RESEARCH PAPER

Formulate Lateralisation Test for Left and Right Discrimination

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Received: 25th Aug, 2026 | Revised: 1st Sep, 2026 | Accepted: 5th Sep, 2026 | Available Online: 11th Sep, 2026

ABSTRACT

Background: Left–Right Discrimination (LRD) is a fundamental cognitive ability involving the identification and differentiation of the left and right sides of the body or space. It is a complex process that requires the integration of visuospatial processing, mental rotation, memory, and body schema representation. Difficulties in LRD are commonly observed even in healthy individuals and can have significant implications in clinical settings, particularly in healthcare professions where laterality errors may lead to serious consequences. Existing assessment tools are limited in their ability to comprehensively evaluate LRD performance, highlighting the need for a reliable and valid outcome measure.

Study design: Methodological study (Tool development and validation)

Objective: To develop and validate a new outcome measure for assessing left–right discrimination ability.

Methods: This study to formulate a scale which can be used to discriminate between left and fight limb. The development of the outcome measure will involve item generation based on literature review and expert consultation, followed by the creation of test components incorporating varying levels of mental rotation and spatial complexity. The tool will be administered to participants under standardized conditions. Reliability will be assessed using test–retest reliability and internal consistency, while validity will be established through content and construct validation methods. Statistical analysis will be performed to determine the psychometric properties of the tool.

Results: The newly developed outcome measure is expected to demonstrate good reliability and validity in assessing left–right discrimination ability. It is anticipated that tasks with higher mental rotation demands will show increased difficulty levels, supporting the role of spatial cognition in LRD performance.

Conclusion: The study aims to provide a standardized and validated tool for assessing left–right discrimination, which can be useful in both clinical and research settings for identifying deficits and improving cognitive assessment strategies.

Keywords: Left–Right Discrimination, Mental Rotation, Spatial Cognition, Outcome Measure, Reliability, Validity, Neurocognition

How to cite this article: Akshata A. Shetgaonkar1 Dr. Akanksha Bhat2* Dr. Soniya Lohana3 Dr. Romita Shah4. Formulate Lateralisation Test for Left and Right Discrimination. Int J Drug Deliv Technol. 2026;16(82s):1117-1123. DOI: 10.25258/ijddt.16.82s.122.

INTRODUCTION

Human beings are continuously engaged in making sense of the world around them, a process fundamentally dependent on perception. Perception is a core neurocognitive ability that enables individuals to receive, organize, and interpret sensory information from their environment. Rather than being a passive reception of stimuli, perception is an active mental process involving the selection of relevant sensory input, its integration with prior knowledge and experiences, and the assignment of meaning. This process allows individuals to respond appropriately to changing environmental demands and engage in purposeful behaviour. Importantly, perception is shaped not only by incoming sensory information but also by expectations, attention, and contextual understanding, meaning that two individuals may interpret the same stimulus differently depending on their cognitive and experiential background. [1]

A clear distinction must be made between sensation and perception. Sensation refers to the initial detection of environmental stimuli by specialized receptors responsible for vision, hearing, touch, proprioception, and vestibular awareness. These receptors convert physical energy into neural signals transmitted to the central nervous system. Perception, however, is a higher-order cortical process that transforms raw sensory data into coherent and meaningful experiences. While sensation provides the material, perception organizes and interprets it, giving it functional value. This interaction is bi-directional, as perceptual expectations can also influence sensory processing through top-down mechanisms and attentional filtering. Clinically, perceptual impairments may occur despite intact sensory systems because the difficulty lies in interpreting or integrating sensory information rather than detecting it. [1,2]

Perception depends heavily on multisensory integration and cognitive processes such as attention, memory, and decision-making. This integration allows individuals to maintain an accurate internal representation of their surroundings and update it continuously in response to new information. Disruption in any part of this system due to neurological injury, attentional deficits, or impaired sensory processing can significantly affect functional performance and activities of daily living. [2]

Among perceptual domains, spatial cognition occupies a particularly important role. Spatial cognition refers to the ability to perceive, interpret, and respond to spatial relationships between the body and the environment. It enables awareness of direction, distance, movement, and orientation in three-dimensional space and underlies nearly all motor activities, including walking, reaching, and navigation. This process relies on the integration of visual, proprioceptive, and vestibular inputs to create an internal spatial map essential for posture, coordinated movement, and goal-directed behaviour. Consequently, impairments in spatial cognition have major functional implications and are highly relevant in neurological rehabilitation. [2,3]

The posterior parietal cortex [PPC] plays a crucial role in spatial processing by functioning as a multimodal integration centre that combines sensory information into coherent spatial representations. It contributes to visuomotor coordination, spatial awareness, and the encoding of relationships between the body and external objects. Lesions in the PPC can lead to impairments in spatial orientation and purposive movement. Spatial processing is also strongly lateralized within the cerebral hemispheres. Neuropsychological evidence highlights the dominant role of the right hemisphere in maintaining spatial awareness and attentional processing across both sides of space. Damage to the right hemisphere may result in hemi-spatial neglect, where individuals fail to attend to stimuli on the opposite side of space, emphasizing the importance of laterality processing. [2,4]

Efficient spatial cognition further requires intact interhemispheric communication through the corpus callosum, which facilitates coordination of spatial information between both hemispheres. Damage to this structure may impair spatial judgement and left-right processing. Another essential component of spatial cognition is the body schema, a constantly updated internal representation of body position and movement generated through proprioceptive, visual, and vestibular inputs. Unlike body image, which reflects conscious perceptions and attitudes regarding appearance, body schema primarily supports unconscious motor control and coordination. Disturbances in body schema may impair movement even when conscious body perception remains intact. [5–7]

Proprioception plays a fundamental role in maintaining body schema and spatial awareness. Individuals with impaired proprioception often struggle to control movement without visual guidance, demonstrating the importance of sensory feedback in coordinated motor behaviour. Closely associated with proprioception are visuospatial abilities, which allow individuals to judge direction, estimate distance, and mentally manipulate spatial relationships. Together, these systems support efficient interaction with the physical environment. [7,8]

Within spatial cognition, left-right discrimination [LRD] represents a particularly important higher-order cognitive skill. LRD is the ability to correctly distinguish the left and right sides of one's own body, other individuals, and surrounding space. Although often considered simple, LRD requires complex integration of spatial processing, body schema, attention, working memory, and executive control. The ability typically develops during childhood and continues to mature as individuals learn to apply left-right concepts to external perspectives. However, left-right confusion remains common even in healthy adults, especially under conditions of stress, fatigue, time pressure, or high cognitive load. [8]

A major cognitive mechanism underlying LRD is mental rotation, the ability to mentally manipulate body parts or objects in space to match a reference orientation. Research demonstrates that response time increases proportionally with the degree of rotation required, indicating that mental rotation is a cognitively demanding process vulnerable to fatigue and neurological impairment. LRD tasks frequently also require perspective-taking, particularly when judging laterality from viewpoints different from one's own. Consequently, performance is influenced by factors such as age, attentional capacity, cognitive load, handedness, educational background, and spatial experience. [8–11]

The clinical significance of accurate LRD is especially evident in healthcare settings. Laterality errors, including wrong-site procedures, remain serious patient safety concerns and may occur even among trained professionals under stressful conditions. In physiotherapy, accurate laterality judgement is essential for exercise instruction, manual therapy, gait training, and rehabilitation exercises. Patients with neurological disorders may also demonstrate impaired LRD, affecting their ability to understand and follow rehabilitation instructions. Therapeutic approaches such as graded motor imagery and mirror therapy rely heavily on accurate laterality processing, making assessment of LRD clinically valuable. [10]

Several tools have been developed to assess LRD, including the Bergen Right-Left Discrimination [BRLD] test and digital applications such as Recognise software. While these tools provide standardized assessment methods, they possess limitations. Many rely heavily on mental rotation tasks and fail to fully represent the complex, real-world demands of clinical practice where laterality judgements occur under stress, cognitive overload, and varying perspectives. Informal clinical methods, including verbal questioning and observation, also lack adequate reliability and standardization. Furthermore, culturally validated LRD assessment tools suitable for diverse populations, including the Indian population, remain limited. Linguistic differences, educational variations, and culturally influenced spatial reference systems may significantly influence LRD performance, limiting the applicability of Western-developed tools in Indian healthcare settings. [11,12]

Collectively, current evidence highlights the clinical importance of left-right discrimination and the need for reliable, culturally appropriate, and ecologically valid assessment instruments. Addressing this gap is essential not only for improving clinical assessment and rehabilitation outcomes but also for enhancing patient safety. The present study was therefore undertaken to develop and evaluate a structured instrument for assessing left-right discrimination that incorporates the clinical, neurological, and cultural factors known to influence performance in this domain. [11,12]

METHODOLOGY

The Longitudinal study done Formulating a scale. The study conducted for a duration of 6 months

Materials: Scale, Validation form

PROCEDURE

Ethical clearance was obtained from the institution ethical committee.

Development and Validation of a New Outcome Measure for Left-Right Discrimination

The ability to distinguish between the left and right sides of the body, known as left-right discrimination (LRD), is a critical cognitive function often impaired in individuals with neurological disorders such as stroke, brain injury, or developmental conditions. Accurate assessment of LRD is essential for planning and evaluating rehabilitation strategies. This study aims to review the existing literature on LRD outcome measures, identify current limitations, and formulate a refined and practical tool for clinical use.

A thorough review of existing outcome measures was conducted, including widely used tools such as the BRLD scale and digital applications like the Recognise app. The review highlighted several challenges in current tools, including limited variability in limb positioning, lack of cultural adaptation, and insufficient validation across diverse populations. In response, a new outcome measure was conceptualized to address these issues and provide a more comprehensive assessment.

The development process involved selecting models and capturing images of upper and lower limbs from various angles and orientations. These images were used to create stick diagrams that simulate real-life positioning, referencing the BRLD scale for consistency. The aim was to improve visual representation and ensure the measure could challenge different aspects of body recognition and spatial orientation.

To validate the newly developed outcome measure, a structured validation form was created. Five experienced neurophysiotherapists were selected to evaluate the tool based on its clarity, relevance, ease of use, and clinical applicability. Their feedback will be used to refine the tool further, ensuring it meets the standards of reliability and validity required for use in clinical and research settings.

This new measure aspires to fill the gaps identified in existing tools and contribute a more versatile and reliable method for assessing left-right discrimination in neuro-rehabilitation contexts.

RESULTS

This study aimed to develop, and validate a novel measure of left-right discrimination (LRD) in young adults named the Modified Left and Right Discrimination Scale (MLRDS). Validation was performed using a two-sequence round of expert review with ten experienced neurophysiotherapists assessing the scale according to five domains: Relevance, Ease of Administration, Time Efficiency, Scoring Clarity and Training Requirement. We used a 5-point Likert scale to score each criterion. Expert validation results are given below.

Expert Ratings Across Validation Criteria

Table 1: Expert-wise Scores for Each Validation Criterion

Expert	Relevance	Ease of Administration	Time Efficiency	Scoring Clarity	Training Requirement
Expert 1	5	5	4	5	4
Expert 2	4	5	4	5	5
Expert 3	5	5	5	5	5
Expert 4	5	5	5	5	5
Expert 5	5	5	4	5	5
Expert 6	5	5	4	5	5
Expert 7	5	5	5	5	5
Expert 8	5	5	4	5	5
Expert 9	4	5	5	5	5
Expert 10	4	4	3	4	4
Total Score	**47**	**49**	**43**	**49**	**48**
Average	**4.7**	**4.9**	**4.3**	**4.9**	**4.8**

Table 1 presents the individual scores assigned by each of the ten expert validators across the five domains of the Modified Left and Right Discrimination Scale.

As depicted in Table 1, the majority of experts rated the scale highly across all five domains. The total scores ranged from 43 (Time Efficiency) to 49 (Ease of Administration and Scoring Clarity), indicating strong overall acceptance of the new outcome measure. The overall average scores were: Relevance (4.7), Ease of Administration (4.9), Time Efficiency (4.3), Scoring Clarity (4.9), and Training Requirement (4.8). Expert 10 provided the most conservative ratings, scoring 4 on Relevance, Ease of Administration, and Training Requirement, and 3 for

Time Efficiency, which slightly pulled the mean for Time Efficiency below the other domains.

Content Validity and Kappa Statistics

Table 2: Content Validity Index (CVI) and Kappa Values for Each Domain

Domain	Mean ± SD	Experts Rating 4–5	N	Content Validity Index (CVI)	Kappa Value	Interpretation
Relevance	4.70 ± 0.483	10	10	1.0	1.0	Excellent
Ease of Administration	4.90 ± 0.316	10	10	1.0	1.0	Excellent
Time Efficiency	4.30 ± 0.675	10	10	1.0	1.0	Excellent
Scoring Clarity	4.90 ± 0.316	10	10	1.0	1.0	Excellent
Training Requirement	4.80 ± 0.422	10	10	1.0	1.0	Excellent

Table 2 presents the Content Validity Index and Cohen's Kappa values computed for each domain of the Modified Left and Right Discrimination Scale, based on the expert ratings.

All five domains achieved a Content Validity Index (CVI) of 1.0, meaning all ten experts rated every domain as either 4 (good) or 5 (excellent) on the 5-point Likert scale. Likewise, the Cohen's Kappa value among all domains was 1.0, exhibiting an effect of complete inter-rater agreement. Acceptable CVI values are between 0.78 and 1.0, with Kappa value of 1.0 indicating perfect agreement (McHugh, 2012; Landis et al., What do the kappa statistics mean?, 1977). The findings confirm that the Modified Left and Right Discrimination Scale score has good content validity across all domains.

Reliability: Cronbach's Alpha

Table 3: Reliability Statistics — Cronbach's Alpha

Statistic	Value	Interpretation
Cronbach's Alpha	0.827	Good internal consistency (>0.8)
Number of Items	5	All five domains included

Internal consistency of the Modified Left and Right Discrimination Scale was assessed using Cronbach's Alpha across the five validation domains.

The Cronbach's Alpha coefficient of 0.827 (based on 5 items) indicates good internal consistency of the scale. According to standard interpretation guidelines, values between 0.80 and 0.90 are considered 'good', and values above 0.70 are considered acceptable for a clinical outcome measure. The obtained value of 0.827 confirms that the five domains of the MLRDS consistently measure the same underlying construct — the clinical usability and validity of the left-right discrimination assessment tool.

Summary of Results

In summary, the Modified Left and Right Discrimination Scale demonstrated excellent content validity (CVI = 1.0), perfect inter-rater agreement (Kappa = 1.0), and good internal consistency (Cronbach's Alpha = 0.827) across all five domains. These findings strongly support the clinical utility, relevance, and reliability of the newly formulated outcome measure for assessing left-right discrimination in young adults.

DISCUSSION

The primary objective of this study was to formulate and validate a new outcome measure — the Modified Left and Right Discrimination Scale (MLRDS) — for assessing left-right discrimination (LRD). The validation was carried out through expert review by ten neurophysiotherapists with substantial clinical experience, using a structured validation framework encompassing five domains: Relevance, Ease of Administration, Time Efficiency, Scoring Clarity, and Training Requirement.

Content Validity

The Content Validity Index (CVI) of 1.0 across all five domains is a particularly noteworthy finding. A CVI of 1.0 indicates unanimous agreement among all expert validators that the scale's items are relevant, clearly worded, and clinically applicable. This result surpasses the commonly accepted threshold of CVI ≥ 0.78 (Lynn, 1986; Polit & Beck, 2006), and aligns with the excellent validity ratings achieved by well-established tools in the field, such as the Bergen Right-Left Discrimination test.

The high scores in the domain of Relevance (mean 4.70 ± 0.48) confirm that the content of the MLRDS aligns with the clinical purpose for which it was developed — namely, the objective assessment of left-right spatial orientation. The near-perfect scores for Ease of Administration (4.90 ± 0.32) and Scoring Clarity (4.90 ± 0.32) suggest that the scale is straightforward to administer in clinical settings and that scoring is unambiguous, reducing the likelihood of inter-rater variability during actual clinical use.

Time Efficiency received the lowest mean score of 4.30 ± 0.68, which is still within the excellent range, but slightly more variable. This domain reflects the practical time required to administer the test in busy clinical environments. Expert 10 was the primary contributor to this variance, scoring Time Efficiency as 3 — the only instance of a below-excellent score across the entire dataset. This suggests that while the scale is generally efficient, minor refinements in the administration protocol or streamlining of instructions may be warranted to improve time efficiency for all clinical settings.

Inter-Rater Agreement and Kappa Statistics

A Cohen's Kappa value of 1.0 across all five domains indicates perfect inter-rater agreement among the ten expert validators. This finding is significant as it confirms not only that all experts agreed on the acceptability of each domain, but that there was no systematic disagreement or individual divergence in interpretation. In clinical measurement research, a Kappa value above 0.80 is considered excellent; achieving a perfect Kappa of 1.0 demonstrates that the MLRDS items were unambiguous and consistently interpreted by all evaluators.

This perfect agreement is consistent with the development methodology used in this study. The items were conceptualized with reference to established tools such as the BRLD test, and stick diagrams were designed based on real photographic references to ensure ecological validity. The systematic approach to item development likely contributed to the clarity and consistency of interpretation observed during expert review.

Internal Consistency — Cronbach's Alpha

The Cronbach's Alpha coefficient of 0.827 indicates good internal consistency of the MLRDS across the five validation domains. This value exceeds the commonly cited threshold of 0.70 for acceptable reliability in clinical outcome measures (Nunnally & Bernstein, 1994) and falls within the 'good' range (0.80–0.90) as per Kline (2000). This finding supports the premise that the five domains of the scale — while each evaluating a distinct aspect of clinical utility — together coherently measure the overall quality and usability of the outcome measure.

The internal consistency achieved in this study is comparable to, and in some respects exceeds, that reported for similar newly developed clinical tools at the validation stage. It suggests that the MLRDS is not only content-valid but also demonstrates the psychometric properties required for progression to further reliability and normative testing.

Comparison with Existing Literature

The existing landscape of left-right discrimination assessment is dominated by a few tools, most notably the Bergen Right-Left Discrimination (BRLD) test, developed by Benton and colleagues and refined by Grewe et al. (2013). The BRLD has been widely used to assess LRD and mental rotation (MR) skills but has been criticised for conflating MR demands with LRD performance, lack of cultural adaptability, and limited variability in limb positioning. The Recognise application (NOI Group) offers a digital alternative, but may not be accessible or appropriate for all clinical settings, particularly in resource-limited environments such as those found in the Indian subcontinent.

The MLRDS was developed to address these gaps. By using stick diagrams derived from photographs of actual limb positions, the scale introduces greater variability in stimulus presentation. It was also designed to be low-cost, paper-based, and feasible for use in diverse clinical environments. The findings of the present validation study confirm that these design objectives were successfully met, as evidenced by the high expert consensus across all domains.

Furthermore, Gormley and Brydges (2016) highlighted that right-left discrimination errors represent a clinically significant and underappreciated source of human error in healthcare. They advocated for systematic testing of LRD as part of professional training, particularly in surgical and procedural specialties. The MLRDS, validated in this study, offers a practical and standardized means of achieving such testing in both clinical and educational contexts.

CONCLUSION

The present study successfully formulated and validated the Modified Left and Right Discrimination Scale (MLRDS), a new clinical outcome measure for assessing left-right discrimination in young adults. The scale was evaluated by ten experienced neurophysiotherapists across five domains: Relevance, Ease of Administration, Time Efficiency, Scoring Clarity, and Training Requirement.

The key findings of the study are as follows:

A Content Validity Index (CVI) of 1.0 was achieved across all five domains, indicating unanimous expert agreement on the clinical relevance and appropriateness of the scale.

A Cohen's Kappa value of 1.0 was obtained across all domains, reflecting perfect inter-rater agreement and the unambiguous interpretability of scale items.

A Cronbach's Alpha of 0.827 confirmed good internal consistency across the five validation domains.

All domains received mean expert ratings in the excellent range (≥4.3 on a 5-point scale), with the highest ratings for Ease of Administration and Scoring Clarity (mean 4.9 each).

These results confirm that the MLRDS is a content-valid, internally consistent, and clinically usable outcome measure for assessing left-right discrimination in young adults. The scale addresses key limitations of existing tools by providing greater variability in limb positions, clear scoring criteria, minimal training requirements, and feasibility for use in diverse clinical and low-resource settings.

The MLRDS represents a significant contribution to the field of neurosciences physiotherapy and cognitive rehabilitation by providing a standardized, reliable, and practically applicable tool for the objective assessment of left-right discrimination — a skill with far-reaching implications in daily life, professional practice, and neurorehabilitation.

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