

Environmental context as a critical factor in clear communication: Lessons from a failed intervention

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Cómo citar este artículo: McDonagh, S. y Orero, P. (2026): Environmental context as a critical factor in clear communication: Lessons from a failed intervention, *Sphera Publica*, 1(26), 9-25.
<http://hdl.handle.net/10952/11178>

Abstract

Clear communication in participatory research is commonly approached through linguistic, cultural, ethical, and accessibility considerations. However, in this article, we argue that an additional and often overlooked dimension, environmental context, plays a crucial role in shaping interaction and engagement, influencing participant's comfort, attention, and willingness to engage, and ultimately the effectiveness of the research intervention. Drawing on an exploratory case study from the 2025 European Researchers' Night in Barcelona, we demonstrate how an intervention designed using clear communication strategies, including user profiling, gamification, accessible materials, and structured interaction phases, was nonetheless derailed by extreme weather conditions. A prolonged heatwave, high humidity, the urban heat effect, and the arrival of storm Gabrielle significantly affected participant's levels of comfort, attention, and willingness to engage, disrupting fundamental conversational principles such as cooperation and relevance. This experience highlights how environmental factors can heighten cognitive strain and compromise effective communication. By analysing this failed intervention, we propose expanding current clear-communication and participatory design frameworks to formally include environmental context as a crucial element in both planning and reporting of research activities.

Keywords: clear communication, participatory research, weather conditions, accessibility.

Beyond Cultural and Language Contexts in Clear Communication: Environmental Contexts

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Resumen

La comunicación clara en la investigación participativa suele abordarse desde consideraciones lingüísticas, culturales, éticas y de accesibilidad. Sin embargo, en este artículo sostenemos que el contexto ambiental es una dimensión adicional, a menudo pasada por alto que desempeña un papel crucial en la configuración de la interacción y la participación, influyendo en la comodidad, la atención y la disposición a participar de los participantes, y en última instancia, en la eficacia de la intervención de investigación. A partir de un estudio de caso exploratorio de la Noche Europea de la Investigación 2025 en Barcelona, demostramos cómo una intervención diseñada con estrategias de comunicación clara se vio no obstante desbaratada por condiciones meteorológicas extremas. Una prolongada ola de calor, la elevada humedad, el efecto de isla de calor urbana y la llegada de la tormenta Gabrielle afectaron significativamente los niveles de comodidad, atención y disposición a participar de los asistentes, alterando principios conversacionales fundamentales como la cooperación y la relevancia. Esta experiencia muestra que los factores ambientales no causan sesgos de manera directa, pero sí pueden incrementar la carga cognitiva y comprometer la comunicación efectiva. Analizando esta intervención fallida, proponemos ampliar los marcos actuales de comunicación clara y diseño participativo para incluir formalmente el contexto ambiental como un elemento fundamental tanto en la planificación como en la presentación de actividades de investigación.

Palabras Clave: comunicación clara, investigación participativa, condiciones climáticas, accesibilidad.

Introduction

Context is an integral component of effective communication, and its importance has been widely examined across disciplines, such as philosophy (Catt, 2014; Doskhozina, 2024), linguistics (Ruzibaeva, 2023), psychology (Siegal and Gardner, 2000), translation (Gutt, 1992), and communication studies (Sadovets, 2019). In participatory activities, understanding and leveraging contextual factors enables researchers to enhance clarity, relevance, and the overall success of their planned interventions (Wibowo, 2018). While existing literature typically focuses on the social and cultural dimensions of context (Manis, 1967; Armstrong and Ferguson, 2010, Fenuku 2024), this article argues that environmental context is an equally critical, yet overlooked, element in communication. Environmental stressors, such as heat and air quality, impact cognition in ways that have the potential to affect decision-making (Hancock and Vasmatzidis, 2009). Recognising the importance of environmental conditions also clarifies that although environmental factors do not directly cause cognitive bias, they can nevertheless shape an individual's cognitive resources, emotional state, and physical comfort in ways that amplify or trigger certain cognitive shortcuts during decision-making. The practical significance of environmental context is particularly evident in participatory research settings, where real-world conditions can directly influence how participants engage, interact, and process information.

This article presents an exploratory case study from the Marie Curie European Researchers Night held in Barcelona in September 2025, which is part of a European-wide initiative aimed at raising public awareness of research and innovation. A participatory research activity, carefully designed following clear communication principles, as described by Juste-Lasierra and Romero-Piqueras (2024), was unexpectedly disrupted by participants recounting experiences of physical discomfort during a period of extreme weather events in Catalonia. Drawing on our experience as facilitators, we highlight the need to formally incorporate environmental context into the planning, implementation, and reporting of participatory research activities. This article begins by examining the links between clear communication principles, participatory interventions, and highlighting the role of environmental context in effectively engaging participants. This is followed by a description of our exploratory case study and reflections as facilitators, and the limitations

of this study. Finally, we discuss the lessons learned, arguing that in participatory interventions, where interaction and mutual understanding are central to the process, environmental stressors can undermine both the quality of the engagement and the reliability of the data produced. Facilitators must therefore anticipate and address how environmental pressures may affect participants' comfort, cognitive loads, and willingness to contribute during participatory activities.

Theoretical background

Effective communication depends not only on a direct style, characterised by concise language and clear organisation of ideas, but also on how well that style aligns with the broader communicative context (Arnall et al., 2024). Research in health communication and public service design has shown that messages that are most effective are accessible, trustworthy, and engaging, often achieved through simple vocabulary, visual supports, and structured validation methods (Chase and Shamo, 2013; Juste-Lasierra and Romero-Piqueras, 2024). In their case study on Child Protection, Juste-Lasierra and Romero-Piqueras (2024) found that implementing clear communication strategies, such as plain language standards, user-centred design, visual communication, terminology clarification, and accessibility measure, significantly improved the ability of families from vulnerable backgrounds to engage with and work with public administrators.

Building on this, plain language guidelines offer a structured framework for shaping clear communication. According to ISO 24495-1, plain language documents should enable readers to find, understand, and use relevant information effectively (ISO, 2023). However, while such frameworks focus primarily on textual reception, ensuring accessibility in dynamic, interactive settings also requires attention to contextual factors that can affect attention and comprehension. This perspective aligns with pragmatic approaches, which view communication as a shared activity in which meaning depends not only on linguistic expression but also on speaker intent as well as situational context (Leech, 1983).

Communication is also profoundly shaped by the environments in which it unfolds. Environmental factors, including ambient conditions, such as room temperature, can guide attention, influence emotional states, and either facilitate or hinder interaction. Integrating clear communication practices with environmental understandings of context therefore offers a more comprehensive approach: one that accounts for the linguistic, interpersonal, and environmental dimensions that collectively determine whether shared meaning can be achieved. Rather than viewing communication as solely linguistic, this perspective highlights how physical and environmental contexts actively participate in the construction of meaning.

This resonates with Norman's (2013) account of how physical environments communicate through *affordances* (the possibilities for action a setting offers) and *signifiers* (the cues that make those possibilities perceptible). Just as poorly designed objects can obscure how they should be used, poorly designed or adverse physical environments can obscure a participant's capacity to attend, interpret, and respond, independent of the clarity of the communication strategy itself.

This approach is especially relevant today, as climate-related events, such as extreme weather events, affect growing numbers of people (World Health Organisation, 2023; Romanello et al., 2022). These environmental pressures alter the contexts, processes of communication, and the conditions necessary for establishing a shared understanding. These shifts call for renewed attention from researchers and practitioners, who must account for environmental variables not as peripheral concerns but as core determinants of communicative effectiveness. To understand precisely how such environmental factors shape communicative processes, it is useful to turn to empirical research that examines their cognitive consequences. Experimental research in cognitive science has examined how the human body responds to environmental stressors, such as heat stress (Hancock and Vasmatazidis, 2003), and high humidity (Zhang et al., 2024). In a systematic review of literature on heat stress, Hancock and Vasmatazidis report consistent evidence that high temperatures and other extreme environmental conditions impair cognitive performance, particularly during complex or demanding tasks. Whereas simple tasks, like basic mathematics or rapid motor responses, tend to remain relatively unaffected, performance on tasks requiring sustained attention and higher order processing deteriorate more quickly. Consequently, the more cognitively demanding the task, the more susceptible it is to heat-induced disruption. Nonetheless, this literature largely focuses on traditional performance markers, such as reaction time, error rates, memory, and attention, and typically relies on artificial lab-based settings. What remains unclear, however, is whether environmental stressors contribute to shifts in judgement or decision-making, and in particular, whether heat exposure makes individuals more susceptible to cognitive strain in ways that compromise communicative effectiveness.

Methodology

To explore these questions in a practical setting, we designed an event informed by the clear communication framework developed by Juste-Lasierra and Romero-Piqueras

(2024), focusing specifically on the inclusive design of the built environment. The framework recommends presenting information in ways that audiences can easily find, understand, and apply. This approach involves simplifying complex terminology, addressing the needs of diverse groups, and accounting for variations in education levels and native languages. This design approach drew on Norman's (2013) principles of affordance and signification: the frogs' jumping mechanism was self-evident through its physical form, while labelled boxes with images served as clear signifiers linking gameplay to the buildings under discussion, minimising the "gulf of execution" between what participants wanted to do and what the activity allowed them to do.

In terms of visual design, they advise the use of visual elements that aid comprehension and materials that feel approachable rather than intimidating. From a usability point of view, they advocate materials that are practical, functional, and easy to navigate. Central to their approach is shifting the question from how something should be written to what content most effectively addresses the underlying need, acknowledging that optimal solutions may be visual, audiovisual, or textual. The framework is fundamentally user-centred, requiring adaptation to target audiences, feedback-driven refinement, and validation in real-world scenarios.

Applying this framework to our Researcher's Night event required translating these principles into concrete methodological steps. The framework's emphasis on accessibility and comprehension was particularly relevant given the public science communication context, where participants would have varying degrees of familiarity with architectural concepts and inclusive design principles. We began by conducting an audience analysis to understand the expected demographic composition of Researcher's Night attendees, including age ranges, educational backgrounds, and potential language barriers. This preliminary step allowed us to anticipate the diversity of needs we would encounter and informed our subsequent design decisions.

Our methodology (Table 1) links each step of the communication plan to its corresponding implementation strategy and anticipated impact. The first step involved identifying the participants: students, teachers, parents, and tutors. Ultimately, 35 people participated, with ages ranging from 12 to upwards of 70 years. While all shared an interest in research, the main challenge was effectively communicating with distinct age groups within a single activity.

After identifying the participants, we determined the type of activity we would conduct. The research we presented focused on the participatory design carried out within three

EU-funded projects: SPICE (Sustainable Public Spaces through Inclusive Community Engagement), ALFIE (Assessment of Learning technologies and Frameworks for Intelligent and Ethical AI), and ClearClimate (Engaging approaches and services for meaningful climate actions). The SPICE project explores methods for communicating with neighbourhood residents in four EU cities to facilitate participatory urban interventions, while the ALFIE project examines strategies to understand and avoid bias in human-AI interaction. ClearClimate seeks to build an international and interdisciplinary network of researchers and professionals to address the key challenges of Climate Information Services. In each case, the discussion topics were inherently abstract, with no laboratory apparatus for the public to interact with directly. While some Researcher's Night activities recreated laboratory practices, our proposed activity required a more dynamic approach to engage participants of all ages in meaningful dialogue.

The framework's principle of choosing the most appropriate medium for conveying information led us to develop a game-based approach. Games offer inherent advantages for public engagement: they provide hands-on interaction, accommodate different learning styles, and create a low-stakes environment where participants can explore complex ideas through experimentation rather than passive reception. This aligned with Juste-Lasierra and Romero-Piqueras's recommendation to prioritise what content best addresses the underlying need, in this case, prompting reflection on inclusive building design, over conventional communication formats.

Our activity presented two communication challenges: clearly linking the game's objective to our research themes (urban planning and data bias) and simplifying the rules to ensure immediate and effortless play. To address these challenges, we chose Jumping Frogs (Figure 1), a widely known game whose mechanics are instantly grasped with minimal instruction. The game involves pressing a lip at the back of each frog to make it jump.



Figure 1. Jumping frogs, photograph the author's own.

The game was structured around individual boxes, each representing a key building in the urban environment: a school, supermarket, park, hospital, and sports centre. These buildings were selected for their relevance across different age groups. Each box displayed a picture and name of the building to ensure clarity. The game component was designed to embody the framework's usability principles by being immediately intuitive, requiring minimal verbal instruction, and allowing participants to progress at their own pace. We deliberately incorporated visual and tactile elements to reduce reliance on text-heavy explanations, making the experience accessible to non-native speakers and younger participants.

Steps to prepare the participatory event

Steps	Description	Strategy	Result
User identification	Children or students with parents or tutors interested in science	Ask organisers to profile participants in Researchers Night: who are the participants, ages, and expectations	Preparation of activity for three different groups: adults, teenager, and children
Interaction activity	Gamification	Explain the game and how to play.	Good reception of the idea, and the materials; easy to understand game and rules
Preparation of materials for interaction	Boxes representing different buildings in the urban environment	Use of recycled materials, to lead by example; use a game that participants could take home, one which is popular and easy to understand.	Recycling of items we had from previous research engagement
Game instructions	Demonstration on how to flip a frog	No ambiguity as to how to play	Fast learning process, fast uptake, high engagement

Table 1. Preparation steps for a participatory event.

The activity took place in three phases that lasted over 30 minutes. First, participants were welcomed and introduced to the projects and their objectives. Second, the game was explained. Third, an open discussion allowed participants to share their choices and reflect on their findings. Each participant received five frogs to use during the game, which they could take home afterwards.

The discussion phase provided an opportunity for dialogue and clarification, creating space for participants to articulate their observations and connect gameplay experiences to real-world applications. This two-part structure reflected the framework's iterative nature: the game served as an experiential introduction to inclusive design concepts, while the discussion enabled us to assess comprehension, address misconceptions, and adapt our explanations to the specific interests and questions that emerged from participants. During the discussion, facilitated by the authors, participants were asked two key questions:

1. Which building(s) do you think need a change in their structure?
2. What change(s) would you make, and why?

One member of the research team facilitated the activity while the other took notes of participants' responses and interactions. These observations were later compiled into a Word document. Throughout the activity design process, we remained committed to the user-centred ethos of the framework, which we define, following Norman (2013), as an approach to design that begins from the needs, capabilities, and expected behaviours of the people who will use a system or environment, rather than from the constraints or conventions of the designer, and which prioritises iterative testing and feedback to ensure that a design functions as intended for its intended users. Applied to our activity, this meant designing materials and interactions that participants could grasp intuitively, with minimal instruction, and adapting our approach in response to how participants actually engaged with the game rather than how we had anticipated they would. We recognised that effectiveness would ultimately be measured not by the sophistication of our materials but by participants' ability to engage meaningfully with the underlying ideas about inclusivity in built environments.

Results: Lessons learned

In response to these two questions, participants focused their comments on the school, sports centre, and hospital, while the market and supermarket received little attention. Across all groups, the preferred improvements focused on creating cooler indoor environments. Ventilation was consistently identified as the most urgent concern, followed by air-conditioning or ceiling fans, and larger windows. Most participant comments drew on recent summer camp experiences in sports centres, where heat had been particularly intense, and on school facilities that lacked air-conditioning or fans. Hospitals were also

highlighted as needing similar upgrades, specifically improved ventilation and increased natural light.

Despite thorough preparation, the results of this activity were nevertheless unexpected. One factor that had been insufficiently considered was the weather. While not a direct source of bias in methodological terms, it nevertheless shaped participation and the nature of the data gathered. At the time of the activity, Catalonia, like most of Europe, was experiencing an extended heatwave in which 670 heat-related deaths were recorded (Catalan News, 2025a). This event occurred within a broader pattern of rising heat-related deaths over the past decade (see Table 2). These conditions likely influenced the focus of participants' responses, drawing greater attention to issues of bodily comfort and public infrastructure that might not have emerged under more moderate weather conditions. In this sense, the heatwave may have functioned as a salience-amplifying condition rather than a source of error, shaping what issues rose to the surface, without necessarily distorting participants' underlying views.

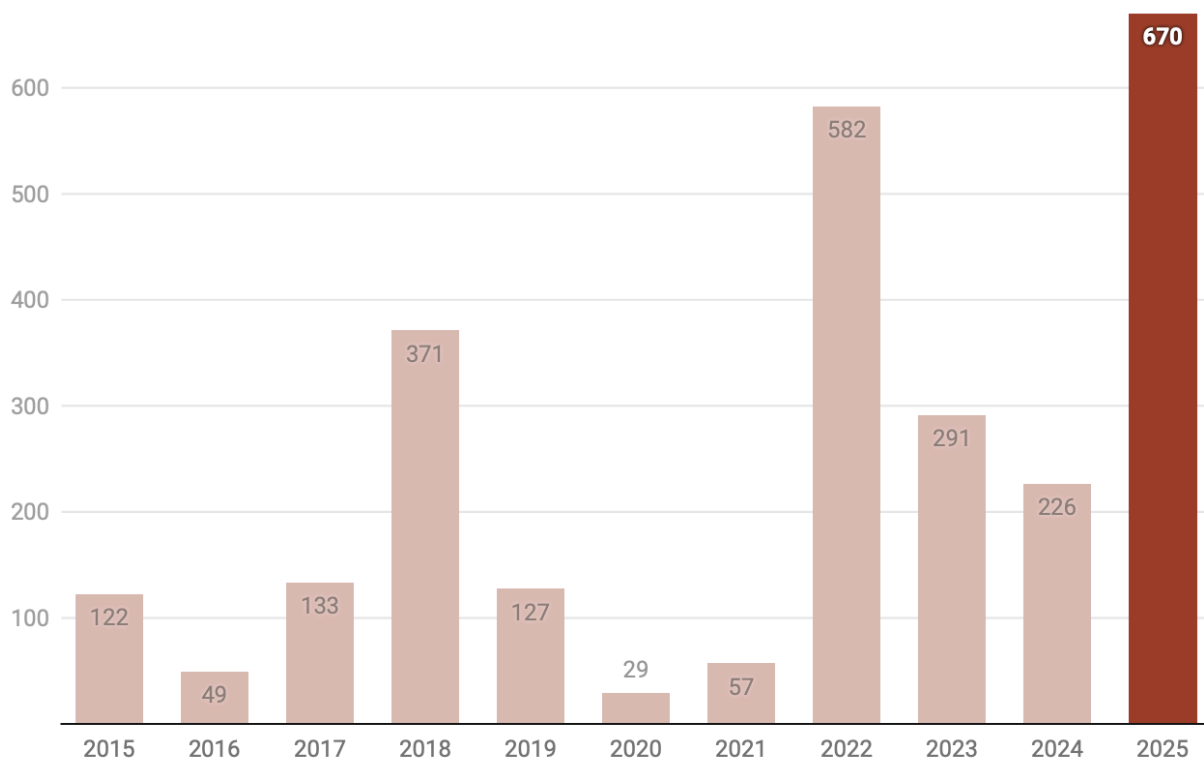


Table 2. Heat related deaths in Catalonia, taken from Carlos III Institute's Daily Mortality Monitoring System (MoMo). Created by Datawrapper.

The timing of the activity added another layer to the context. Conducted during Catalonia's summer break, when most children attend summer camps, typically held in hybrid indoor/outdoor sports centres, the activity coincided with a period in which participants, mostly children, were spending extended periods of time in overheated facilities. This likely influenced the prominence of heat-related concerns in participant feedback. At the same time, Catalonia's built environment, especially in densely populated areas such as Barcelona, intensifies heat exposure due to the urban heat island effect (Kim, 1992). Factors including concrete architecture, limited green space, and dense urban sprawl, contribute to temperatures several degrees higher than in surrounding rural areas. Additionally, the day of the event, Barcelona was affected by a tropical storm that brought extreme flooding to the region (Catalan News, 2025b). Although the storm itself did not feature in participants' comments, its presence formed part of a broader backdrop of extreme weather events.

These external conditions invite reflection on how environmental context may have shaped the data gathered. If participants were already experiencing bodily discomfort in their daily routines, this activity may have elicited disproportionately heat and climate-focused responses, not because these concerns were unimportant, but because the timing magnified their immediacy. This pattern is consistent with what might be called an immediacy effect: a tendency to give disproportionate weight to things being experienced in the moment, relative to concerns more distant in time. In other words, the extreme weather may have shaped which needs felt most pressing to participants, rather than providing a balanced picture of participants' year-round priorities.

Other contextual factors may have shaped the experience, for example the timing and location of the activity, which took place at 19:30, as the final session of the day, in a basement room with no windows. The room had been in continuous use, leaving it hot and humid, with poor ventilation during the activity. These conditions closely mirrored the issues participants later raised, namely the need for better airflow and natural ventilation. It may be that the discomfort experienced during the activity heightened participants' attention to these aspects. This does not point to a methodological flaw so much as a reminder that feedback is shaped by the immediate physical setting in which it is gathered, both in the direction and emotional tone. The recurrence of references to summer camps, schoolrooms, and the activity space itself, mentioned by children and adults alike, suggest that participants were drawing heavily on immediate embodied experiences.

Taken together, these contextual elements highlight important methodological considerations. Environmental conditions, both external and site-specific, may have influenced the salience of certain themes in participants' responses. While this does not undermine the legitimacy of their concerns, it does underscore the need for careful interpretation, particularly when analysing data collected under atypical or extreme environmental circumstances. More broadly, this experience suggests that environmental context is not merely a backdrop to participatory research but an active variable shaping engagement, and one that warrants explicit consideration in both the design and reporting of future activities.

Limitations

While these findings emphasize the importance of environmental context in participatory research, they must be interpreted with caution due to several limitations in this study. Firstly, our conclusions are drawn from a single case study involving a relatively small number of participants ($n=35$), which restricts the generalisability of the findings. As an exploratory, practice-based account rather than a controlled experimental study, the activity was not designed to isolate environmental variables from other confounding factors, such as time of day, room configuration, or the fact that the session took place as the final activity of the evening. Consequently, while we highlight plausible links between environmental stressors and shifts in participant focus, we cannot establish causal relationships between specific conditions, such as heat or humidity, and the effects discussed.

Data collection relied on facilitator observation and participant comments gathered during an open discussion phase, rather than on validated psychometric instruments or physiological measures of heat stress, such as those used in laboratory-based cognitive research (e.g. Zhang et al., 2024). Consequently, our interpretation of participants' cognitive load and engagement is necessarily qualitative and inferential, based on the content and framing of their responses rather than direct measurement. Similarly, no baseline data were collected on participant priorities under more temperate conditions, which would have allowed for a clearer comparison of how far environmental circumstances shaped the salience of heat-related themes relative to participants' everyday concerns.

The setting itself further complicates interpretation. As a public engagement activity embedded within Researcher's Night, the intervention combined multiple contextual pressures, extreme heat, poor ventilation, storm conditions, and a demanding activity schedule, that occurred simultaneously and cannot be disentangled from one another. It is therefore not possible to determine the relative contribution of each factor, or whether similar effects would emerge under isolated conditions. Additionally, participants were self-selected attendees of a public science event, which may not be representative of participants in other research settings or with other motivations for engagement.

Finally, our own positioning as facilitators and authors introduces a further limitation. Our reflections on the session were recorded after the fact and may be subject to hindsight bias, particularly given that the disruptive role of the weather became apparent only in retrospect. Future research would benefit from replicating this type of activity across multiple sites and seasons, incorporating more systematic measures of environmental conditions and participant experience, in order to test and refine the propositions advanced here.

Conclusion

This article has argued that environmental context represents a critical yet systematically overlooked dimension in participatory research design and clear communication frameworks. While linguistic accessibility, cultural sensitivity, and ethical considerations have rightfully become standard elements of research planning, our exploratory case study demonstrates that physical environmental conditions can equally determine whether meaningful engagement occurs. The disruption we experienced during the European Researchers' Night was not a matter of inadequate preparation or flawed communication strategy; it was the result of environmental stressors that fundamentally altered participants' capacity to participate.

The implications extend beyond isolated instances of extreme weather. As climate change intensifies, researchers can expect environmental disruptions to become more frequent and severe, affecting not only outdoor fieldwork but also indoor activities through factors such as heat stress and poor air quality. This reality demands a shift in how we conceptualise context in participatory research. Environmental conditions are not merely background factors to be noted in passing; they actively shape who participates, how information is processed, and which concerns emerge as salient. Failing to account for

these factors risks producing data that reflects immediate environmental pressures rather than participants' considered perspectives.

Moving forward, we propose that participatory research frameworks incorporate environmental context as a formal planning consideration alongside existing dimensions of accessibility and inclusion. This means conducting environmental risk assessments before scheduling activities, ensuring adequate physical comfort during sessions, and developing contingency plans for adverse conditions. It also requires transparency in reporting: researchers should document environmental conditions during data collection and reflect on how these may have influenced participant responses. Such practices would strengthen both the methodological rigour of participatory research and our collective understanding of how environmental factors mediate human communication and decision-making in an era of climate crisis.

Acknowledgement

This research has been funded by the EU funded projects ALFIE grant no. 101177912, CLEARCLIMATE MSCA 101131220 and SPICE grant no 101215492.

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