to decline [3]. Young and Stanton believe that mental load reflects "the level of attention resources required to meet objective and subjective performance standards" [4], and is regulated by task requirements, external conditions, and personal experience. Liao Jianqiao, a domestic scholar, holds that mental load is an indicator for measuring a person's information processing system and is inversely proportional to the person's idle and unused information processing capacity [5]. He also points out that its definition links information processing capacity with mental load, making the measurement somewhat difficult.

Table 1. Definitions Related to Mental Load.

Scholar	Definition	Analytical Perspective
Hancock	Mental workload is the product of the cognitive resources expended to meet task demands.	Resource Balance
Young、Stanton	Mental workload reflects the level of attentional resources required to meet objective and subjective performance criteria.	Resource Demand
Liao Jianqiao	Mental workload is a metric for measuring an individual's information processing system.	Information Processing Capacity

In conclusion, mental load is a multi-dimensional concept. It can be roughly summarized as the extent to which resources are occupied by a person's information processing system when processing information during mental activities. These resources include time resources, cognitive resources, and attention resources, etc.

3.2 Summary of Methods for Measuring Mental Stress

In recent years, research on mental load has achieved rapid development and has been widely applied in practice. The research focus during this period was mainly concentrated on the measurement of mental load. This is because how to objectively, accurately and efficiently measure mental load is of great significance for optimizing task design, improving work processes, enhancing mental work efficiency and reducing error rates.

Researchers are dedicated to developing various methods and tools to measure mental load. At present, the methods for measuring mental load can be roughly divided into three categories, namely task performance measurement, physiological measurement, and subjective measurement. By combining different measurement methods, researchers can obtain multi-dimensional and multi-angle data on mental load, thereby better understanding the cognitive burden of individuals in cognitive tasks. In order to better apply the appropriate mental load measurement methods to the right situations, the methods are summarized, compared and concluded.

3.2.1 Task Performance Measurement.

Task performance measurement can be further divided into primary task measurement methods and secondary task measurement methods. The main task measurement is to calculate the mental load imposed on the operator by the performance results of the operator during the work [6]. The assumption of the main task measurement is that an increase in mental load will consume more mental resources, which are limited. This is reflected in the performance of the main task as an increase in error rate, a decrease in efficiency, and a decline in performance. Table 2 summarizes the common main task types and measurement indicators.

Table 2. Summary of Common Main Task Measurement Scenarios.

Task Type	Common Primary Tasks	Measurement Metrics
Cognitive Load Tasks	Mathematical problem solving, logical reasoning, memory tasks	Execution time, accuracy rate, reaction time, error types.
Working Memory Tasks	Number manipulation (e.g., N-back task), spatial memory	Accuracy rate, reaction time, error types, learning curve.
Attention Tasks	Continuous performance test, visual search tasks	Hit rate, accuracy rate, omission rate, false alarm rate.
Motor Skill Tasks	Typing, swimming, playing ball sports	Execution time, speed, precision, technical score.

Sub-task measurement assumes that the capacity of a person's information processing system is fixed. Therefore, when a person is performing a major mental task, the excess mental resources will be used to complete the sub-task. The evaluation of the performance of secondary tasks can indirectly reflect the mental resources occupied by the main task. The higher the completion level of the current task, the lower the mental load of the main task. Often in multi-task scenarios, such as driving simulation tasks where auditory or reading tasks are completed simultaneously, common sub-tasks include memory, numerical calculation, reaction time, time estimation, and tracking.

However, most mental tasks require different mental resources, and their internal mechanisms are also very complex. It is difficult to fully express them with just one or two indicators of the main task. Coupled with the characteristics of mental tasks, the performance measurement indicators themselves are difficult to unify. Therefore, the main task measurement method has recognized flaws. As for the secondary task measurement method, there are also certain doubts [7]. First, the premise assumption of the secondary task measurement method is that the information processing system capacity of human beings is fixed, but this assumption is somewhat inconsistent with the facts. Second: Secondary tasks can affect the main task, especially when completing highly complex tasks. People tend to deliberately reserve some mental resources for secondary tasks, thus passively responding to the main task. Thirdly, when the nature of psychological resources for the main task and the secondary task is significantly different, there will be considerable differences in the nature of the psychological resources required by the two, which leads to a lower correlation between the completion performance of the secondary task and the mental load of the main task, and the evaluation effect of the secondary task measurement method becomes worse. Therefore, when using the secondary task measurement method to evaluate the mental load, it should be noted that the design of the secondary task should be based on the type of the main task.

3.2.2 Physiological Measurement Method.

The physiological measurement method measures the magnitude of mental load by observing the changes in physiological indicators of the worker during work [8]. QinYimin et al. found through experimental research that workload assessment based on electroencephalogram (EEG) can reveal the psychological changes of workers in real time [9]. According to Yu Guoming et al., eye movement indicators and speech indicators can reflect changes in workload[10].Eye movement indicators include average fixation duration, fixation frequency, saccades frequency, average saccades duration, average saccades distance, blink frequency, average blink duration, and pupil diameter. Speech indicators include the number of calls and average call duration. Zhang Qiliang et al. conducted human factors experiments based on four typical debugging duty tasks of different difficulty levels [11]. When Tan Wei et al. explored the visual characteristics of pilots under different levels of mental load, they also proved that as the level of mental load increases, the number of blinks, the number of scans and the duration of scans will increase accordingly, and the visual search performance of pilots will decrease accordingly[12]. Based on the evaluation of the frequency bands of electroencephalogram (EEG) signals, Tao Ye et al. proposed applying the histogram of directional gradients to EEG topographic maps [13], visualizing and analyzing EEG signals, which has a more advanced research algorithm. Tao Da et al. found through experimental data that task difficulty has a significant impact on subjective mental load, driving behavior performance, eye movement and skin conductance indicators [14]. Li Rui et al. found through experiments that the recognition rate based on multi-physiological information feature fusion is higher than that of traditional mental load recognition methods [15]. The commonly used physiological indicators at present include electroencephalogram, skin electrical response, heart rate variability, eye tracker, speech monitor, blood flow changes, etc[16].Table 3 summarizes the commonly used physiological indicators and their specific indicators.

Table 3. Summary of Common Physiological Measurement Metrics.

Common Physiological Indicator	Specific Indicators
Electroencephalogram (EEG)	Alpha waves: Frequency range 8-12 Hz, associated with lapses in attention. Beta waves: Frequency range 12-30 Hz, associated with focused attention and cognitive tasks. Theta waves: Frequency range 4-8 Hz, associated with attention shifting and creative thinking. Delta waves: Frequency range 0.5-4 Hz, associated with deep sleep and restorative processes.
Galvanic Skin Re-	Skin Conductance Level (SCL): Can be used to assess emotional arousal

Common Physiological Indicator	Specific Indicators
sponse (GSR)	levels and mental workload.Skin Conductance Response (SCR): Momentary changes in skin conductance, typically related to emotional arousal and attention.
Heart Rate Variability (HRV)	High-Frequency (HF) component: Reflects heart rate variations induced by respiration, related to parasympathetic nervous system activity. Low-Frequency (LF) component: Reflects heart rate variations regulated by both the sympathetic and parasympathetic nervous systems, can be influenced by emotions and stress. Standard Deviation of NN Intervals (SDNN): Assesses the overall level of heart rate variability, reflecting the regulatory capacity of the autonomic nervous system.
Eye Tracker	Average fixation duration, fixation frequency, saccade frequency, average saccade duration, average saccade distance, blink frequency, average blink duration, pupil diameter.
Speech Monitor	Number of utterances, average utterance duration.
Blood Flow Changes	Functional Near-Infrared Spectroscopy (fNIRS): Measures changes in blood oxygen content in the cerebral tissue beneath the scalp to assess brain region activity and cognitive load.

3.2.3 Subjective Measurement Method.

The basic assumption of the subjective measurement method is that the operator can subjectively assess their mental load when completing a task, mainly including the degree of effort they make to complete the task, the psychological resources they occupy, and the difficulty of the task, etc. The commonly used subjective measurement methods at present include the Cooper-Harper subjective evaluation method, the NASA-TLX scale and the SWAT subjective evaluation technique.

The Cooper-Harper subjective evaluation method is one of the earliest methods used to assess the difficulty of aircraft maneuvering. This method requires pilots to make a subjective assessment of the difficulty of piloting the aircraft based on a scoring system consisting of 10 levels. This method aims to quantify the cognitive load and task difficulty that pilots face during the driving process. These grades cover a range from easy to difficult, with a score from 1 to 10, where 1 indicates the lowest level of difficulty and 10 indicates the highest level of difficulty. Pilots choose an appropriate grade based on their subjective feelings to reflect their evaluation of the difficulty of piloting this type of aircraft.

The NASA-TLX scale divides the assessment of psychological load into six dimensions: mental need, physical need, time need, effort level, difficulty level and emotional need. Each dimension is scored using a continuous scale from 0 to 100, and participants choose the appropriate scale position based on their subjective feelings. Finally, the scores of each dimension are combined through weighted calculation to obtain the overall task load score.

The SWAT subjective assessment method divides the factors influencing mental load into three aspects: time, stress and effort level. Each factor has three levels: high, medium and low, and is divided into twenty-seven levels of mental load.

Subjective measurement methods are often used in the modern stage to measure mental load due to their convenience, but their existence is easily influenced by individual subjective biases and memory effects. The subjective assessment of participants may be influenced by psychological factors, emotional states and memory distortion, etc., which can lead to inaccuracy of the assessment results.

3.2.4 Horizontal Comparison of Measurement Methods.

Table 4. Horizontal Comparison of Methods for Assessing Mental Workload.

Measurement Method		Advantages	Limitations
Task Performance Measurement	Primary Task Measurement	The method is simple and easy to implement, and can provide objective performance data based on the participant's performance.	(1)It is difficult to fully measure mental workload using only one or two indicators from the primary task. (2)Due to differences in the nature of mental tasks, the performance metrics for primary tasks themselves are inherently challenging to standardize.
	Secondary Task Measurement	By measuring both the primary and secondary tasks simultaneously, more data can be obtained, which facilitates analysis.	(1) The underlying assumptions do not fully align with reality. (2)The secondary task interferes with the primary task. (3)When the mental resource demands of the primary and secondary tasks differ significantly, the performance on the secondary task correlates poorly with the mental workload of the primary task, reducing the effectiveness of the assessment.
Physiological Measurement		Physiological indicators can directly reflect changes in brain activity, thereby providing an objective and accurate assessment of mental workload.	The use of physiological index measurement methods requires professional equipment and techniques, and is usually carried out in a controlled laboratory environment. The operation and application of physiological index measurement methods are relatively complex and limited.
Subjective Measurement		Simple and easy to administer, allowing for quick collection of participant feedback.	It is easily influenced by individual subjective biases and memory effects, thereby leading to inaccurate assessment results.

Through the summary in Table 4, we can find that task performance measurement, physiological measurement methods and subjective measurement methods all have their own advantages and disadvantages. Therefore, when assessing mental load in reality, we will choose the required measurement methods according to our own priorities. As Cheng Shan et al. emphasized, techniques for measuring mental load and designing task load should all be based on actual working scenarios[17].

Under normal circumstances, in order to have a relatively comprehensive and objective assessment of mental load, researchers usually use a combination of two or more methods. For instance, scholars such as Yu Qiwei used these three measurement methods to collect index data and measure and evaluate mental load under complex assembly tasks[18]. In order to study the detailed characterization of the changes in mental load under different types and difficulties of cognitive combinations, Fu Jiahao et al. conducted a comprehensive assessment of mental load in different situations by combining subjective scale scores of the subjects, task performance and electroencephalogram signals[19].

4 The Theoretical Basis of how Mental Load Affects Work Performance

4.1 Information Processing Theory

Information processing theory points out that human thinking and cognitive processes can be regarded as an information processing system, similar to the information processing process of a computer. The information processing process mainly consists of three parts: information storage, cognitive process and cognitive execution. It involves multiple stages such as perception, encoding, storage, retrieval and output of input information. As shown in Figure 3, when external environmental stimuli enter the sensory system, they are processed to form short-term sensory storage. Afterwards, the brain compares the corresponding memories in the short-term and long-term memories within the sensory system and defines the external stimuli. Further information processing is mainly the responsibility of the perceptual system, which classifies information into specific categories. After this, the individual needs to make a choice. The first option is to express the processed information in the form of reaction selection; The second option is to convert this stimulus into working memory and store it.

Based on the theory of information processing, the significant role of attention is indispensable in every stage of information processing. Attention can help distinguish various kinds of information. During the process of task execution, an individual's attention resources are limited. If certain stages consume a large amount of attention resources, the available attention resources for other stages will decrease, thereby affecting the reaction performance.

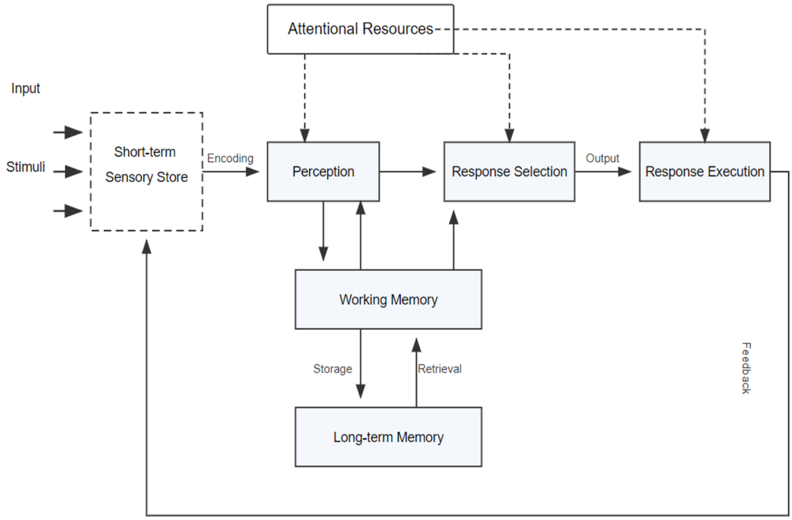

Fig. 3. Diagram of the information processing procedure.

4.2 The Theory of Limited Resources

The theory of limited resources includes the single-resource theory and the multi-resource theory. The core viewpoint of both holds that human cognitive resources are limited, including attention, working memory, processing speed, etc. When people undertake tasks, these resources need to be allocated and utilized in different cognitive processes. However, due to its limited nature, resources must be allocated among multiple tasks, which leads to resource competition and constraints. That is, there is a problem of resource allocation. Since the total amount of cognitive resources is fixed, allocating more resources to one task will lead to fewer resources being allocated to other tasks. This may cause competition, interference and performance degradation among resources.

According to the theory of limited resources, human cognitive resources are fixed. Every task consumes cognitive resources. When the mental load exceeds the available capacity of cognitive resources, the resources become insufficient to support multiple tasks simultaneously. This may lead to resource strain and bottleneck effects, resulting in a decline in the speed and accuracy of task completion. For instance, when handling multiple complex tasks simultaneously, the brain may not be able to fully mobilize the necessary resources, leading to a decrease in processing efficiency and thus affecting work performance.

5 The Relationship Between Mental Load and Work Performance

As early as 1980, scholars Yerkes and Dodson conducted research on the correlation between mental load and performance. After years of development, a large number of scholars have proved that there is a significant relationship between mental load and job performance. Among them, the following two are the most representative.

5.1 Three-stage Mode

Scholar Meister described the relationship between A worker's mental load and performance as a three-stage model as shown in Figure 4, namely segments A, B, and C[20]. As shown in the figure, at stage A, the worker is in a state of low mental load. When the mental load increases, the work performance remains stably at the highest level. In stage B, as the mental load increases, its performance gradually declines. The greater the mental load, the faster the performance drops. In stage C, as the mental load further increases, the performance level of the worker does not change, which indicates that the worker is already in an overloaded state, and at this time, the performance is at its lowest level.

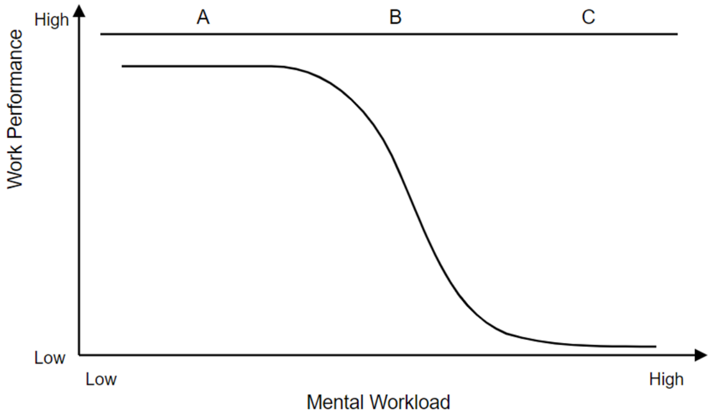

Fig. 4. Three-stage Model: The Relationship between Mental Load and Performance.

5.2 Inverted U-shaped Pattern

Scholar DeWaard proposed the inverted U-shaped pattern by adding one stage to the three-stage model, as shown in Figure 5. This pattern is divided into four stages: A, B, C, and D. Among them, area A2 represents the optimal working state for workers, where they can achieve the best work performance with the lowest workload. In sections A1 and A3, although work performance remains at a relatively stable level, the mental load of workers in this area has increased compared to that in section A2. This is because workers need to make efforts to provide temporary compensation. When the task demand is very low, it is in stage D. At this time, the worker needs to invest cognitive resources to get themselves into the working state. As the task demand increases, the mental load decreases while the work performance rises. When an individual's efforts can no longer compensate for their capacity, they will enter Zone B. As the demand for tasks increases, so does the mental load, leading to a decline in work performance. When the demand for tasks keeps increasing, due to the limited information processing capacity of the worker's brain, it enters the C zone, and the mental load keeps rising or even overloading occurs, with performance dropping to the lowest level.

In conclusion, the optimal range for mental load and work performance is in Zone A2, while the warning points should be located at the transition points from Zone A2 to Zone A3 and from Zone A2 to A1.

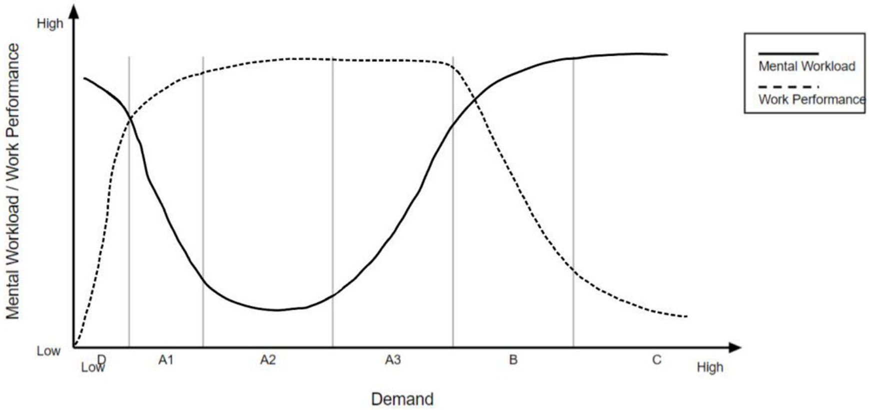

Fig. 5. The "inverted U-shaped" relationship between mental load and work performance.

6 Research Review

With the proliferation of digital and human-machine collaborative technologies, mental workload has become the predominant form of load for modern workers, and its impact on job performance has increasingly become a focus of academic attention. Scholars, both domestically and internationally, have expanded their research perspectives on this topic, moving beyond traditional ergonomics to encompass broader application scenarios, thereby driving theoretical deepening and practical integration.

Existing research has established the following consensus: mental workload is a multidimensional concept, influenced by multiple factors including task, individual, and environmental conditions; its assessment methods can be categorized into three types: task-performance measures, physiological measures, and subjective measures; and there is a significant correlation between mental workload and job performance, with the inverted U-shaped model being more consistent with real-world situations.

Nevertheless, there remain notable limitations in both theoretical and practical aspects of the related research:

First, the applicability of existing research is notably limited, as it primarily focuses on safety-sensitive occupations such as pilots and drivers. However, with the digital transformation of enterprises, it has become increasingly important to assess and manage the mental workload of corporate knowledge workers. Moreover, given the significant differences between these two groups in terms of operational environments, skill requirements, and task systems, further optimization is still needed in areas such as the selection of influencing indicators and the allocation of weights to develop a quantitative model of mental workload better suited to knowledge workers in Chinese enterprises.

Second, although the multidimensional nature of mental workload is widely acknowledged in academia, a standardized definition or dimensional framework has yet to be established. Clarifying its definition and structure would help unify academic discourse, prevent conceptual confusion, and represents an important direction for future theoretical development.

Third, there remains a lack of normative guidance on the selection and combination of measurement methods. Although multi-method approaches have become common practice to enhance assessment validity, systematic guidelines are still absent regarding how to choose the optimal combination of methods in specific contexts and how to reasonably allocate weights across different measures.

Fourth, existing studies predominantly focus on the correlation between mental workload and performance, with limited in-depth exploration of the underlying mechanisms—that is, how, when, and through what pathways mental workload influences job performance. Research on these mechanisms remains noticeably underdeveloped.

7 Conclusions

This paper provides a systematic review of the relationship between mental workload and job performance, synthesizing its conceptual evolution, measurement methods, theoretical foundations, and predominant explanatory models. The literature consistently indicates that mental workload, as a multidimensional construct, exhibits a notable inverted U-shaped association with performance, whereby moderate levels tend to optimize outcomes, whereas both excessive and insufficient levels can be detrimental.

On a theoretical level, this review underscores persistent gaps in the standardization of the construct and in the understanding of its underlying mechanisms. On a practical level, it highlights the imperative to extend research focus toward knowledge workers in enterprise settings. Especially within the context of digital transformation, developing adaptable assessment and intervention frameworks suitable for diverse occupational environments remains critically important.

Future research should advance in several key directions: expanding the scope of inquiry to include corporate employees in empirical studies; promoting conceptual and dimensional standardization of mental workload; formulating contextualized guidelines for integrating measurement approaches; and deepening the investigation into mediating and moderating mechanisms—particularly through cognitive and behavioral pathways. Collectively, these efforts would establish a stronger theoretical and practical foundation for organizations to manage employee workload effectively, enhance performance, and foster both well-being and organizational efficacy.

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