A Conceptual Mapping of Communication Demands in Collaborative Software Development: Implications for the Inclusion of Developers with ADHD

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Abstract. *Communication is central to collaborative software development, enabling coordination and shared understanding. However, cognitive differences may affect how these interactions are experienced. This study investigates cognitive barriers in collaborative communication involving developers with ADHD. We adopt a qualitative and exploratory approach integrating Software Engineering and Psychology. Based on Grounding in Communication and Brown's Executive Functions model, we propose a conceptual mapping relating communication situations to cognitive demands. Results highlight recurring demands on attention, working memory, and concurrent stimuli, illustrated through interviews with developers with ADHD.*

1. Introduction

Communication is a central element in software development, supporting activities such as task coordination, knowledge sharing, and problem solving [Herbsleb and Mockus 2003]. In this work, communication refers to interactions that support coordination, knowledge sharing, and alignment among developers in collaborative software development. In collaborative systems, models such as the 3C model [Fuks et al. 2011] and Malone and Crowston [Malone and Crowston 1994] frame communication as a key mechanism for coordination and collaboration. However, they do not explicitly examine how specific communication demands interact with different cognitive profiles.

This gap limits the understanding of how communication may create barriers to inclusion in collaborative software development. Software Engineering has increasingly incorporated the neurodiversity perspective [Morris et al. 2015], which considers neurological variations as part of human diversity [Singer 1999]. One such profile is Attention Deficit Hyperactivity Disorder (ADHD), a neurodevelopmental disorder characterized by persistent patterns of inattention and/or hyperactivity-impulsivity that may interfere with different areas of life [American Psychiatric Association 2013]. In software development teams, these characteristics may influence how professionals deal with attention, organization, and interaction demands [Gama and Lacerda 2023, Liebel et al. 2024]. This work investigates cognitive barriers in collaborative communication involving software developers with ADHD and addresses the following research questions:

RQ1. *What cognitive barriers may emerge in collaborative communication situations in Software Engineering activities involving software developers with ADHD?*

RQ2. *How do software developers with ADHD describe their experiences in these situations?*

We adopt a qualitative and exploratory approach [Creswell and Creswell 2017], combining perspectives from Software Engineering and Psychology to analyze communication situations that may increase cognitive effort, with possible effects on inclusion. Reports from developers with ADHD illustrate how these barriers manifest in practice. As a contribution, this work proposes a Conceptual Mapping that relates communication situations to cognitive demands, supporting understanding of how communication may create cognitive barriers and informing inclusive communication practices in software.

2. Background

This section presents the concepts that support the importance of communication in collaborative systems, based on the perspective of Grounding in Communication, as well as notions related to ADHD and Executive Functions.

2.1. Collaboration and the Grounding in Communication Perspective

In the context of collaborative systems, the 3C model (Communication, Coordination, and Cooperation) highlights the central role of communication among participants [Fuks et al. 2011]. From an inclusion perspective, the way communication is structured may directly influence team members' participation, as different interaction formats may require distinct levels of cognitive effort, affecting how individuals understand information, express themselves, and contribute to collaborative work [Clark and Brennan 1991].

To analyze this cognitive effort, this study adopts the theory of Grounding in Communication [Clark and Brennan 1991], which describes how interlocutors build and maintain shared understanding (common ground). Clark identifies 16 factors that influence the effort required for successful communication. In this work, these factors are used as analytical lenses to characterize communication situations in collaborative software development contexts.

2.2. ADHD and Executive Functions

ADHD is a neurodevelopmental disorder characterized by persistent patterns of inattention and/or hyperactivity-impulsivity that may impact performance in different contexts [American Psychiatric Association 2013]. In software development, these characteristics are relevant, as activities often involve high cognitive demand, sustained attention, and time management [Gama and Lacerda 2023, Liebel et al. 2024].

To analyze these processes, this work adopts Brown's Executive Functions (EF) model [Brown 2008], which includes six interrelated groups: activation, focus, effort, emotion, memory, and action. These functions support the analysis of how communication situations may impose distinct cognitive demands on software developers with ADHD.

3. Related Work

The recognition of neurodiversity in the technology sector has increased, highlighting the potential of neurodivergent professionals to contribute to innovation and creative problem solving [Harvard Business Review 2017, Simplify Hire 2022]. In Software Engineering research, studies have advanced the understanding of the experiences and strategies of professionals with ADHD. Researchers identified barriers related to organization and communication, while also highlighting strengths such as non-linear thinking and proposing adaptive practices in agile methodologies and explicit documentation [Liebel et al. 2024, Gama and Lacerda 2023].

Complementarily, [Gama et al. 2025, Cartagena et al. 2025] examined how these professionals experience the work environment, identifying cognitive and emotional tensions in social interactions and effort estimation, reinforcing the need for more adaptable organizational contexts. The relationship between behavioral patterns and productivity has also been explored in the literature [Morris et al. 2015, Newman et al. 2025], discussing phenomena such as hyperfocus, mental fatigue, prioritization difficulties, and compensatory strategies, including assistive tools and structured written communication.

These findings are consistent with studies on well-being and mental health in Software Engineering, which associate emotional states with sustained attention and cognitive performance [Ford et al. 2021, Graziotin et al. 2018, Godliauskas and Šmite 2025, Ford and Parnin 2015, Storey et al. 2022]. Although prior work provides a solid foundation on individual profiles, work experiences, and adaptation strategies, fewer studies investigate how these phenomena manifest in concrete technical collaboration situations mediated by communication. This gap motivates the present analysis of collaborative interactions from the perspective of cognitive effort associated with communication.

4. Methodology

This work adopts a qualitative and exploratory approach [Creswell and Creswell 2017], based on expert validation [Shull et al. 2007] from the field of Psychology and on the empirical investigation of software professionals diagnosed with ADHD. The objective is to propose a Conceptual Mapping to analyze how communication demands in collaborative systems may interact with the cognitive functioning of software developers with ADHD. To achieve this, interaction situations grounded in the aspects of Grounding in Communication [Clarke 2025] were investigated and contextualized to software development, aiming to identify scenarios with potential Executive Functions overload. The methodological procedure was organized into five stages: the first four focus on identifying cognitive barriers (RQ1), while the fifth stage addresses the experiences of professionals with ADHD, contributing to the analysis of the second research question (RQ2).

Stage 1: Definition of Communication Scenarios: based on the researchers' experience, the 16 aspects of Grounding in Communication [Clarke 2025] were translated into representative situations of collaborative practices in software teams, such as explaining a bug during a sprint meeting, conducting a code review, clarifying requirements in a technical chat, or resuming context after task switching. This stage allowed subsequent analyses to be anchored in real development settings.

Stage 2: Technical-Cognitive Mapping: two Software Engineering researchers independently analyzed the communication scenarios and classified them according to Brown's six Executive Function groups [Brown 2008], selected for its clinical grounding in ADHD and functional organization. For each scenario, the most relevant Executive Function was identified as primary, with complementary demands classified as secondary. Disagreements were resolved through discussion until consensus was reached.

Stage 3: Clinical-Cognitive Mapping: two psychologists independently applied the same procedure using the communication scenarios and Brown's six Executive Function groups [Brown 2008]. Each scenario was classified according to the Executive Functions requiring greater cognitive effort from the perspective of developers with ADHD. The classifications were compared, and disagreements were resolved through discussion until consensus was reached. The resulting mapping was used in the cross-analysis in Stage 4.

Stage 4: Proposal of the Conceptual Mapping: this stage combines the results from Stages 2 and 3 to propose a Conceptual Mapping that relates technical (Software Engineering) and clinical (Psychology) cognitive demands. The mapping is analyzed based on degrees of convergence, indicating the level of agreement between perspectives regarding the cognitive impact of each scenario. The associations were classified as: *(i)* **Total Convergence**, when both analyses identified the same Executive Functions; *(ii)* **Partial Convergence**, when at least one Executive Function overlapped; and *(iii)* **Divergence of Perspective**, when no overlap was identified, indicating complementary views of the analyzed situation.

Stage 5: Empirical Exploration of Experiences: interviews were conducted with two software developers previously diagnosed with ADHD, recruited through convenience sampling. All participants reported a prior clinical diagnosis obtained independently of this study: Developer A (23 years old, 1.5 years of experience) and Developer B (27 years old, 2.5 years of experience). Participants completed the ASRS-18 (Adult Self-Report Scale) [Mattos et al. 2006] for descriptive purposes only, not for diagnostic use. Medication information was collected as contextual data and not treated as an analytical variable.Participants reported experiences based on the communication scenarios from previous stages, allowing the mapping to be connected to real Software Engineering practice. This stage is exploratory, aiming to illustrate how cognitive barriers manifest in real-world communication. The study was approved by the institutional Research Ethics Committee (CAAE: 88054525.1.0000.5347), and all participants provided informed consent. The instruments are available in the replication package [1].

5. Results and Discussion

This section presents the Conceptual Mapping derived from the Technical-Cognitive (Stage 2) and Clinical-Cognitive (Stage 3) mappings, along with the empirical exploration from Stage 5. The mapping relates aspects of *Grounding in Communication* to Brown's Executive Functions, highlighting communication situations that may impose cognitive demands for developers with ADHD. The analyzed situations are organized by degrees

[1] https://zenodo.org/records/18746097

of convergence between technical and clinical perspectives. Table 1 summarizes the 16 scenarios and their classification.

5.1. Analysis of the Conceptual Mapping and Response to RQ1

The detailed analysis of the proposed Conceptual Mapping allows answering RQ1 by identifying the cognitive barriers that may emerge in different interaction contexts. For clarity, the results are discussed according to the degree of convergence between the analyzed areas. In Total Convergence, situations are identified in which the technical and clinical communication mappings intersect directly. As shown in Table 1, situations associated with IDs 1, 2, and 3 (explaining complex problems, resuming context, and following logic in real time), as well as those related to coordination and maintenance of team communication (IDs 7, 8, 10, 11, 13, and 15), predominantly demand the Executive Functions of **Focus** and **Memory**. In these cases, the barrier is not related to the developer's technical competence but to the cognitive cost of sustaining attention and manipulating different informational contexts in working memory during interaction, which may contribute to mental fatigue or misunderstandings.

In Partial Convergence, analyzed situations present context-dependent barriers. In interactions involving interpreting tone in written messages or initiating a question with colleagues (IDs 4 and 5), as well as in activities related to presentation and attention monitoring within the team (IDs 9 and 12), the Executive Functions groups of **Emotion** and **Activation** emerge as potential barriers, associated with the cost of initiating interaction and with communication ambiguity. In situations involving simultaneity and maintaining focus across multiple information streams (IDs 14 and 16), coordination among **Focus**, **Activation**, and **Effort** is required, which may result in momentary information loss or difficulty organizing responses in real time.

Finally, in Divergence of Perspective, the scenario of waiting for a response in asynchronous communication (ID 6) illustrates how a situation with apparently low impact from a Software Engineering perspective may constitute a relevant barrier for professionals with ADHD. While the technical perspective tends to emphasize the **Effort** associated with context switching, the clinical mapping indicates that waiting may affect **Emotional Regulation**, impacting engagement and making it more difficult to resume activity after interruption. This type of barrier may remain invisible when analyzed solely through traditional productivity metrics.

5.2. Reported Experiences of Software Developers with ADHD in Response to RQ2

To answer RQ2, qualitative interviews were analyzed with two software developers with ADHD, identified as Developer A and Developer B. The interviews were conducted using the same communication scenarios used to construct the Conceptual Mapping. For participant characterization, both completed the ASRS-18 (Adult Self-Report Scale) [Mattos et al. 2006], whose results indicated a predominantly inattentive profile for Developer A and a combined inattention and hyperactivity/impulsivity profile for Developer B. The excerpts presented below were selected for their representativeness regarding the three identified degrees of convergence, with the aim of illustrating how cognitive barriers emerge in the real experiences of software developers with ADHD.

In Total Convergence scenarios, the reports highlight difficulties with sustained attention and the organization of reasoning during communication. In the scenario corresponding to ID 1, related to explaining technical problems, Developer A stated, *"if I don't have something external pulling me back, I get lost in the middle of the explanation,"* while Developer B reported, *"in my head it is organized, but when I speak it does not come out in the same order."* A similar situation appears in ID 3, in which both developers reported difficulty following long explanations in environments with multiple stimuli. Developer A indicated, *"I lose parts of the explanation when it is long and requires a lot of attention,"* while Developer B emphasized, *"if there is too much happening, I end up missing important parts of what the person is saying."*

In scenarios classified as Partial Convergence, the reports indicate variation in how barriers manifest and in the strategies adopted. In ID 14, associated with simultaneity of stimuli, both reported cognitive overload when dealing with speech and messages in parallel. Developer A stated, *"when I focus on one thing, the rest simply disappears,"* while Developer B highlighted, *"either I follow what the person is saying or I read the messages; doing both at the same time does not work for me."* Another example appears in ID 16, associated with maintaining attention in contexts with interruptions. Both developers reported difficulties related to sustained focus. Developer A observed, *"this happens even outside work, like when I do not reply to messages in chats with close people,"* while Developer B emphasized, *"when I am interrupted, I have difficulty resuming exactly where I stopped."*

These reports reinforce the contextual and dynamic nature of cognitive barriers associated with communication. The situation classified as Divergence of Perspective, corresponding to ID 6, was described by both developers as cognitively challenging. Developer A reported repeated checking behavior, stating, *"I keep refreshing the page to see if the answer has arrived, and if it takes too long, I end up doing something else."* Similarly, Developer B stated, *"I keep checking the chat several times, even while trying to do something else."* These excerpts make visible the emotional and attentional dimensions involved in waiting for asynchronous responses, highlighted in the Conceptual Mapping presented in Table 1 as a point of divergence between technical and clinical perspectives.

Both developers reported recurring use of compensatory strategies, such as calendars, alarms, and digital notes, to manage daily demands. Developer B also mentioned perceived differences before and after medication use, highlighting greater control over the impulse to interrupt. Together, these reports illustrate how the different degrees of convergence identified in the Conceptual Mapping manifest in real experiences of software developers with ADHD. These results are consistent with prior studies that identified attention, organization, and communication challenges among software developers with ADHD [Gama and Lacerda 2023, Liebel et al. 2024]. However, while previous work has primarily described the challenges and coping strategies reported by professionals, this study contributes by making explicit how specific communication situations in collaborative contexts may generate cognitive demands that impact participation in teamwork. These findings suggest that communication-related cognitive demands may also affect coordination mechanisms, such as task synchronization, turn-taking in meetings, and dependency management, influencing collaborative flow in software teams.

5.3. Implications for Practice and Design

The results suggest actionable implications for communication practices and tool design in collaborative software development. Situations requiring sustained attention and working memory indicate that structuring communication into smaller, sequential units (e.g., step-by-step explanations or segmented messages) may help reduce cognitive overload.

Scenarios involving simultaneity of information highlight the importance of minimizing parallel communication channels or providing mechanisms to prioritize information streams, supporting developers in maintaining focus. In asynchronous communication, the observed impact of waiting suggests that providing feedback signals (e.g., read receipts, typing indicators) or expected response times may reduce uncertainty and support engagement. Explicit signals of understanding, such as confirmations or brief summaries, may reduce the cognitive effort required to monitor communication and maintain alignment. These findings indicate that relatively simple adjustments in communication practices and collaboration tools may improve inclusion for developers with ADHD, while also benefiting team coordination more broadly.

Limitations: this study involved two software developers with ADHD, limiting the diversity of experiences. The empirical stage was exploratory, aiming to relate the conceptual mapping to real-world practice, and both participants had similar profiles in age and experience, which may further limit generalization.

6. Conclusion and Future Work

This work proposes a Conceptual Mapping to analyze how communication demands in collaborative Software Engineering interact with the cognitive functioning of developers with ADHD. By combining Grounding in Communication [Clark and Brennan 1991] and Brown's Executive Functions model [Brown 2008], different degrees of convergence between technical and clinical perspectives were identified, highlighting situations with potential cognitive overload. The findings indicate that communication characteristics involving attention, working memory, and competing stimuli may create barriers related to cognitive effort rather than technical competence. These results provide a structured basis for identifying communication-related cognitive barriers in collaborative software development. From the perspective of the 3C model [Fuks et al. 2011], communication effort may influence coordination, task alignment, and team dynamics. The proposed mapping contributes to understanding how communication affects the experience of neurodivergent developers in practice. Although focused on ADHD, it may also inform broader reflections on more structured and inclusive communication in software teams. As future work, we propose applying the mapping to a larger sample, investigating communication interventions based on the identified convergence points, and extending the analysis to other neurodivergent profiles. Longitudinal studies may examine whether communication adjustments are associated with reduced cognitive overload and improved retention.

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Use of AI: LLMs were used for language refinement only. All scientific content and interpretations were developed by the authors.

Table 1. Conceptual Mapping of Communication: relationship between aspects of Grounding in Communication, Software Engineering situations, and Executive Functions.

ID	Aspect	Description (Clark & Brennan)	Situation (SE)	Technical Mapping (EFs)	Clinical Mapping (EFs)
1	Formulation	Planning the content considering the other's prior knowledge in order to minimize comprehension effort.	Explaining a technical problem to a colleague, evaluating what they already know to decide what to say before starting.	Activation / Memory	Activation / Memory
2	Production	Effort to articulate the message while maintaining continuity of reasoning and clarity of instruction.	Conducting a Code Walkthrough while maintaining logical sequence throughout the technical explanation.	Focus / Memory	Focus / Memory
3	Reception	Effort to capture and process signals from beginning to end while the message is being produced.	Following the explanation of a complex algorithm, maintaining sustained attention to avoid losing the sequence.	Focus / Memory	Focus / Memory
4	Understanding	Process of achieving mutual understanding and signaling that the speaker's intention was perceived.	Receiving a technical configuration instruction and clearly signaling that the message was understood.	Emotion / Focus	Emotion / Memory
5	Initiation (Start-up)	Cost of establishing initial contact and confirming whether the other person is available for interaction.	Contacting a colleague to clarify a doubt and verifying whether they are available at that moment.	Activation / Emotion	Activation / Action
6	Delay	Cost generated by pauses that interrupt the flow of interaction and affect work progress.	Waiting for a colleague's response in a technical chat while needing the information to unblock the code.	Effort / Memory	Emotion / Focus
7	Speaker Change	Coordination required to identify the transition moment without causing overlap or silence.	Observing the flow of a Planning meeting to identify the right moment to suggest a solution.	Focus / Action	Focus / Action
8	Repair	Effort to correct information identified as incorrect or incomplete during interaction.	Realizing that the explanation of an API was incorrect and correcting it during the conversation.	Action / Emotion	Action / Emotion
9	Presentation	Offering a contribution to the group and monitoring whether it was perceived.	Presenting the result of a task (User Story) and monitoring whether the team understood or still has doubts.	Memory / Activation	Activation / Memory
10	Acceptance	Providing evidence that the presentation was understood so that the interaction can proceed.	Signaling to a colleague, after explaining a bug, that they can continue because the point was understood.	Focus / Memory	Focus / Memory
11	Minimal Responses	Use of brief responses to confirm receipt and decide whether the topic can be closed.	Using short messages in Slack (e.g., "ok", "done") to confirm the task and close the discussion.	Focus / Memory	Focus / Memory
12	Attention Monitoring	Monitoring signals to adjust the message in real time according to the other's reaction.	Observing during a Daily meeting whether colleagues seem confused to decide if the explanation needs adjustment.	Focus / Emotion	Focus / Action
13	Chunking	Technique of dividing long messages into smaller units to facilitate confirmation of understanding.	Dividing the explanation of a system architecture into smaller parts to facilitate step-by-step understanding.	Focus / Memory	Focus / Memory
14	Simultaneity	Managing the processing of multiple sources of information occurring at the same time in the medium.	Explaining code in a video meeting while managing and responding to questions that arise simultaneously in the chat.	Focus / Memory	Focus / Effort
15	Revisability	Ability to review and edit the message before it becomes public to the interlocutor.	Performing a textual revision in a Code Review comment before officially sending it to a colleague.	Focus / Effort	Focus / Effort
16	Sequentiality	Effort to maintain tracking of the main topic in channels with interference from other topics.	Maintaining focus on the main subject in a channel where multiple bug discussions occur simultaneously.	Focus / Memory	Focus / Effort

TC Total Convergence; **PC** Partial Convergence; **DP** Divergence of Perspective.

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