Cognitive Assistive Technology Should Address Functional Barriers Instead of Medical Diagnoses

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Abstract. Research on Cognitive Assistive Technology (CAT) has historically applied a user-centered approach, involving end users in the design process and recruiting participants based on medical diagnoses. While well-intentioned, we argue that although a diagnosis indicates potential barriers, it is inconclusive regarding how a system should be designed to meet an individual's specific assistance needs. Diagnoses and functional barriers are loosely coupled; a single diagnosis can encompass diverse barriers, while similar functional barriers often occur across diagnoses. The International Classification of Functioning, Disability and Health (ICF) already advocates this perspective, and this is an accepted principle for sensory and motor impairments in general accessibility considerations, where barriers are already addressed more directly in practice. We therefore argue that research and development of CATs should similarly be driven by functional barriers and profiles rather than diagnostic labels to more effectively meet user needs. We as a field should, at a minimum, clearly identify and discuss the functional barriers our designs aim to address. Finally, we briefly outline which concrete steps we as a community could take to advance towards this perspective.

Keywords: Assistance · Technology · Accessibility · Design · Inclusion

1 Introduction

According to the World Health Organization (WHO), Assistive Technologies (ATs) are defined as products that "can enhance performance in all key functional domains such as cognition, communication, hearing, mobility, self-care and vision" [27]. For the purpose of this paper, we define Cognitive Assistive Technologies (CATs) as technologies that support cognitive functioning by addressing specific functional barriers, for example, difficulties in sustaining attention, remembering information or intentions, and higher-level cognitive functions such as planning or sequencing actions. Exemplary technologies of such support encompass a broad spectrum: from ubiquitous everyday tools, such as mobile apps that scaffold routines, to emerging technologies such as Artificial Intelligence (AI) assistants and Augmented Reality (AR) headsets designed to guide users through complex procedures.

Involving the end-user in the development of such technologies is a critical and universally accepted principle in the broader domain of Human-Computer Interaction (HCI) [17]. Naturally, this user-centered approach is also established in the design of ATs in general [18]. Because the overarching goal of such systems is to effectively assist individuals, user-centered design proves especially vital when developing solutions aimed at supporting human cognition [13]. Consequently and justifiably, there is extensive research on CATs that evaluates their solutions through user-centered approaches. To effectively employ user-centered approaches and methods through empirical studies, researchers must conceptualize and group their target demographics. However, user perspectives are most commonly aggregated based on diagnostic labels. This persistent tendency likely originates from the field's historical roots in the medical model of disability, which traditionally emphasizes "curing" over "caring" [1, 15]. Even in contemporary CAT research on emerging technologies such as robotics, AR, or AI, studies of our field continue to rely on this diagnostic model as a foundational basis of shared characteristics [16]. Arguably, organizing users strictly by diagnosis introduces significant theoretical and practical challenges. On the one hand, there is a vast diversity of functional impairments and abilities present within a single diagnosis [8, 21]. On the other hand, a substantial overlap in functional barriers across entirely different diagnostic categories is also possible [4, 9].

An alternative to this diagnostic model is an approach that instead focuses on the functional abilities and barriers of users, examining what users can and cannot do. In fact, research has argued for a stronger focus on underlying human functioning rather than medical diagnoses across several disciplines for some time. For example, in the clinical healthcare context, Reed et al. [19] argue that "Functional status may be a better indicator of health care needs and outcomes than diagnosis". More specifically, in the context of cognitive assistance and accessibility of digital services, Johansson [11] articulates that "From a design perspective, there is poor accuracy in diagnoses". Recent systematic literature reviews also highlight this perspective, arguing that "conceptually, there appears to be an urgent need for consensus on definitions of cognitive accessibility and inclusive design that are grounded in neurodiversity theory rather than medical diagnostic categories" [21].

Interestingly, this transition of accessibility research toward functional profiling in general is already strongly advocated for by prominent international frameworks and official channels. Notably, the WHO's International Classification of Functioning, Disability, and Health (ICF) explicitly embraces a functional approach. The ICF argues that "by shifting the focus from health condition to functioning, it places all health conditions on an equal footing, allowing them to be compared using a common metric" [26]. This perspective is echoed in recent

WHO initiatives that argue for a shift from a strict medical model of disability to addressing "functional impairments in policy and practice" [5, 14].

While the preceding examples demonstrate that a functional approach is already clearly advocated for by established frameworks, and it is in fact already commonly applied for sensory and motor accessibility concerns [24], its application remains far less standard in the context of CATs. Even without singling out particular studies for the sake of the argument here, this pattern is readily apparent (and easily verifiable through straightforward literature database searches combining diagnoses and CATs), as much of the research in this field continues to be framed primarily in terms of diagnostic labels.

In the remainder of this paper, we articulate our position from the perspective of CAT design and development (Sec. 2), then formalize and visualize the specific mismatch between diagnosis-centered framing and the functional barriers technologies are actually meant to address (Sec. 3), discuss why existing functional perspectives have not yet translated into a sufficiently grounded approach for CAT research (Sec. 4.1, 4.2), and finally outline how we as a research community can work toward a more functionally grounded approach (Sec. 4.3).

2 A Functional Grounding for CAT Research

We argue that CATs should be conceptualized, designed, and evaluated based on functional barriers and profiles rather than diagnostic categories. While user-centered design is rightfully regarded as foundational in this context, we believe that diagnoses are an imprecise proxy for driving research on CATs. This is crucial for two reasons: first, a single diagnosis can encompass substantial heterogeneity in functional barriers; second, similar functional barriers often overlap across different diagnoses. As such, diagnoses and functional barriers are loosely coupled, and a diagnosis alone neither reliably indicates which barriers a system should address nor which users may or may not benefit from that support.

We contend that while this functional perspective may be more challenging to operationalize than, for example, in the sensorimotor domain, the potential benefits for CATs would be even more substantial. In the context of CATs, the goal shifts from making technology or content accessible to designing technology as the primary means of enabling cognitive accessibility itself. To provide meaningful, individualized support, CAT research should therefore prioritize the question "Which functional barriers does the system intend to address?" over broader inquiries regarding specific diagnostic categories.

The following section develops this argument in more detail by formalizing the two central problem dimensions of a diagnostic approach and situates our position in relation to existing functional perspectives.

3 The Mismatch Between Diagnosis and Support Need

To describe these issues formally, let P be the set of individuals, D the set of medical diagnoses, and B the set of functional barriers. For any $p \in P$, we define

$diag(p) \subseteq D$ as the set of diagnoses for a person p, and $barr(p) \subseteq B$ as their specific set of cognitive barriers.

3.1 Within-Diagnosis Heterogeneity

Diagnostic categories are built from symptom clusters and classification rules, not from a uniform mapping to everyday functioning. As a consequence, people who share the same diagnostic label commonly present very different constellations of cognitive strengths and limitations (*e.g.*, in attention, working memory, or emotional regulation). Designing and evaluating assistive systems around a diagnosis therefore tends to optimize for group averages or modal features and thereby risks producing solutions that are irrelevant, insufficient, or even counterproductive for some individuals within that group. Formally, for any two individuals $p_1, p_2 \in P$, the sharing of a diagnosis $d \in D$ therefore does not guarantee functional equivalence:

$$(\mathrm{diag}(p_1) = \mathrm{diag}(p_2)) \;\;\not\Longrightarrow\;\; (\mathrm{barr}(p_1) = \mathrm{barr}(p_2))$$

This misalignment undermines the interpretability of study outcomes, weakens claims about mechanisms of action, and complicates replication. When an evaluation reports effects for individuals sharing a diagnosis $d \in D$, it remains unclear which specific functional barriers or processes were addressed. See Fig. 1 for a conceptual illustration of within-diagnosis heterogeneity in autism.

3.2 Cross-Diagnosis Overlap

On the other hand, functional barriers that CATs aim to remediate can be shared by different diagnoses. Identical or highly similar impairments can appear across multiple but distinct medical conditions. Formally, for any two individuals $p_1, p_2 \in P$, the disjointness of their diagnostic sets does not imply that their functional barriers are also disjoint:

$$(diag(p_1) \cap diag(p_2) = \emptyset) \;\;\not\Longrightarrow\;\; (barr(p_1) \cap barr(p_2) = \emptyset)$$

When research is organized by diagnosis, interventions through CATs that target these shared functions become fragmented across silos. The practical consequence is that CATs validated in one diagnostic cohort are often not systematically evaluated for other cohorts with the same functional need, and the underlying evidence is harder to retrieve and synthesize because it is dispersed across diagnosis-specific literature. This reduces both the reach of effective solutions and the visibility of reusable, functionally grounded intervention principles. Fig. 1 conceptually illustrates this cross-diagnosis overlap of functional barriers across autism, stroke, and depression.

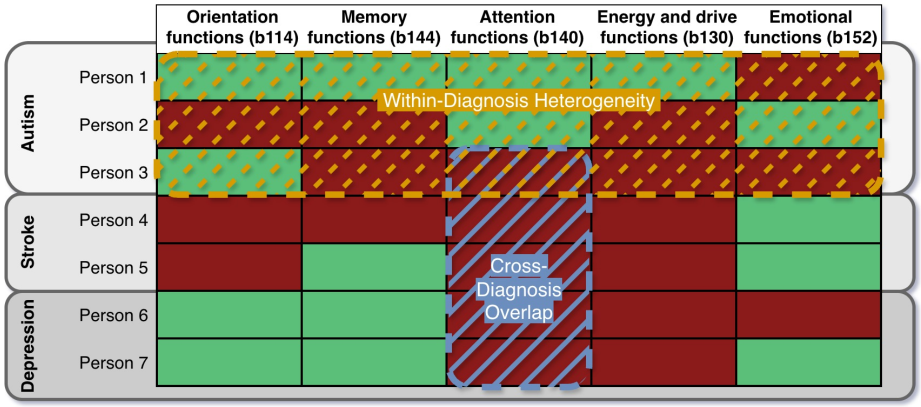

Fig. 1. Illustration of the relationship of diagnoses and barriers. Rows illustrate individuals grouped by diagnosis, and columns show an example set of barriers according to associated ICF core sets [25]. Dark red cells indicate the presence, and light green cells the absence, of a functional barrier. Gold highlights a potential within-diagnosis heterogeneity; blue highlights a potential cross-diagnosis overlap.

3.3 Why Existing Perspectives Are Not Sufficient

The problem outlined above does not imply that functional perspectives are absent from the field. Efforts toward a more functional perspective already exist in related domains, for example, web accessibility [23], neurodivergent game design [21], and sensorimotor AT [24]. However, this reflection also emerges from our own work in AR- and AI-based ATs, where we recognize the same pattern: diagnostic categories continue to dominate recruitment practices, reporting structures, and design rationales, as systematic literature reviews confirm [2, 3, 16]. Even where researchers, ourselves included, may implicitly aim to address concrete functional barriers, these barriers are often not described with sufficient clarity and explicitness to guide design rationale and interpretation beyond the diagnostic group under study. In this sense, our position is not a radical or contrarian departure from existing thinking. Rather, we see this paper as a necessary reminder and consolidation of an already articulated perspective that remains insufficiently implemented in our field. If we aim for effective and meaningful impact of CATs, we must more consistently anchor our research in explicitly described functional constructs.

4 Implications for CAT Research Practice

Having outlined our argument and the limitations of a diagnosis-centered approach, we now want to discuss how a more functional perspective can be realized for CATs. In the following, we first position the ICF [26] as the conceptual foundation for such an approach. We then acknowledge practical realities that make a fully function-centered perspective challenging but conclude by highlighting concrete steps that authors, reviewers, and the broader CAT community can take to move research in this direction.

4.1 ICF as the Conceptual Foundation

For a functional approach to CAT research to be feasible, it needs a robust and widely shared basis for describing user needs. In particular, it needs a language that can be understood and applied as readily as diagnostic categories. To that effect, we see the ICF [26] at the core of any functional approach to CAT research. More specifically, chapter b1 on mental functions is especially relevant to many CAT contexts, while the broader ICF helps relate these functions to activities, participation, and context. As a well-established and scientifically validated framework, it provides a robust basis for describing functional barriers in a way that can inform research practice and reporting. In this sense, the ICF offers the shared vocabulary needed to move CAT research beyond diagnosis as the dominant frame of reference and toward the functional needs that systems intend to address.

4.2 Functional Grounding Under Real-World Constraints

While we are convinced that a fully function-oriented approach is worth striving for and there have been efforts towards this goal [4, 10, 12], we acknowledge that it is difficult to realize in practice. Functional barriers are often harder to measure and operationalize than diagnoses. Identifying them requires additional assessment effort from both researchers and participants. While standardized tests, if available, add additional burden on participants and researchers, self-reported measures are not necessarily objectively valid [22]. Beyond operationalization, functional barriers can also vary in severity and qualitative expression. For the sake of simplicity and comprehensibility in this position paper, we nevertheless treat barriers as either present or absent, while acknowledging that this binary simplification does not hold in practice and that variation in degree and qualitative expression would further shape how barriers manifest. Apart from that, there are also reasons why diagnosis cannot and should not be removed from CAT research completely. Diagnostic labels remain relevant in clinical contexts or service pathways. They also play a role in self-identification and mental well-being [6]. A functional approach should therefore not be understood as a rejection of diagnosis. Instead, it aims to prevent diagnosis from remaining the default framing device for CAT research.

4.3 Actionable Steps for CAT Research

A transition toward more functionally grounded CAT research is not an all-or-nothing endeavor. Even within current research workflows, there are practical first steps that can be taken now to make functional barriers more explicit in how studies are framed, designed, and interpreted. In the following, we highlight actionable steps for authors, reviewers, and the broader CAT community.

Authors At the level of individual studies, one of the most direct opportunities is to make the functional basis of the work explicit by naming the targeted ICF functions in the methods section, even when studies still rely primarily on diagnosis-based recruitment and samples. Doing so clarifies, or at least makes visible to others, which functional barriers the intervention is intended to address. Participant descriptions can also be extended by reporting functional profiles alongside diagnostic labels. We also encourage authors to justify their methodological choices in relation to these target functions, which improves the traceability and transparency of technical implementation decisions. For instance, systematically reflecting on potential functional barriers in the assistance context before developing the corresponding CAT can be a further step toward aligning research methods with assistance targets [12]. When contextualizing their own research through their related work section in scientific publications, authors can also retrospectively discuss prior diagnosis-based work through a functional lens. This not only helps organize the broader literature in terms of functional barriers but can also aid authors in positioning their own contribution more precisely, for example, by clarifying which barrier they address in a novel way or through a different technological approach. We see a useful example of this kind of functional articulation in the work by Hu et al. [10]: although not ICF-based, they make participants' functional usage barriers, as well as changes in psychological states, explicit and connect them to concrete design opportunities for conversational agents. Beyond individual papers, dedicated systematic mapping studies that analyze which functional barriers particular CAT subfields actually target could themselves make a valuable contribution to the field and show where, from a functional perspective, important gaps in the literature remain. Evaluation should also be aligned with the targeted functional barriers. Making these targets explicit is not only useful for organizing the literature but also for operationalizing whether a system actually addresses the intended support need, rather than relying solely on generic usability or satisfaction metrics. Similarly, generalizability could then also be discussed in functional terms by mapping findings to barriers rather than broad population categories.

Reviewers One concrete way to reinforce these practices as a reviewer is to explicitly ask which functional barrier a study addresses. Even a single comment to that effect can help normalize the expectation that CAT research should identify its functional target clearly. We do not suggest that missing functional grounding should, by itself, be treated as a reason for rejection. In many cases, a brief post-hoc reflection may be enough to make functional considerations visible that likely implicitly already informed the work. Reviewers should also flag when design rationales remain vague and diagnosis-based. In that case, they should challenge the assumed homogeneity of the participant group and ask for a specification of participants' functional profiles. If function is discussed, reviewers should assess whether the applied methods and chosen evaluation formats meaningfully align with the targeted functions. Where these links remain loose, authors can be asked to clarify how their claims relate to the intended function.

Community At the field level, functional grounding should ideally be treated as an expected part of CAT submissions rather than as an optional extra. Research venues, and especially journals, shape reporting norms, review expectations, and how work is grouped and compared. Submission guidelines and calls for papers should therefore explicitly ask authors to state which functional barriers their systems target and how those targets informed design and evaluation. More ambitious mechanisms, such as structured abstracts or short supplementary reporting forms for functional targets, may be most realistic for specialized venues and journals, similar in spirit to ethics statements or other structured reporting frameworks [7]. In addition, the community could promote functional keywords or tagging, extending systems such as the ACM computing classification system [20], to improve searchability by targeted functional domains. Another practical lever lies in how papers are brought into conversation with one another. Paper and workshop sessions organized post-submission around specific functional domains could bring together researchers who might currently publish in diagnosis-specific silos and make cross-diagnosis commonalities in support needs and design strategies more visible. Finally, the community and journals should encourage survey or mapping papers that retrospectively analyze CAT literature through a functional lens. Gillespie et al. [4], for example, used the ICF in a systematic review to categorize both the cognitive domains being assisted and the tasks being performed across studies of assistive technology for cognition, providing a concrete example of the kind of functional mapping that can reveal patterns and gaps at the field level.

5 Conclusion

In this paper, we argued that CATs should be conceptualized based on functional barriers rather than diagnostic categories. We do not suggest that diagnostic categories are irrelevant, since they remain important in clinical practice and personal identity. However, diagnosis alone neither provides a sufficient framing for CAT research nor a sufficient basis for design rationale, because it does not reliably indicate which barriers an AT should address or which users may benefit from that support. At a minimum, CAT research should state clearly which functional barriers a system is intended to address, make its design rationales explicit in view of those target functions, and discuss evaluation and generalizability in functional rather than purely diagnostic terms. Future work should also pursue this through systematic reviews mapping CAT literature along both diagnosis and function, as well as case studies stress-testing how function-centered framing changes research and design decisions in practice. Ultimately, grounding CAT research more explicitly in functional barriers could make findings more transferable across diagnostic groups that share similar support needs and increase the visibility of reusable, functionally grounded intervention principles.

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