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Citizen Science

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Citizen science involves nonprofessional volunteers—‘citizens’—in the process of science. Citizens can be involved in many ways, from a contributory role on existing data (e.g., data annotation) to providing their own data or even co-creation of research (e.g., co-design of study protocol). In cognitive science, citizen science is opening up new ways of studying how the human brain works and how people think and behave. By involving volunteers from a wide range of backgrounds, citizen science enables the collection of data from larger and more diverse groups than would be possible in a typical laboratory. This helps make findings more generalizable to the real world and different cultures. Citizen science also encourages a more open and collaborative form of research, where members of the public are actively involved in the scientific method, helping to make cognitive science more inclusive and widely understood.

History

Citizen science has a long history, with its roots dating back to early naturalists who collaborated with the public to document and study natural phenomena. Early organized projects, such as the Audubon Society’s Christmas Bird Count established in 1900 ([Dickinson et al., 2012](#)), formalized public participation in data collection. As technology advanced, the scope and scale of citizen science expanded. The internet enabled projects like Galaxy Zoo, which began in 2007, where volunteers contributed to classifying galaxies ([Lintott et al., 2008](#)).

In recent years, cognitive science has adopted this approach. For example, the [Sea Hero Quest project](#) used a video game for mobile devices to assess the spatial navigation ability of 4 million participants from every country on Earth, see [Figure 1](#) ([Coutrot et al., 2018](#); [Spiers et al., 2023](#)) [see [Spatial Cognition](#)]. Today, projects in cognitive science use smartphones, social media, and mobile applications to collect data from diverse populations across the globe ([Long et al., 2023](#), [Allen et al., 2024](#)), enabling researchers to capture more representative samples and unprecedented volumes of data.

Core concepts

Scale and diversity

Traditional laboratory-based studies in cognitive science often rely on small sample sizes, generally involving undergraduate participants. This limits the diversity and generalizability of findings ([Henrich et al., 2010](#)) [see [WEIRD](#)]. Citizen science allows for larger, more heterogeneous samples, including those from groups that are underrepresented in scientific research. As an example, [The Music Lab](#) is an online platform studying how people around the world—including in small-scale societies—engage with music and whether there are universal patterns to music cognition across cultures ([Mehr et al., 2019](#)).

Ecological validity

Laboratory settings often fail to capture real-world behavior accurately due to their controlled nature (Vigliocco et al., 2024). Citizen science projects provide participants with tasks that are more aligned with real-world experiences. By collecting data from participants in their natural environments, such as on their phones at home or while commuting, researchers can gain insights into how people's cognitive functions operate under everyday conditions, enhancing the ecological validity of findings (Pedersen et al., 2023).

Gamification for engagement

Citizen science projects often incorporate gamification—using game-like elements to enhance engagement [see [Affordances](#)]. Gamification can include transforming experiments into bespoke games, embedding experiments in existing games, and extracting data from ongoing ones. Gamified studies can lead to better participant retention and engagement, reduce dropout rates, and increase the quality of the data collected (Germiné, 2012; Tinati et al., 2017; Allen et al., 2024).

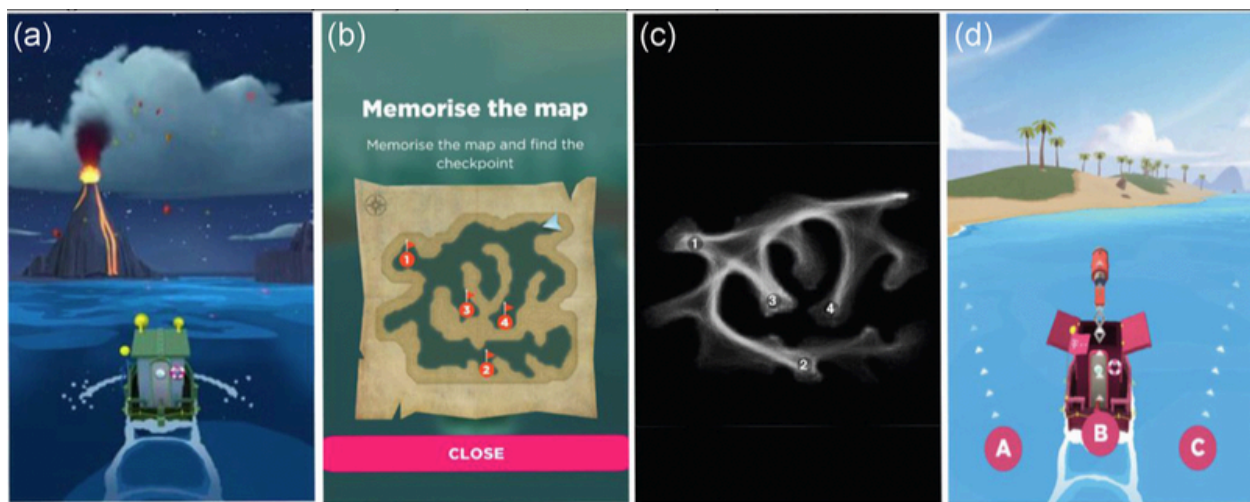


Figure 1

Example citizen science project: Sea Hero Quest. The task, which collected navigation data, was embedded in a mobile video game application. (a) Game design: players sail a boat to find checkpoints in a set order. (b) In wayfinding levels, a map of the level featuring the ordered set of checkpoints to reach is presented and disappears when the navigation starts. (c) Superposition of 1,000 individual trajectories randomly sampled from Level 32. (d) Path-integration task: After navigating the level, participants must shoot a flare back to the starting point. Reproduced from Coutrot et al. (2018).

Questions, controversies, and new developments

The rapid growth of citizen science in cognitive research brings new challenges and raises key questions.

Data privacy and ethics

Large-scale data collection often requires sensitive information, such as clinical, demographic, or geographic details. Researchers often obtain consent and anonymize data to protect participant privacy. However, ethical concerns about data security and transparency remain, especially when corporate entities are involved ([Resnik, 2019](#)).

Bias and accessibility

Despite the potential for broader representation, citizen science is not as representative of cultural diversity as often claimed ([Majid, 2023](#)). For instance, tasks can only be accessible with a smartphone, which may exclude certain demographics such as older people. Additionally, because participation is voluntary, self-selection bias may arise, with those interested in gaming or science being overrepresented ([Stone et al., 2024](#)).

Data quality and validation

A common critique of citizen science is the potential for inconsistent or unreliable data due to the variability in participant engagement and experience levels ([Cai, 2024](#)). Validation strategies, including comparing citizen science data with established experimental benchmarks, are crucial to ensuring that findings are scientifically robust and replicable ([Balázs et al., 2021](#)).

Participatory research

The involvement of nonprofessional scientists in the scientific process is a cornerstone of citizen science. Citizen participation in cognitive science has mainly been passive. Scientists simply collect people's behavior and cognition, which doesn't really empower citizens in the scientific process ([Van den Bussche, 2024](#)). Future studies should aim to include citizens' voices at all stages of the research. This is particularly true when the research involved indigenous communities.

Broader connections

Mental health

Research in mental health has historically not been conducted in collaboration with the people whose specific challenges are being studied. The use of citizen science in mental health research is emergent and still needs to address specific issues, such as careful consideration of the consent process. This approach allows mental health researchers and citizen scientists to co-create mental health-tailored projects ([Gillan & Rutledge, 2021](#); [Todowede, 2023](#)).

Public health and disease prevention

Citizen scientists can improve regional data collection and avoid the one-size-fits-all approach ([Rowbotham, 2017](#)). For instance, Sea Hero Quest has laid the groundwork for personalized cognitive assessments that could potentially screen for early signs of dementia ([Spiers et al., 2023](#)). Citizen scientists

can also be great vectors to communicate health information to a broad audience ([de Cocker, 2019](#)) and enhance trust in science and scientific experts ([den Houting, 2021](#)).

Artificial intelligence and machine learning

The wide cultural diversity around the globe is not fully captured by the data that current AI models are being trained on ([Atari et al., 2023](#)). The magnitude and diversity of training datasets enabled by citizen science may help to mitigate these biases.

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