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REVIEW

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Understanding task "challenge" in stroke rehabilitation: an interdisciplinary concept analysis

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ABSTRACT

Purpose: Rehabilitation plays a critical role in minimising disability after stroke, with the concept of "challenge" proposed to be essential to rehabilitation efficacy and outcomes. This review unpacks how challenge is conceptualised in stroke rehabilitation literature from the perspectives of physiotherapy, occupational therapy, speech-language therapy and people with stroke. A secondary purpose was to provide a definition of challenge that is applicable to stroke rehabilitation.

Methods: Principle-based concept analysis was utilised to examine challenge within the stroke rehabilitation literature. Forty-two papers were included. Data analysis involved immersion, analytical questioning, coding and synthesis to elicit the conceptual components of challenge.

Results: Challenge was understood as a multidimensional and dynamic concept with three facets: nominal, functional and perceived challenge. Functional and perceived challenge were integral to *optimal* challenge. Optimal challenge was central to enhancing the outcomes and experiences of people with stroke, in rehabilitation and everyday life.

Conclusions: Challenge is a key concept which, when carefully optimised to the person's ability and experience, may positively influence their learning, recovery and engagement after stroke. This review lays a conceptual foundation for better understanding, operationalisation and advancement of challenge, offering important implications for addressing the growing burden of stroke disability, through rehabilitation.

IMPLICATIONS FOR REHABILITATION

- Challenge involves a multifaceted, multidimensional and dynamic interaction between the task, the person's ability and their subjective experience.
- The therapist and the person's perspective should collectively shape the process of co-creating a challenge that is truly optimal for the person.
- Therapists should consider both functional and perceived approaches to operationalising challenge *with* the person.

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Stroke; rehabilitation; concept analysis; review; challenge; engagement; intensity; dose

Introduction

Stroke is a leading cause of disability worldwide, creating a personal and societal burden that is projected to grow exponentially if we do not rethink our understanding and approaches of rehabilitation [1,2]. Stroke rehabilitation is commonly seen as the primary mechanism of minimising disability and promoting independence after stroke [3]. This involves a sustained and co-ordinated problem-solving process where a person with stroke works collaboratively with their family and healthcare professionals, such as physiotherapists, occupational therapists and speech-language therapists, to achieve their goals [3,4]. However, several gaps remain in understanding the concepts that make rehabilitation effective, such as dose, challenge and engagement [3,5,6]. Challenge, in particular, is a concept that is purportedly important to neurological and functional recovery after stroke [5,7–9]. It is emerging as a key feature of innovative rehabilitation approaches, including virtual reality, robot-assisted and computer-based therapies [10–12]. Research has also begun exploring the experience of challenge and its influence on aspects such as learning, performance, engagement and therapeutic relationships [13–16]. Yet, despite the frequent reference to and use of challenge in stroke rehabilitation, the concept is poorly understood.

Over the past decade, several authors have identified that there is considerable variability and ambiguity in the description of challenge and have proposed definitions for stroke rehabilitation [1,17]. For example, Hayward and colleagues [1] describe challenge as "how hard the *task* is" where challenge is intrinsic to the type of task. Alternatively, Page and colleagues [17] refer to challenge as "the amount of physical or mental work put forth by the *client*" where challenge is dependent on the effort exhibited by the person. Both articles also allude to a subjective or psychological component to challenge. The authors noted that while an individual's subjective feeling or psychological effort may vary, it can serve as a proxy of physical and mental exertion, and may inform the individual's engagement in rehabilitation more broadly [18,19]. Stroke rehabilitation has also begun to draw on the fields of

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exercise science and psychology, which theorise that there is an 'optimal' challenge [20,21]. This diversity in understandings is exacerbated by the fact that challenge is often mentioned in the literature, without being defined. A lack of clarity may stem from the assumption that challenge is an everyday concept that is familiar to most [1,16,17,22,23]. However, when scientific and everyday perspectives are not delineated carefully, the concept may become unknowingly lost or blurred, all while it appears the same concept is still being discussed [18]. Such ambiguities are also reflected by the various interchangeable terminologies used to describe challenge, both within and across rehabilitation perspectives. For instance, terms such as "intensity," "difficulty," "complexity," "load" and "demand" are all commonly used to describe the *same* concept as challenge, but may also be used to describe *different* concepts in stroke rehabilitation [1,16,17,22,23]. Without clarifying the concept first, these conceptual confusions will only be compounded as challenge evolves [18].

Disparate perspectives among researchers, therapists and people with stroke on fundamental concepts, such as challenge, poses significant limitations to the advancement of stroke rehabilitation [1,5,17]. Poor understanding may risk the development of inconsistent, inadequate and inefficient approaches to the operationalisation of challenge in clinical practice [24,25]. Consequently, people with stroke may have to adapt to a diversity of interpretations and applications of challenge [24,25]. If we are to capitalise on the therapeutic potential of challenge, we must first establish a clear and shared understanding of the concept. Greater consensus within research may provide a theoretical foundation for advancing the application of challenge in clinical practice, and enhance the outcomes and experiences of people with stroke [1,5,26,27]. Therefore, this study aims to explore how challenge is conceptualised in the stroke rehabilitation literature from the perspectives of physiotherapy, occupational therapy, speech-language therapy and people with stroke. A secondary aim was to propose a definition of challenge that is applicable to stroke rehabilitation.

Methods

Methodology

Concept analysis is an established health research methodology used to develop a comprehensive understanding of a partially mature concept [18,28,29]. Partially mature concepts are characterised as identifiable but lacking explicit understanding and carrying a breadth of ambiguous definitions, terminologies and uses, rendering them inadequate for effective operationalisation [29]. This review drew on Penrod and Hupcey's [18] principle-based concept analysis method to evaluate the state of science surrounding challenge in stroke rehabilitation. Philosophical principles of epistemology, pragmatics, linguistics and logic guided the interrogation of carefully selected theoretical and empirical literature [18,29]. By following a process of immersion, analytical questioning, coding and synthesis, this research elucidated the conceptual components of challenge and derived a definition which may inform future stroke rehabilitation research and clinical practice.

Data selection

A systematic and iterative approach was used to select papers for this concept analysis. A comprehensive scoping process was conducted across various sources, rehabilitation contexts and disciplinary literature to explore the different terminologies, descriptions and applications of challenge. This informed the search strategy, which was conducted in EBSCO (MedLINE, CINAHL, SPORTDiscus), OVID (AMED, PsycINFO, Cochrane CENTRAL, Cochrane Systematic Reviews, Health and Psychosocial Instruments) and Scopus databases, and was last run in June 2023. The inclusion of papers was not limited by the date of publication, therefore, the earliest publication date was dependent on the database. The search strategy can be found in the Appendix.

The data selection process is illustrated in Figure 1. A total of 1740 deduplicated papers were screened. Only peer-reviewed papers written in English were considered. Papers were included if they: (1) explored or conceptualised challenge in stroke rehabilitation or (2) shared key findings relating to challenge in stroke rehabilitation. All papers underwent title and abstract screening according to the inclusion criteria, which excluded 1190 papers. The large number of remaining papers was not feasible for full-text screening—a common issue inherent to concept analysis studies [18]. To address this, Penrod and Hupcey [18] suggest prioritising a dataset that is feasible, valuable and representative. Therefore, an additional inclusion criterion was introduced, requiring papers to also (3) be deemed to have high informational value. Informational value was based on Whiffin and colleagues' [30] description of the papers' relevance and resonance to our study aims and is further defined in the Table. To identify papers with high informational value, the full-texts of remaining papers were uploaded to QSR NVivo 20 and reviewed using the text query function [31]. This enabled a streamlined identification and review of excerpts that discussed the concept of challenge and helped determine which papers met the revised inclusion criteria for high informational value. Consequently, a further 397 papers were excluded. Papers were primarily excluded because the key terms of challenge were not relevant to the concept under investigation. For example, "intensity" was commonly used to describe the amount of therapy or level of stimulation from a neuromodulatory rehabilitation adjunct. When the concept of challenge was used with relevance, it was often only mentioned incidentally and with minimal resonance to the evidence base. Subsequently, full-text screening excluded a further 111 papers and confirmed the eligibility of the remaining papers. As defined in the Table, the 42 included papers were prioritised into core, central or peripheral classifications based on their informational value [30].

Data analysis

Starting with core, central and then peripheral papers, each paper was read twice for immersion and then coded. Core papers underwent rich coding based on analytical questions, such as: How is challenge defined? How does the purpose and operationalisation of challenge change throughout the rehabilitation process? And how are different conceptualisations of challenge

Table. Classification of core, central and peripheral papers based on informational value.

Core	Relevance: Research question aligns with the current study's aims Resonance: Findings are rich, complex and evocative and make a meaningful and insightful contribution to advancing the evidence base
Central	As above but may fail to meet one or both of the criteria in its fullest sense
Peripheral	Relevance: Research findings are relevant but the research question is not completely aligned to the current study's aims Resonance: Findings are superficial, thin or expected and do not advance the evidence base in a meaningful way

Adapted from: Whiffin et al. [30].

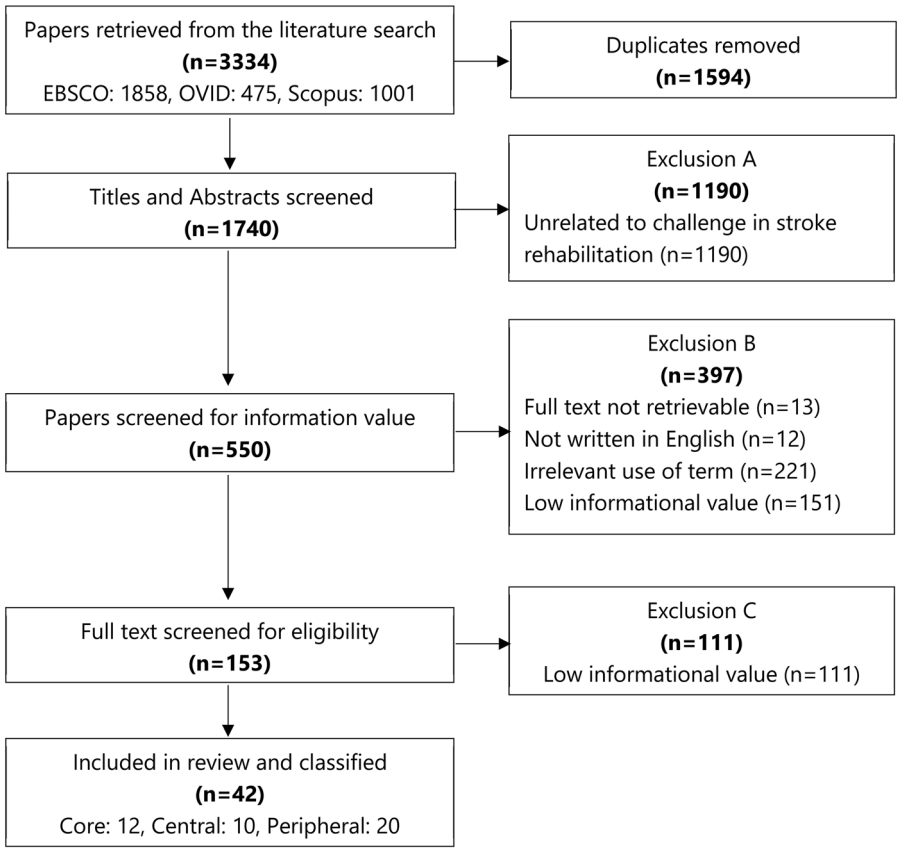

Figure 1. Data selection.

reflected by terminology? Central papers then applied or expanded on these codes and new codes were identified through further analytical questioning. Peripheral papers subsequently refined and 'tested' these codes, developing a few new codes. Matrices were used to conduct constant comparison and synthesise codes [19]. This process derived the antecedents, attributes and outcomes of challenge in stroke rehabilitation. As a guide, antecedents included phenomena that preceded and influenced challenge, whereas attributes were the characteristics of the understanding or process of challenge and outcomes were the effects that followed the occurrence of challenge [32].

Rigour

Rigour was embedded throughout the research process. To promote methodological soundness, an author (FB) with expertise in concept analysis supported the development of the methods. Furthermore, a person with stroke and researchers from physiotherapy, occupational therapy and speech-language therapy backgrounds reviewed the search strategy. The inclusion and classification of a sample of the final dataset was agreed upon by two researchers from different disciplines. Any disagreement was resolved through discussion between the researchers until consensus was achieved. Additionally, the analysis of papers based on their classification facilitated a scaffolded approach whereby the core and then central papers were used to gain a broad and deep understanding of challenge, which was then refined by the peripheral papers. Both data selection and data analysis were accompanied by memoing, reflexivity and interdisciplinary team discussions. These processes tested and refined conceptual ideas as they emerged, and enhanced the credibility of the findings [33].

Results

A total of 42 papers were included in this concept analysis. A full summary of the included papers, including their perspective and key conceptual contributions with relevant examples, can be found in the Supplementary File. For brevity, only the most relevant papers are referenced within this Results section. Overall, the papers represented a range of study designs, including experimental, intervention-based, qualitative, mixed methods and review papers. Of the 42 papers, 20 were from physiotherapy, 5 from occupational therapy, 5 from speech-language therapy and 12 from a mix of perspectives, which also included the perspectives of people with stroke. The results represent the combined conceptual understandings gained from exploring challenge across key perspectives in stroke rehabilitation. While the findings reflect important nuances in how challenge is understood and operationalised, this study did not specifically aim to compare the findings from each perspective. The following results conceptualise challenge through its antecedents, attributes and outcomes (see Figure 2), and proposes a definition of challenge that may be applicable to stroke rehabilitation. Hereafter, the "person" refers to a synthesis of excerpts that shared the perspective of people with stroke, whereas "therapists" refer to a synthesis of excerpts from the perspectives of physiotherapy, occupational therapy and speech-language therapy.

Antecedents of challenge

This analysis identified two interrelated antecedents of challenge: understanding the *task* and understanding the *person*. The "task" often referred to the discrete or combined

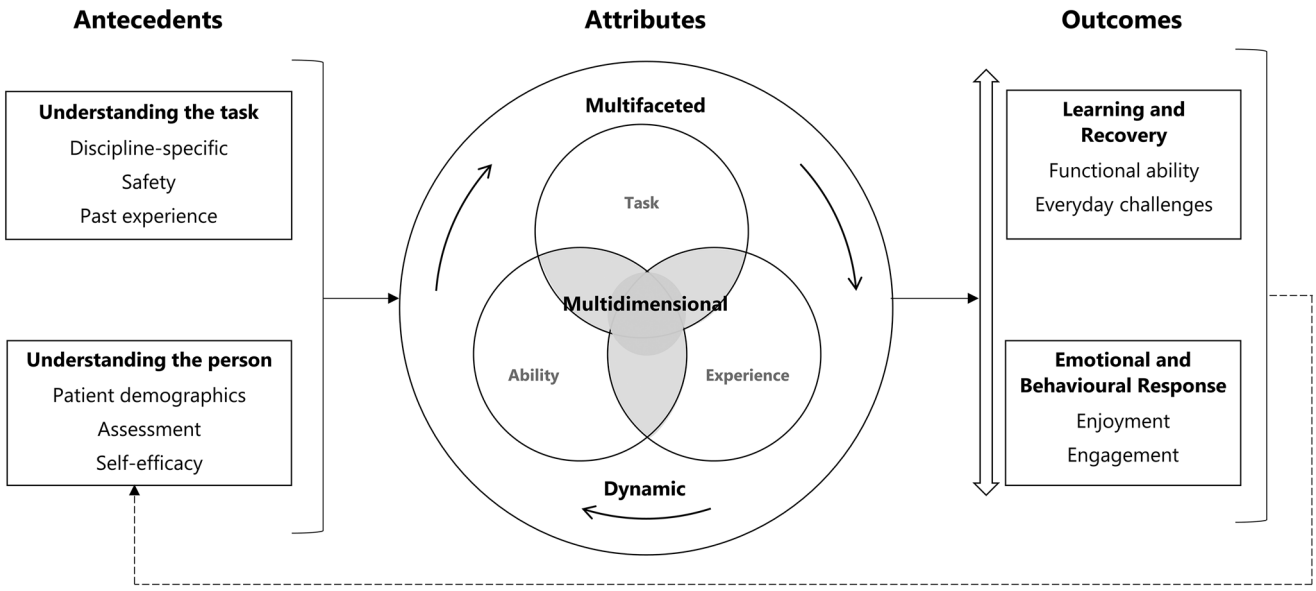

Figure 2. Conceptual components of challenge in stroke rehabilitation.

components of a rehabilitation movement, activity or goal. All papers from the perspective of physiotherapy, occupational therapy and speech-language therapy understood the task through their disciplinary lens. In contrast, people with stroke appeared to understand the task through the clarity of instructions [34,35] and the therapeutic context [35–37], and was shaped by the person's personality [38–41] and past experiences of the task [35,42,43]. Understandings of the task were often contextualised to understandings of the person, either at an individual or group level. Therapists frequently understood the person through their age [34,40,44], gender [40,45,46], stage of stroke [35,42], lesion location [47–49], presence and severity of impairments and disability [34,38,50,51], physical and psychological comorbidities [44,48,52] and medication effects [43,44,53,54]. Both therapists and people with stroke integrated these antecedents through their anticipations of the person's probability of successfully performing the task [20,51,55] or safety of engaging with a challenging task [44,46]. This task-person interaction was frequently understood through the therapist's observations, which were supported by formal assessments, including objective tests, algorithms and measures pertaining to challenge [20,35,42,53,56,57]. Therapists could use their evaluation of the task-person interaction throughout rehabilitation as a precursor to treatment involving challenge [20,51]. On the other hand, people with stroke based their expectations of the task-person interaction on their self-efficacy [38,46], physical or mental desire to be challenged [41,52] and trust in their therapist [20,37]. For example, Pollock and colleagues [20] described how the therapist and person could collaboratively set the challenge based on the person's performance of a stepping task and the person's expressed readiness for challenge.

Attributes of challenge

Challenge was *multifaceted*, characterised by nominal, functional and perceived facets of challenge. Across these facets, challenge was also characterised as *multidimensional* and *dynamic*. The conceptual attributes of challenge are visualised in Figure 3.

Challenge is multifaceted

The concept of challenge encompasses three interlinked facets: nominal, functional and perceived challenge. Nominal challenge denoted the task difficulty based on the characteristics of the task and the environmental demands [20,34,36–39,41–45,48–51,53–73]. Functional challenge was described as the task difficulty based on the characteristics of the task *and* the person's ability [20,36–42,44–51,53–59,61,62,64–73]. Finally, perceived challenge was described as the person's sense of effort or subjective experience of difficulty associated with the task, often reflecting their level of mental engagement or fatigue [20,34–41,43,45–49,53–55,60,63,64,66–69,73].

These three facets were understood and operationalised as continuums, each holding hierarchical levels of challenge depending on the task characteristics, the person's ability or their subjective experience. For example, Woodbury and colleagues [51] used continuums of task difficulty (easy to hard upper limb tasks) and patient ability (poor to good upper limb skills) to predict if a person would be unable, partially able or fully able to successfully accomplish a task or activity. Assessment and treatment procedures could move across these continuums to understand and operationalise levels of challenge [20,34–42,44–51,53–73]. Nominal challenge was particularly pertinent to impairment-focused training, such as finger tapping or word retrieval within physiotherapy and speech-language therapy respectively [34,70,72,74]. In contrast, functional and/or perceived challenge were often associated with more activity-based operationalisations, such as home and gardening programmes within occupational therapy [41,45,51,62,71]. This reflected a potential link between facets of challenge, the type of task and the disciplinary approach to rehabilitation. The three facets were often considered interdependent, where an increase of difficulty in one facet was expected to be paralleled by an increase in the others [34,51,55,60]. However, some papers contradicted this assumption. Papers that used subjective measures of challenge or considered the perspective of

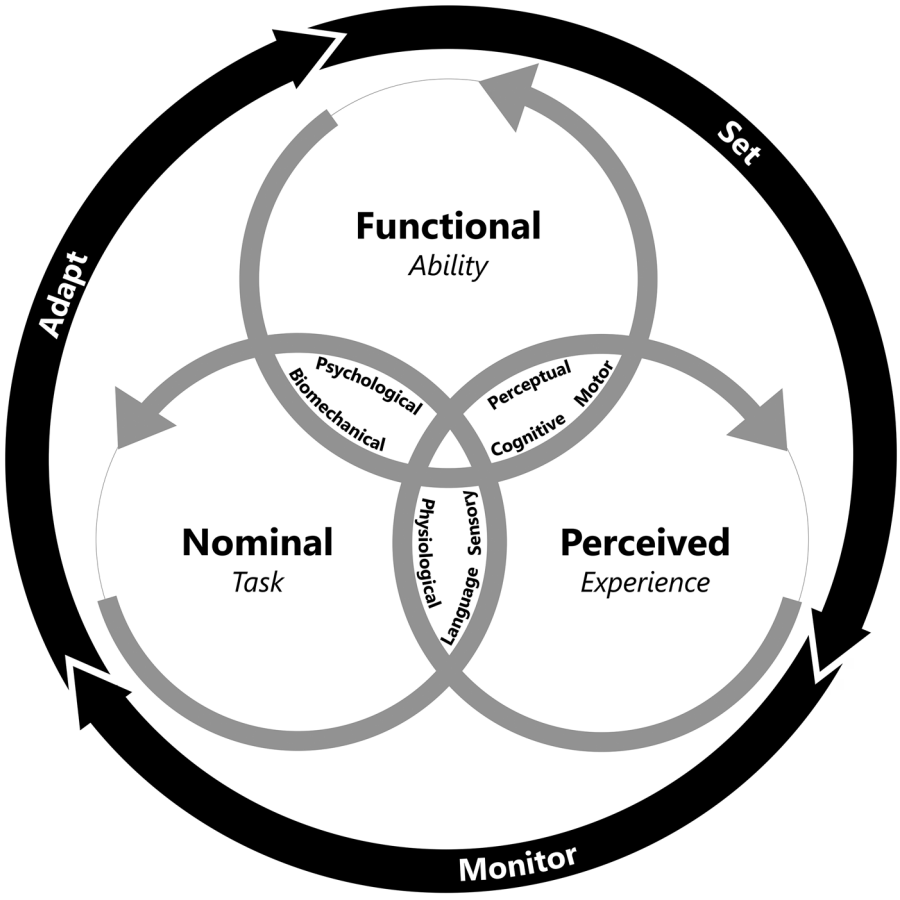

Figure 3. Conceptual attributes of challenge in stroke rehabilitation. *Note*. The multifaceted attribute of challenge is represented by the three interlinked facets of nominal, functional and perceived challenge. The multidimensional characteristic of challenge is captured by the dimensions (psychological, biomechanical, perceptual, cognitive, motor, physiological, language, sensory) within the overlap between facets. The dynamic nature of challenge is illustrated by the iterative set, monitor and adapt process within the outer circle of continuous arrows.

people with stroke illustrated that perceived challenge was not necessarily commensurate with nominal and functional challenge [36,38,41,47–49,52,55]. Perspectives from occupational therapy and people with stroke particularly noted that perceived challenge could remain low regardless of high levels of physical and mental effort, *if* rehabilitation was perceived to be fun, empowering and rewarding [37,41,52,67]. These perspectives also highlighted the influence of physical, social, cultural, environmental and therapeutic contexts on perceived challenge, which in turn, influenced the functional challenge. While all three facets were closely related, challenge was largely conceptualised through functional and/or perceived facets, reflecting the person-oriented nature of challenge in stroke rehabilitation.

Challenge is multidimensional

Challenge was described as multidimensional, understood and operationalised through various "body systems" related to the task, the person and their experience. Papers referred to motor, cognitive, sensory, biomechanical, physiological, language, perceptual and psychological dimensions. In this way, the multidimensional nature of challenge appeared to reflect the diverse nominal task requirements, heterogenous functional impairments or abilities, and how these were perceived by people with stroke. Each dimension was inconsistently supported by its own terminology, theories and empirical research to explain the nature and effects of challenge; these differences appeared to stem from the differentiated understandings and types of task challenge within each discipline. Physiotherapy commonly described challenge through motor "task difficulty" [20,50,61,66,69], whereas speech-language therapy referred to the "cognitive load" or "complexity" [38,58,74]. Interestingly, occupational therapy and people with stroke often shared a focus on perceptual and psychological "effort" or how "easy/hard" the experience was [37,38,40,49,51,52,63]. This reflects how most papers focused on one or two dimensions of challenge that were relevant to the purpose, tasks and disciplinary perspective of the study. For example, Yang and colleagues [50] used dual-tasks encompassing cognitive and motor dimensions, which were separately manipulated through various levels of serial subtraction and walking difficulty, and further manipulated by accuracy and speed requirements. The multidimensionality of challenge underpinned its operationalisation, where each dimension of the task could be manipulated differently to adapt the level of challenge. The alignment or mismatch between the task characteristics and the person's abilities or experience with respect to these dimensions, often determined the functional and perceived outcomes of engaging with challenge.

Challenge is dynamic

Challenge was characterised as dynamic, operationalised and experienced variably within and across moments, tasks and sessions of rehabilitation. While the nominal challenge of tasks would remain constant, functional and perceived challenge were noted to be influenced by changes in the person's ability [34,42,51], pain [35,44], fatigue [44,49,52], therapeutic interactions [20,34,61,63], mood [38,41,63] and self-perception [34,41,45,52], as well as the person's

sense of motivation and engagement [37,38,40,42]. For example, Kumar, Fang and Pirogova [40] discussed how the level of challenge may be inter-related to a person's perception of performance errors, and subsequently, their mental fatigue, engagement, motivation and perceived challenge associated with the task. Therapists and rehabilitative technologies frequently considered such changes in creating *optimal* challenge [20,35,37–42,46,51,53,55,56,61,62,65–67,72], whereas people with stroke learned how to adapt the level of challenge intuitively [36,37,45,71,73].

Responsiveness to the dynamic nature of functional and perceived challenge was often operationalised through a continuous and iterative process of setting, monitoring and adapting the level of challenge, to maintain a state of optimal challenge. Reflecting functional challenge, authors described the optimal challenge as a task that was just beyond the person's current ability but still achievable, or a task that was neither too easy nor too hard for the person [20,35,37–39,42,45,51,53,55–57,61,62,65,66,69]. Therapists and adaptive technologies could employ a dynamic process of clinical judgement, trial and error or draw on objective proxies to set, monitor and adapt the level of functional challenge [20,42,56,61,69]. However, optimal *functional* challenge was often understood and used alongside optimal *perceived* challenge, which was seen as a mentally engaging psychological experience [35,39,53] or a learning context which fostered a sense of mastery [41,71]. For example, Archer, Smith and Newham [34] created functionally challenging swallowing tasks by using biofeedback to motivate the person to continuously exceed their perceived maximal effort swallow. Optimal challenge could be sought by therapists and people with stroke by manipulating nominal task challenge in response to changes in functional and/or perceived challenge. While this process often opted for a functional approach by responding to the person's performance, occupational therapy and people with stroke particularly noted that perceived challenge could also be adjusted by maintaining an optimal sense of confidence [20,41,46], enjoyment [35,39] and engagement [35,42,52,53]. This reflects how optimal challenge was dynamically understood and operationalised across both facets of functional and perceived challenge. However, some papers from physiotherapy and speech-language therapy also explored optimal challenge through nominal challenge [34,44,58–60,70].

Outcomes of challenge

All papers identified outcomes of nominal, functional or perceived challenge, which broadly pertained to the interrelated effects of challenge on the person's learning and recovery, and emotional and behavioural response. The specific effects of challenge varied across low, optimal and high levels of challenge, in rehabilitation and everyday life. Low levels of nominal and functional challenge were said to produce minimal learning, and therefore, minimal neurological and functional recovery [46,51,58,62]. This coincided with perceived boredom [35,39,55], excessive relaxation [53] and low benefit [35,37], and led to behaviours of disengagement [56,63] and withdrawal from the task or rehabilitation all together [38]. Similarly, high levels of nominal and functional challenge were said to make learning and recovery unrealistic [42,50,51,66] and was manifested by poor performance [38,46,50] and safety concerns [44–46], as well as perceptions and experiences of frustration [42], anxiety [38,53], pressure [52], exhaustion [47] and losses to confidence and resilience [38]. This could lead to maladaptive strategies [51,58,70], fear-avoidance and abandonment [20,38] of the task or rehabilitation, and could translate to functional deterioration and social isolation in the community [20,38,50]. However, optimal functional and perceived challenge could *improve* neurological and functional recovery [20,51,57,74] and fostered perceived enjoyment [35,67], motivation [38,52,65], engagement [39,42] and a sense of reward [34,35]. This could be reflected by incremental improvements in the person's ability [34,51,62] and enhanced the person's experience of rehabilitation [37,39,41,61,71], including reinforcement of trust in the therapist's competence [37]. This often translated to re-mastery of 'challenges' in the community or everyday life [20,46,59] and encouraged self-efficacy to continue engaging with rehabilitation [38,41,69]. This reflects the cyclical process of engaging with challenge, where people with stroke and therapists could predict future experiences of challenge based on past reflections and real-time outcomes or experiences.

A proposed conceptual definition of challenge in stroke rehabilitation

Synthesis of the key conceptual components described above informed a theoretically and empirically derived definition of challenge in stroke rehabilitation:

> Challenge is a multifaceted, multidimensional and dynamic interaction between the task, the person's ability and their subjective experience. Optimal challenge is a functional and perceived experience which may be operationalised within rehabilitation and everyday life to foster learning, recovery and engagement in people with stroke.

Discussion

Overall, this interdisciplinary concept analysis identified challenge as a multifaceted, multidimensional and dynamic concept, which plays a critical role in the learning, recovery and experiences of people with stroke in rehabilitation and everyday life. The synthesis of theoretically and operationally diverse literature uncovered shared and differentiated conceptualisations of challenge within and across the perspectives of people with stroke, physiotherapy, occupational therapy and speech-language therapy. This diversity, in part, reflected the various uses of challenge in stroke rehabilitation. However, differences in understanding also introduced an element of conceptual ambiguity and reaffirmed challenge as a partially mature concept [29]. We identified that implicit assumptions and minimal discourse around the concept of challenge often gave rise to narrow, unidimensional and therapist-centric applications of the concept. The findings of this review align with systematic reviews, which underscore a lack of clarity and consensus regarding the definition, terminology and reporting of challenge in rehabilitation [23,75,76]. A poor conceptual understanding risks misinterpretation when synthesising research evidence and integrating evidence-based findings into clinical practice, which may restrict the evolution of best practice guidelines [18]. Therefore, this review provides a comprehensive conceptual foundation to capitalise on and advance the therapeutic potential of challenge in stroke rehabilitation.

A place for perceived challenge

A key finding of this review was the significant and complex influence of perceived challenge. In contrast to therapist and technology-led approaches which emphasised functional challenge, occupational therapy and people with stroke often highlighted the effect of perceived challenge on the person's engagement and performance [35,38,41,52,71]. Attending to the person's perspective to inform understandings of challenge aligns with psychology and education fields, which emphasise an

individual's perception as a powerful mediator of self-efficacy, learning and performance [77–79]. These fields highlight how an individual's perception of challenge can determine their engagement and success with a task, irrespective of their actual ability [77,78,80]. Such perspectives often underpinned more person-driven approaches to operationalising challenge. For example, when people with stroke set their own level of challenge according to their perceived challenge, and were supported to do so by occupational therapists, they naturally developed the skill and desire to challenge themselves in both rehabilitation and everyday life [41,52,71]. In the context of advances in rehabilitation which call for self-regulatory skill development and person-centred approaches, perceived challenge may be crucial to emphasising the person's input in shaping and managing their own rehabilitation [14,81–83].

The intersection of functional and perceived challenge

Differences in understanding and operationalising challenge, whether through functional or perceived facets, reflected broader complexities of rehabilitation. In our review, papers predominantly described the importance of personalised and progressive functional challenge. Papers from physiotherapy particularly valued these therapist and technology-led approaches for their supposed feasibility and accuracy, especially for people who experienced cognitive, communicative, sensory or perceptual impairments after stroke [43,47,54,68]. Research suggests that such impairments may impact the person's ability to accurately discern and report their experience [17,84,85]. These considerations are purported to diminish the relevance of perceived challenge and reinforce the utility of functional challenge [17]. While therapists may value perceived challenge and its potential role in person-centred rehabilitation, it was not always seen as effective or safe in practice [47,54]. However, as previously discussed, papers from the perspective of occupational therapy and people with stroke contradicted the assumption that people with stroke may not have the capacity to judge their experience of perceived challenge [41,45,52,71]. Misconceptions may be further perpetuated by therapist's limited skills and resources to effectively elicit information about the person's experience. Furthermore, to assume that therapists must choose one approach over the other may represent an overly simplistic and dichotomous view of person-centred rehabilitation. Kayes and Papadimitriou [86] note that, in the context of complex and competing demands, both moments of person-centred and non-person-centred care are necessary to rehabilitation. The need to attend to both functional and perceived challenge may further demonstrate the complex and layered clinical reasoning process that underpins person-centred practice [86,87]. While our findings highlight the overlooked importance of perceived challenge, this review discerns that both functional and perceived challenge hold value in exploring and responding to the unique needs of people with stroke. In fact, it may be that *because* the operationalisation of challenge is complex, that it is best undertaken by leaning into person-centred approaches which accept the various influences that shape rehabilitation and ask therapists to continuously question "what is best?", to optimise challenge *with* the person [88,89].

Understanding "optimal" challenge

A related tension which may impact the advancement of challenge was the differing interpretations of what constituted 'optimal' challenge. While predominantly conceptualised through functional challenge, some papers drew on perceived or nominal facets to inform optimal challenge. When challenge was optimised to perceived challenge, it was often with the goal of sustaining patient engagement, and as a result, achieving a greater dose of practice [35,39,52]. Research indicates that the combination of optimal challenge and high dose is essential for neuroplasticity, learning and recovery after stroke [5,90–92]. However, some physiotherapy and speech-language therapy papers also spoke to maximising patient outcomes within limited therapy time/dose by optimising challenge to the highest level of nominal challenge [34,44,58–60,70]. This confronts the notion that "more is better" and may indicate a shift toward finding alternative ways of enhancing outcomes, which acknowledge the barriers to engaging in extensive doses of practice [93–95]. Given the range of applicable interventions and philosophies which underpin different approaches to rehabilitation, some diversity in the way optimal challenge is operationalised is expected. However, differences in understanding may stem from a lack of complete and shared conceptualisation. Such disparities may impede the visibility and scope of challenge in stroke rehabilitation, particularly where disciplines primarily leverage one facet. This contributes to a self-perpetuating cycle, where immature conceptualisations limit our ability to systematically investigate the influence of challenge on outcomes [18,19]. If we do not continue to work towards shared conceptualisation, we will be left with a long-standing assumption that challenge is important to rehabilitation, without a path forward to understand and optimise its use in practice [19].

Future research

Further research is needed to enhance our understanding of challenge in stroke rehabilitation. Future research should explore how people with stroke and therapists understand challenge, including how perceived challenge may vary in different patient populations and contexts [96–98]. Qualitative research may provide insight into the uses and experiences of challenge in clinical practice. Experimental research may build on this and explore the relationship between patient and therapist perceptions of challenge, and their relationship to hierarchies of nominal challenge [99,100] and other parameters pertinent to rehabilitation [53,54]. Such research may also enable better understanding of how common stroke sequalae, such as fatigue, pain and mood changes, may dynamically influence functional and perceived challenge. Further research is also needed to advance the use of challenge in stroke rehabilitation. This concept analysis may be used as a foundation to the application, reporting and evaluation of challenge in stroke rehabilitation research. For example, our findings may inform the development of a tool, such as a patient-reported measure, which could improve responsiveness to perceived challenge in research and clinical practice.

Clinical implications

The findings of this review contribute to a comprehensive and shared understanding of challenge across key perspectives involved in stroke rehabilitation practice. We propose that the operationalisation of challenge requires consideration of the interaction between the task, the person's ability and their experience. While therapists may hold expertise in understanding the task, the person is the "expert" in understanding their own experience—both of which directly influence the person's ability and should collectively shape the process of co-creating a challenge that is truly optimal for the person. This conceptualisation supports the use of

observational and objective approaches to considering functional challenge, but also confronts current practice norms, where perceived challenge is often overlooked or underexplored. Therapists are encouraged to consider perceived challenge in collaboration with the person and throughout the rehabilitation process. Our findings support the use of strategies such as informal subjective interviewing and patient-reported measures to gain a shared understanding of perceived challenge, whilst remaining attentive to potential nuances and inclusivity of the strategies used. Recognising the multidimensional and dynamic nature of challenge may also support therapists to think beyond their disciplinary lens of the task-person interaction and be more attuned to the various ways challenge can manifest and evolve during rehabilitation.

Limitations

A limitation of this study is the the data selection strategy. "Challenge" is associated with many terminologies and meanings, and is not well-indexed in the stroke rehabilitation literature. Therefore, a pragmatic approach was taken to develop a broad but relevant search strategy. The additional inclusion criterion of seeking high informational value was also required to feasibly derive an appropriate dataset. This followed a comprehensive, systematic and interdisciplinary supported process to maximise rigour and minimise threats to the validity of our findings. However, our analysis does not include all the literature pertaining to challenge in stroke rehabilitation. For example, papers that solely conceptualised "intensity" in relation to amount, rather than challenge, were excluded. Although the relationship and conceptual delineations between challenge and amount were carefully considered in our analysis [39,52,67], this may have limited our exploration of how challenge relates to duration, repetitions or endurance. These limitations are unsurprising given the partial maturity of the concept, and indeed, reinforces the rationale for concept analysis [18,29]. Secondly, a large proportion of the included literature used an experimental design. Although all papers were comprehensively analysed for their unique contributions to conceptualisation, it is possible our findings are weighted towards these explorations of challenge. The large number of experimental studies may further reflect the partial maturity of challenge, where stroke rehabilitation researchers are wanting to better understand the nature of challenge, before operationalising or reviewing its therapeutic effects within intervention-based studies. Similarly, the distribution of perspectives within our dataset may indicate more explicit reference to challenge in physiotherapy research compared to explorations of the perspectives of occupational therapy, speech-language therapy and people with stroke. This may be related to the current emphasis on motor aspects of 'task' challenge, which are particularly evident within physiotherapy. While the other perspectives attended to these aspects, they also considered cognitive, psychosocial, environmental and contextual aspects, and often at an 'activity' level, alluding to more complex uses of challenge that are yet to be fully explored in the stroke rehabilitation literature [37,38,41,45,52,71].

Conclusions

This study unpacks challenge as a multifaceted, multidimensional and dynamic concept in stroke rehabilitation. Understanding of the task, the person's ability and their subjective experience informed the inter-related facets of nominal, functional and perceived challenge, and their outcomes of learning and recovery, and emotional and behavioural responses. The findings question the predominantly therapist-driven approaches to functional challenge, and highlight the importance of the person's perspective in perceived challenge. While wider conceptual consensus is needed to gain a shared understanding within and across disciplines, this review offers a stepping stone to the advancement of challenge in stroke rehabilitation research and clinical practice. Researchers and therapists may adopt a broader approach to understanding and operationalising challenge that goes beyond the task and the person's abilities, and considers the person's experience of challenge within context. Given the potential effects of challenge on the learning, recovery and engagement of people with stroke, this conceptual foundation may have important implications for addressing the growing burden of stroke disability, through rehabilitation.

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