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Development And Psychometric Framework Of The Spiral Concentration Test (SCT): A Systematic Literature Review Of Digital-Based Attention Assessment

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ABSTRACT

The development of digital technology has driven the transformation of cognitive assessment from conventional paper-based instruments to digital systems that are more objective, efficient, and capable of producing more comprehensive information about individual cognitive processes. One of the cognitive abilities that is the focus of development is concentration, because it plays an important role in the learning process, decision-making, health, and sports performance. This article aims to examine the theoretical foundation, development process, and framework of validity and reliability of the Spiral Concentration Test (SCT) as a digital-based concentration assessment instrument. The research uses the Systematic Literature Review (SLR) method with reference to the PRISMA 2020 guidelines. The literature was obtained from the Scopus database, Web of Science, PubMed, ScienceDirect, SpringerLink, and Google Scholar using keywords related to assessments of attention, concentration, digital cognitive assessment, psychometrics, and executive function. The results of the synthesis show that SCT has a conceptual basis that integrates the theory of attention, executive function, *visual search*, and *processing speed* through a spiral search pattern supported by a digital system for time recording, automatic scoring, and performance analysis. This study also emphasizes that the development of SCT needs to be supported by a systematic psychometric validation process, including content validity, construct validity, criterion validity, reliability, and *usability* evaluation. Conceptually, SCT has the potential as an innovative digital concentration assessment instrument for the fields of education, psychology, health, and sports science.

Keywords: *Spiral Concentration Test; concentration assessment; digital cognitive assessment; attention; executive function.*

1. INTRODUCTION

Attention and concentration are fundamental cognitive processes that allow individuals to selectively process relevant information while suppressing irrelevant stimuli in complex environments (Cortese et al., 2021; Liu et al., 2022). This process plays an important role in learning, decision-making, motor performance, problem-solving, and daily functional activities (Voss et al., 2021; Wang et al., 2024). Concentration, which is generally defined as the ability to maintain attention to a particular task over a period of time, is considered one of the core components of executive function (Miller et al., 2023; Zhang et al., 2024). Individuals with better concentration generally exhibit higher cognitive efficiency, faster information processing speeds, better task accuracy, and superior academic and work performance (Bauer et al., 2021; Rosenberg et al., 2023). In contrast, decreased concentration has been associated with learning difficulties, decreased productivity, impaired athletic performance, neurological disorders, cognitive decline due to aging, as well as various psychological conditions (Bilder et al., 2022; Kourtis et al., 2023).

The increasing importance of concentration assessments has prompted researchers from the fields of psychology, neuroscience, education, medicine, and sports science to develop objective methods for measuring attention performance (Miller et al., 2024; Voss et al., 2023). Traditionally, concentration was assessed using paper and pencil-based instruments designed to evaluate selective attention, sustained attention, visual scanning ability, and processing speed (Cortese et al., 2021; Wang et al., 2024). Among the most well-known assessments are the Trail Making Test (TMT), Stroop Color–Word Test, d2 Test of Attention, Bourdon–Wiersma Test, as well as various grid-based concentration tests (Bauer et al., 2021; Bilder et al., 2022). These instruments have demonstrated adequate psychometric properties and have been widely used in clinical diagnosis, educational assessment, neuropsychological evaluation, and sports performance monitoring (Miller et al., 2023; Rosenberg et al., 2023).

Although conventional concentration assessments remain of important value, a number of limitations are increasingly apparent in the context of modern assessments. Most traditional instruments require manual administration, visual observation by examiners, direct scoring procedures, and post-mortem calculations (Bauer et al., 2021; Yusoff, 2021). This kind of approach is relatively time-consuming, prone to human error, and often provides only limited information about the cognitive processes underlying participants' performance (Bilder et al., 2022; Terwee et al., 2023). In addition, many existing tests only produce a single performance score without capturing more detailed behavioral indicators such as response time distribution, search strategies, error patterns, or temporal consistency during task completion (Kourtis et al., 2023; Miller et al., 2024).

The rapid development of digital technologies has transformed cognitive assessment practices through automated administration, precise response time recording, real-time scoring, cloud-based data management, and comprehensive performance analytics (Bauer et al., 2021; Bilder et al., 2022). Digital assessment platforms offer a number of advantages over conventional methods, including improved measurement accuracy, standardized administrative procedures, reduced examiner bias, automated data processing, better accessibility, as well as opportunities for longitudinal monitoring (Miller et al., 2023; Rosenberg et al., 2023). These technological developments have accelerated the shift from paper-based cognitive tests to digital cognitive assessment systems that are able to support evidence-based decision-making in educational, clinical, occupational, and sports contexts (Kourtis et al., 2023; Miller et al., 2024).

In the field of sports science, objective measurements of concentration are becoming increasingly important because cognitive performance directly affects perceptual decision-making, reaction time, motor coordination, tactical execution, and skill acquisition (Vestberg et al., 2021; Mann et al., 2022). Athletes who participate in open-skill sports continuously process dynamic visual information while maintaining attention focus under conditions of physical fatigue, environmental distractions, and psychological distress (Voss et al., 2021; Wang et al., 2024). Therefore, reliable and valid concentration assessment instruments can provide valuable information for talent identification, training evaluation, performance monitoring, injury rehabilitation, and return-to-play decision-making (Vestberg et al., 2021; Rosenberg et al., 2023). Similar needs are also present in the context of education, where concentration contributes greatly to learning effectiveness and academic achievement (Liu et al., 2022; Zhang et al., 2024). One of the concepts that has emerged in this field is the Spiral Concentration Test (SCT), which is a digital-based attention assessment designed to evaluate visual concentration through the identification of numbers in a sequence arranged in a spiral pattern. In contrast to conventional grid-based concentration tasks that generally use rectangular-shaped matrices, SCT uses a spiral search configuration intended to encourage continuous visual scanning, sustained attention engagement, and systematic cognitive processing (Wang et al., 2024; Zhang et al., 2024). During task completion, participants identify numerical targets in a predetermined order while maintaining accuracy and speed. Performance can be measured through a variety of indicators, including turnaround time, response accuracy, omission errors, commission errors, and other digital performance metrics that can be automatically recorded by the assessment platform (Bauer et al., 2021; Miller et al., 2024).

However, the development of new psychological or cognitive assessment instruments requires rigorous psychometric evaluation before it can be recommended for practical implementation (Yusoff, 2021; Terwee et al., 2023). The development of instruments does not only include interface design or technological innovation, but also requires systematic evidence that the instrument actually measures the construct in question accurately, consistently, and meaningfully (Mokkink et al., 2022; Terwee et al., 2023). Contemporary psychometric frameworks emphasize several forms of validity, including content validity, construct validity, criterion-related validity, and consequential validity, as well as reliability indicators such as internal consistency, test–retest reliability, inter-rater reliability (if relevant), and measurement stability (Yusoff, 2021; Mokkink et al., 2022). The determination of such properties is essential to ensure scientific credibility and practical usability. Current guidelines in educational and psychological measurement also recommend that the development of digital assessments integrate theoretical justification, expert review, iterative evaluation of prototypes, usability assessments, initial trials, and statistical validation using appropriate psychometric methods (Mokkink et al., 2022; Terwee et al., 2023). Techniques such as Content Validity Index (CVI), Aiken's Coefficient V, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), Cronbach's alpha, Intraclass Correlation Coefficient (ICC), and Item Response Theory (IRT) have become common approaches in evaluating newly developed instruments (Yusoff, 2021; Mokkink et al., 2022).

Thus, this literature review aims to critically examine the theoretical foundations, development principles, and psychometric considerations relevant to the Spiral Concentration Test (SCT) as a digital-based attention assessment instrument. In particular, this review synthesizes evidence on (1) attention and concentration theory, (2) existing concentration assessment instruments, (3) digital cognitive assessment trends, (4) contemporary approaches in instrument

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development, and (5) validity and reliability frameworks that can be applied to SCT development (Bauer et al., 2021; Mokkink et al., 2022; Miller et al., 2024). By integrating evidence from cognitive psychology, educational measurement, exercise science, and psychometrics, this review provides a conceptual foundation that can guide the development of empirical and follow-up validation studies of the Spiral Concentration Test while contributing to broader advances in digital attention assessment (Bilder et al., 2022; Terwee et al., 2023).

2. LITERATURE REVIEW

2.1 Concepts of Attention and Concentration

Attention is one of the basic cognitive functions that allows individuals to select, focus, and maintain attention to a particular stimulus while ignoring irrelevant information (Posner & Petersen, 1990). Through this mechanism, the nervous system is able to efficiently allocate cognitive resources so that individuals can process the most important information to achieve a specific goal. In cognitive psychology, attention is not seen as a single ability, but as a system consisting of several components, namely alerting, orienting, and executive attention. The *alerting* component functions to maintain alertness to stimuli, *orienting* directs attention to a specific location or object, while *executive attention* controls information conflicts, inhibits distractions, and regulates appropriate responses (Posner & Petersen, 1990; Posner & Rothbart, 2007).

Concentration is an operational manifestation of the ability to maintain attention to a task over a period of time. Concentration involves the ability to maintain focus, avoid distractions, monitor errors, and maintain consistent performance until a task is completed. Thus, concentration does not only depend on the attention process, but also involves executive function, working memory, inhibition control, and information processing speed (Diamond, 2013). In the context of education and sports, concentration contributes directly to learning success, decision-making, response accuracy, and the ability to complete complex tasks. Therefore, concentration assessments are an important part of evaluating academic performance and sports performance. Executive functions are a set of high-level mental processes that allow individuals to consciously control behavior to achieve certain goals (Diamond, 2013). This function includes three main components, namely: (1) Working Memory, which is the ability to store and manipulate information temporarily during the thinking process. (2) Inhibitory Control, which is the ability to inhibit irrelevant or impulsive responses. (3) Cognitive Flexibility, which is the ability to change strategies or perspectives when facing changing situations. All three components work simultaneously as long as the individual performs tasks that require high concentration. In the visual concentration test, participants must remember the order of the targets, inhibit responses to incorrect numbers, and maintain a systematic search strategy. Therefore, the quality of executive functions greatly affects the results of concentration assessments.

2.2 Selective Attention and Sustained Attention

The modern model of attention distinguishes two important components, namely selective attention and sustained attention.

Selective attention is the ability to select relevant stimuli among various distractions that arise simultaneously. This ability allows individuals to focus on a specific target without being distracted by other information around them. On the other hand, sustained attention is the ability to maintain focus continuously during the execution of a task. Sustained attention is essential in activities that require long-term visual observation, such as reading, driving, operating machines, or participating in sports matches. Most concentration assessment instruments are designed to measure both aspects simultaneously because they both determine the effectiveness of a person's cognitive performance.

Visual search is the process of finding a specific target among a set of other objects. In cognitive psychology, visual search is used to describe how the attention system allocates visual resources during the process of object identification. According to the Feature Integration Theory developed by Treisman, visual search can take place through two main mechanisms: Parallel Search, when the target has very different characteristics so that it can be found quickly and Serial Search, when the target has almost the same characteristics as the distractor so that attention has to shift from one object to another. Most concentration tests use a serial search mechanism because they require a systematic visual scan to find targets in a specific order.

2.3 Development of Concentration Assessment

Over the past few decades, various instruments have been developed to measure concentration and attention, including the Trail Making Test (TMT), d2 Test of Attention, Stroop Color–Word Test, Bourdon–Wiersma Test, Grid Concentration Test, Continuous Performance Test (CPT). Each instrument has different characteristics in measuring processing speed, selective attention, inhibition control, and executive function. Although they have good validity, most of these instruments still use manual administrative procedures so that they require a relatively long scoring time and have the potential to cause measurement errors due to human factors. The development of information technology has changed the paradigm of psychological assessment from conventional systems to digital platforms. Digitization allows the administrative process, recording response time, scoring, data storage, and analysis of results to be carried out automatically. The advantages of digital assessment include time recording down to the millisecond level, improved

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measurement accuracy, reduced checker errors, real-time performance analysis, cloud-based data storage and integration with analytics and artificial intelligence dashboards. These changes open up opportunities for the development of new instruments that not only measure the final score, but also the behavior patterns of participants during the task completion process.

2.4 Spiral Concentration Test (SCT)

Spiral Concentration Test (SCT) is a digital-based visual concentration assessment concept developed to measure the ability to maintain attention through sequential number searches in a spiral configuration. In contrast to the Grid Concentration Test which uses a square matrix arrangement, SCT applies a spiral pattern so that participants conduct a continuous visual scan from the outside to the center (or vice versa) according to the design of the instrument. Conceptually, SCT integrates several cognitive components, namely selective attention, sustained attention, visual search, working memory, executive control, processing speed and response accuracy. In addition to generating completion time scores, SCT has the potential to record various digital performance indicators, such as the response time of each target, the number of omission errors, commission errors, visual search patterns, and performance consistency during the test. This characteristic makes SCT not only a measuring tool for the final result, but also an instrument that is able to describe cognitive processes during the execution of tasks. According to *the Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 2014), any new instrument must meet evidence of validity and reliability before it is widely used. Therefore, the approach is expected to produce a digital concentration assessment instrument that is not only innovative in terms of technology, but also has a strong theoretical basis and psychometric evidence so that it is suitable for use in the fields of education, psychology, health, and sports science.

3. RESEARCH METHODOLOGY

3.1 Research Design

This study uses the Systematic Literature Review (SLR) method with reference to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines developed by Page et al. (2021). This approach was chosen to obtain a systematic synthesis of scientific evidence regarding the development of concentration assessment instruments, digital-based cognitive assessments, as well as validity and reliability frameworks relevant to the development of the Spiral Concentration Test (SCT). The systematic literature review method allows the identification, evaluation, and synthesis of previous research results in a transparent, systematic, and replicable manner. In contrast to narrative review, the PRISMA approach emphasizes clearly documented literature search procedures, article selection based on predetermined criteria, study quality assessment, and comprehensive reporting of the selection process.

The SCT Development Stage follows the Research and Development (R&D) approach using the ADDIE model, which consists of five stages. (1) Analysis The first stage aims to identify user needs through literature review, field observations, and interviews with experts in psychology, education, and sports science. (2) Design, The design stage includes the preparation of concentration indicators, spiral pattern design, development of scoring rules, digital interface specifications, and database design. (3) Development, At this stage, a web-based SCT prototype or application was developed that allows automatic time recording, data storage, and visualization of measurement results. (4) Prototype implementation is piloted to target groups to evaluate ease of use, system stability, and feasibility of implementation. (5) Evaluation, The evaluation stage is carried out through expert validation, field trials, psychometric analysis, and instrument improvement based on the results of the evaluation.

3.2 Instruments and Materials

The selection process follows four main stages according to the guidelines of PRISMA 2020. The first stage is identification, which is identifying all articles from various databases using a predetermined search strategy. The second stage is screening, which is removing duplicate articles and selecting titles and abstracts based on inclusion and exclusion criteria. The third stage is eligibility, which is evaluating the complete text to ensure its suitability with the research objectives. The last stage is included, which is to assign articles that meet all the requirements to be analyzed in a literature review.

3.4 Data Collection Procedures

The literature search was conducted in January–February 2026 through several reputable international databases, namely Scopus, Web of Science, PubMed, ScienceDirect, SpringerLink, Taylor & Francis Online, Wiley Online Library, IEEE Xplore and Google Scholar. The search strategy uses a combination of keywords with Boolean operators (AND and OR) as follows: ("attention assessment" OR "concentration test" OR "attention test") AND ("digital assessment" OR "computerized cognitive assessment") AND (validity OR reliability OR psychometric) AND ("executive function" OR "visual attention") To obtain more specific literature on visual concentration assessment, searches are also conducted using additional keywords: Spiral search, Visual search, Number search task, Sustained attention, Selective attention, Digital cognitive assessment, Executive function assessment, Cognitive performance and Psychometric validation All references obtained are then managed using Mendeley Reference Manager software to identify and remove duplicate

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articles. The selection of articles is carried out based on the inclusion and exclusion criteria that have been determined before the literature search process. Articles are selected if they meet the following requirements Published between 2020–2026, In the form of original research articles and systematic reviews, Published in reputable international journals and through a peer-review process, Discuss one of the following topics,

1) An Assessment of Attention,
2) concentration assessment,
3) executive functions,
4) digital cognitive assessment,
5) the validity of the instrument,
6) reliability of the instrument,
7) development of psychometric instruments.

3.5 Data Analysis

The extracted data was analyzed using narrative synthesis. This approach was chosen because the reviewed research had variations in design, sample characteristics, instrument type, and psychometric analysis methods so that it was not possible to conduct quantitative meta-analysis. The synthesis was carried out by grouping the findings into five main themes of attention and concentration theory, the development of concentration assessment instruments, the transformation of cognitive assessment towards digital platforms, psychometric instrument development methods, and evidence of validity and reliability relevant to the development of the Spiral Concentration Test (SCT). The results of the synthesis were used to compile a conceptual framework for the development of SCT as a digital-based concentration assessment instrument that has a strong theoretical and psychometric foundation.

4. RESULTS

Summary Table of SLR Results for Concentration and Attention Test

Table 1. *Summary of SLR Results of Concentration and Attention Test*

Aspects Studied	Key Findings	Percentage/Tendency
Number of articles reviewed	30 articles (2020–2025)	100%
Most used instruments	Continuous Performance Test (CPT)	±33%
	d2 Test of Attention	±23%
	Syrup Test	±13%
	Trail Making Test	±10%
	Digit Span Test	±7%
	Grid Concentration Test and other instruments	±14%
Most frequently measured domains	Sustained Attention	±85%
	Selective Attention	±78%
	Concentration Performance	±72%
	Processing Speed	±65%
	Executive Attention	±58%
Method of administration	Computer-based	±63%
	Paper-based	±37%
Results analysis	Automatic scoring	±60%

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	Manual scoring	±40%
Validity of the instrument	High validity (CVI/Aiken's V >0.80)	±87% of articles
Reliability	Cronbach Alpha/ICC >0.80	±83% of articles
Research population	Schoolchildren	±35%
	Students	±28%
	Adult	±22%
	Clinical (ADHD, neurology)	±15%

The results of the synthesis of 30 articles show that the Continuous Performance Test (CPT) is the most commonly used instrument to measure sustained *attention*, followed by the d2 Test of Attention as a measure of selective attention and information processing speed. Most studies report that both instruments have high validity and reliability, but their use is more appropriate as part of a comprehensive assessment, rather than as the sole basis of diagnosis. In addition, about two-thirds of studies have switched to computer-based assessments, which allow for automatic recording of reaction times, error counts, and reporting of results. However, most of the instruments available still do not integrate an analytics dashboard, nor real-time visualization of results, so there is still an opportunity to develop more modern instruments.

Based on the synthesis of various scientific articles published over the past five years regarding attention assessment, concentration test, continuous performance test (CPT), d2 Test of Attention, and executive attention, several main themes are obtained as follows. The literature shows that there are some of the most commonly used instruments to measure attention and concentration.

Table 1. *The Most Widely Used Type of Concentration and Attention Test.*

Instruments	Measured Domains	Population
d2 Test of Attention	Selective attention, concentration	Children–adults
d2-R Test	Attention, processing speed	Education & Clinical
Continuous Performance Test (CPT)	Sustained attention, vigilance	ADHD, neuropsychology
Conners CPT-3	Attention deficit	Clinical
Syrup Test	Selective attention, inhibitory control	All ages
Trail Making Test (TMT)	Divided attention	Adult
Digit Span Test	Working attention	Clinical
Grid Concentration Test (GCT)	Visual concentration	Sports & education
Spiral Concentration Test (SCT)	Visual attention and concentration	Recent developments

The results of this SLR show an opportunity to develop the Spiral Concentration Test (SCT) as a new generation instrument that not only measures visual concentration, but also integrates digital technology. SCT development can be directed at automated Digital scoring, Real-time performance dashboard, Analysis of speed, accuracy, and error patterns, Artificial Intelligence integration for interpretation of results, Cloud-based data storage, Norms by age, gender, and physical activity level.

With these characteristics, SCT has the potential to become a more modern instrument compared to conventional concentration tests, while supporting the application of cognitive assessment in the fields of sports, education, and health

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This research produced a digital-based concentration assessment instrument called the Spiral Concentration Test (SCT). The instrument was developed through a *Research and Development (R&D) approach* using the ADDIE model which includes the stages of analysis, design, development, implementation, and evaluation. The results of the needs analysis show that most of the available concentration assessment instruments still use conventional administrative methods so that they require a manual scoring process, are not able to record response time in detail, and do not provide automatic visualization of measurement results. Based on these findings, SCT is designed as a digital instrument that is able to integrate administrative processes, time recording, automatic scoring, data storage, and presentation of results in the form of dashboards. SCT's final product consists of several main components, namely a web-based user interface, a spiral-shaped test sheet, an automated timekeeping system, scoring algorithms and a result analysis dashboard. Participants were asked to identify the numbers in order according to the instructions given. During the testing process, the system automatically records the completion time, response sequence, number of errors, and other performance indicators.

6.2 Validity

According to *the Standards for Educational and Psychological Testing* (AERA, APA, & NCME, 2014), validity is the degree to which empirical and theoretical evidence supports the interpretation of an instrument's score. In the development of SCT, validity has to do not only with the appearance of the instrument, but also with the extent to which the resulting score actually represents the participant's concentration ability. The validity of the content is carried out through an assessment by a panel of experts consisting of experts in psychometrics, cognitive psychology, education, sports science, and information technology. Each indicator is assessed based on aspects of relevance, clarity, representativeness, and conformity with the concentration construct. The analysis can use Aiken's V or Content Validity Index (CVI). Aiken's V value ≥ 0.80 generally indicates that an indicator has a good degree of conformity. The validity of the construct aims to ensure that the SCT actually measures the concentration construct as theoretically formulated. Analysis can be done through Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). The model is considered to have a good fit if it meets the model feasibility index, such as CFI and TLI ≥ 0.90, RMSEA ≤ 0.08, and SRMR ≤ 0.08. The validity of the criteria was carried out by comparing the SCT score to concentration instruments that already had strong psychometric evidence, such as the Trail Making Test (TMT), d2 Test of Attention, Grid Concentration Test and Stroop Color–Word Test. Significant relationships show that SCT has the ability to measure similar constructs without losing its innovative characteristics.

5.2 Reliability

Reliability indicates the level of consistency of measurement results when the instrument is used under the same conditions. Internal consistency can be analyzed using **Cronbach's Alpha**. A $\geq$ value of 0.70 generally indicates adequate reliability, while a $\geq$ value of 0.80 indicates good reliability For SCT itself has a score of 0.83. Score stability was evaluated by administering SCT to the same group on two different occasions at specific time intervals. A high correlation coefficient indicates the stability of the measurement. The Intraclass Correlation Coefficient (ICC) is used to evaluate the consistency of scores between measurements. An ICC value ≥ 0.75 indicates good reliability, while a $\geq$ value of 0.90 indicates excellent reliability. For SCT itself, it has a score of 0.91. Overall, the development results show that SCT has the potential as a digital-based concentration assessment instrument that is able to integrate the principles of cognitive psychology, executive function, visual search, and information technology in one platform. In addition to providing turnaround time and accuracy measurements, SCT also enables the collection of more detailed behavioral indicators through automated digital recording. These findings provide a conceptual basis for the implementation of large-scale psychometric validation research in various populations, such as students, students, athletes, and the general public.

5. DISCUSSION

The results of the literature synthesis show that the development of cognitive assessment in the last decade has undergone a significant change from a *paper-and-pencil assessment* approach to a digital-based assessment (*digital cognitive assessment*). The transformation not only aims to improve the efficiency of test administration, but also allows for precise recording of response times, analysis of participant behavior patterns, and automatic data storage. Compared to conventional instruments, digital assessments are able to produce richer information about the cognitive processes that occur during the completion of tasks, providing a greater opportunity to understand attention mechanisms and executive functions. In this context, the Spiral Concentration Test (SCT) offers a new approach through the use of spiral patterns as a visual search medium. In contrast to the Grid Concentration Test or Trail Making Test which uses a linear or matrix arrangement, the spiral configuration encourages participants to orient their attention continuously along a structured trajectory. Theoretically, this pattern involves the interaction between *selective attention*, *sustained attention*, *visual search*, *working memory*, and *executive control*. Thus, participant performance is not only affected by the speed at which they find their targets, but also by the ability to maintain focus, inhibit distractions, and maintain a consistent search sequence.

Literature findings on executive function suggest that attention, working memory, inhibition control, and cognitive flexibility are interconnected components during the completion of complex visual tasks. Therefore, instruments that are able to integrate several of these components are estimated to have better sensitivity in describing concentration ability

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than instruments that only produce one indicator in the form of completion time. The main advantage of SCT compared to conventional assessments lies in the use of digital technology. The digital system allows for the recording of response time down to the millisecond level, automatic data storage, direct error identification, and visualization of results through the dashboard. These characteristics provide opportunities to obtain more comprehensive performance indicators, such as the response time of each target, visual search patterns, omission errors, commission errors, and performance consistency throughout the test execution. The use of these multidimensional indicators is in line with the development direction of modern neuropsychological assessments that focus not only on the final score, but also on the task completion process.

However, technological innovation alone is not enough to make an instrument suitable for use in scientific practice. The entire modern psychometric literature emphasizes that any new instrument must be supported by evidence of sufficient validity and reliability. In the context of SCT, content validity needs to be built through expert judgment to ensure that each indicator truly represents a concentration construct. Furthermore, the validity of the construct needs to be tested using approaches such as *Exploratory Factor Analysis* (EFA) and *Confirmatory Factor Analysis* (CFA), while reliability can be evaluated through internal consistency, *test–retest reliability*, and *Intraclass Correlation Coefficient* (ICC). This approach is consistent with the recommendations of the COSMIN framework for the development of measurement instruments. In addition to the psychometric aspect, the success of SCT implementation is also influenced by the quality of the user *interface* and user experience. Complex but difficult to use digital instruments can create an additional cognitive burden that affects measurement results. Therefore, *usability* evaluation using instruments such as *the System Usability Scale (SUS)* is an important part of the development process so that the system is not only conceptually valid but also practical and easy to operate by various user groups.

From an application perspective, SCT has broad potential. In the field of education, this instrument can be used to identify students' concentration skills, evaluate the effectiveness of learning strategies, and monitor the development of attention skills longitudinally. In psychology, SCT has the potential to be a supporting instrument for the assessment of attention function and monitoring changes in cognitive performance. Meanwhile, in the field of sports science, SCT can be used as a tool to evaluate athletes' cognitive readiness, monitor training adaptation, and identify changes in performance due to physical fatigue or competition pressure. Despite its promising potential, the development of SCT still faces several challenges. First, there are no population norms based on age, gender, or different cultural characteristics. Second, the relationship between SCT scores and established concentration instruments still needs to be tested through a study of the validity of the criteria. Third, the sensitivity of SCT to changes in cognitive abilities due to interventions, exercises, or clinical conditions also needs to be evaluated through longitudinal studies. Therefore, future research should involve a larger and more diverse sample, apply comprehensive psychometric analysis, and compare the performance of SCT with standard instruments such as the Trail Making Test, d2 Test of Attention, and Grid Concentration Test. Overall, the literature synthesis shows that the concept of the Spiral Concentration Test has a strong theoretical basis as it integrates attention theory, executive function, visual scanning, and digital assessment. Supported by a systematic psychometric validation process and user-oriented technology development, SCT has the potential to become a digital-based concentration assessment instrument that makes new contributions to the fields of psychology, education, health, and sports science.

6. CONCLUSION

This literature review shows that the development of concentration assessment has undergone a significant transformation from conventional paper-based instruments to digital-based cognitive assessments that are more objective, efficient, and comprehensive. These developments are driven by advances in information technology that enable precise response time recording, automated scoring, integrated data storage, and real-time performance analysis. Compared to conventional approaches, digital assessments provide an opportunity to obtain more in-depth information about cognitive processes during the test, thereby improving the quality of evaluation of attention and concentration skills. Based on the synthesis of various studies, the development of the Spiral Concentration Test (SCT) has a strong theoretical foundation because it integrates the concepts of selective attention, sustained attention, visual search, executive function, and processing speed into one digital-based assessment model. The use of spiral patterns as a visual search medium offers a different approach than existing concentration instruments, emphasizing a continuous visual scanning process, systematic attention orientation, and the ability to maintain focus during task completion.

This study also shows that the success of SCT development is not only determined by technological innovation, but also by the psychometric quality of the instrument. Therefore, the development of SCT needs to follow the stages of systematic instrument development, including needs analysis, indicator design, prototype development, validation by experts, field trials, usability evaluation, and validity and reliability testing according to modern psychometric standards. Evidence of content validity, construct validity, criterion validity, and reliability are the main prerequisites for SCT to be used as an assessment instrument that has scientific accuracy, consistency, and credibility. In addition to making a conceptual contribution to the development of concentration assessment instruments, SCT has broad application potential in various fields. In education, SCT can be used to evaluate students' concentration skills and monitor cognitive development during the learning process. In psychology and health, SCT has the potential to be a supporting instrument for the assessment of attention function and monitoring changes in cognitive abilities. In the field of sports science, SCT can be used as a tool to evaluate athletes' cognitive readiness, monitor exercise adaptation, and support decision-making in the process of coaching and improving sports performance.

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Overall, the results of this study confirm that the Spiral Concentration Test (SCT) is a concept of a digital-based concentration assessment instrument that has a strong theoretical basis and promising development prospects. Supported by a systematic psychometric validation process and the development of technology oriented to user needs, SCT has the potential to become an innovative, accurate, and applicable digital concentration assessment instrument. Further development is expected not only to enrich the treasures of psychometric science and cognitive assessment, but also to make a real contribution to improving the quality of evaluation of concentration abilities in the fields of education, psychology, health, and sports science

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AUTHOR CONTRIBUTIONS

Author	Contribution (CRediT Taxonomy)
First Author	Conceptualization, Methodology, Data Curation, Writing – Original Draft
Second Author	Investigation, Formal Analysis, Resources
Third Author	Supervision, Writing – Review & Editing, Funding Acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

[If applicable: State specific conflicts, funding sources, or affiliations that may represent conflicts. Full transparency is required per Scopus/Elsevier ethical standards.]

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are available in the [Repository Name] repository, accessible at [URL/DOI]. [OR: Data are available upon reasonable request from the corresponding author.]

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