Response to the Letter to the Editor

Reappraising Digital Competence and Cognitive Reserve as Protective Factors in Older Adults' Cognition

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Estela Calatayud 1,2, Bárbara Oliván-Blázquez 2,3,4, Alejandra Aguilar-Latorre 2,4,5*, Juan Nicolás Cuenca-Zaldivar 6,7,8 Rosa Mª Magallón-Botaya 2,4,9, Isabel Gómez-Soria 1,2

1. Department of Physiatry and Nursing, Faculty of Health Sciences, University of Zaragoza, 50009 Zaragoza, Spain. estelacs@unizar.es isabelgs@unizar.es

2. Aragonese Primary Care Research Group (GAIAP), Institute for Health Research Aragón (IIS Aragón), CIBA building, Avda. San Juan Bosco, 13, 50009 Zaragoza, Spain.

3. Department of Psychology and Sociology, Faculty of Social and Labor Sciences, University of Zaragoza, 50009 Zaragoza, Spain. bolivan@unizar.es

4. Research Network on Chronicity, Primary Care and Health Promotion (RICAPPS, RD24/0005/0004), Carlos III Health Institute, 28029 Madrid, Spain.

5. Department of Psychology and Sociology, Faculty of Human Sciences and Education of Huesca, University of Zaragoza, 22003 Huesca, Spain.

6. Department of Physiotherapy, Catholic University of Avila, 05005 Avila, Spain. j.nicolas7251@gmail.com

7. Primary Health Center “El Abajon”, 28231 Las Rozas de Madrid, Spain.

8. Universidad de Alcalá, Facultad de Medicina y Ciencias de la Salud, Departamento de Enfermería y Fisioterapia, Grupo de Investigación en Fisioterapia y Dolor, 28801 Alcalá de Henares, Spain.

9. Department of Medicine, Psychiatry and Dermatology, Faculty of Medicine, University of Zaragoza, 50009 Zaragoza, Spain. rosamaga@unizar.es

*Corresponding author: Alejandra Aguilar-Latorre

Email address: aaguilar@unizar.es

Department of Psychology and Sociology, Faculty of Human Sciences and Education of Huesca, University of Zaragoza, 22003 Huesca, Spain.

Ethics statement

N/A.

Conflict of Interest Statement

None.

Dear Editor,

We sincerely thank Dr. Sathian and colleagues for their thoughtful and constructive comments regarding our article “Digital Competence and Cognitive Reserve in Relation to Different Domains of Cognitive Functioning in Older Adults.” We deeply appreciate their recognition of our study’s contribution to understanding protective factors for cognitive health in aging populations and welcome the opportunity to clarify several methodological and interpretive aspects. However, we do not agree with the observations they have made.

With regard to their suggestion of a corrigendum, we respectfully consider that such a correction is not warranted. The methodology and interpretation presented in our article are consistent with current standards for causal reasoning in observational research using Directed Acyclic Graphs (DAGs). This analytical framework provides a structured approach for representing hypothesized causal relationships among variables, identifying confounders, and determining the minimal sufficient adjustment set required to minimize bias in statistical models (Tennant et al., 2021). DAGs have been widely adopted across epidemiological and clinical research to enhance transparency in modeling assumptions and to avoid inappropriate covariate adjustments (Piccininni et al., 2020; Williams et al., 2018). Moreover, the use of DAGs is not limited to longitudinal or experimental designs. As demonstrated by Shahar and Shahar (2013), and more recently by Savitz (2023), cross-sectional studies can also adopt a causal framework through DAGs to represent and test theoretically grounded causal hypotheses, provided that directionality is conceptually justified and assumptions are made explicit. These studies emphasize that DAGs do not constitute empirical proof of causality but rather formalize causal assumptions, allowing researchers to distinguish between associational and causal pathways, identify sources of confounding, and clarify the logic underlying model specification. In this sense, our study followed best practices for applying DAGs in observational settings by articulating hypothesized relationships between digital competence, cognitive reserve, and cognitive performance prior to statistical analysis. Collectively, methodological literature converges on three central ideas that underpin our approach: (1) DAGs serve as visual and theoretical tools for representing causal relationships rather than

demonstrating empirical causality (Tennant et al., 2021; Piccininni et al., 2020); (2) they facilitate the explicit formulation of causal hypotheses and the identification of appropriate confounders for valid modeling (Williams et al., 2018); and (3) they provide a coherent causal framework that can guide analysis and interpretation even within cross-sectional designs (Shahar & Shahar, 2013; Savitz, 2023). On this basis, we maintain that our use of causal terminology reflects theoretical modeling conventions rather than empirical claims of intervention effects, and therefore, a corrigendum is unnecessary.

Regarding the issue of causality and the potential for reverse causation between digital competence and cognition, we fully acknowledge that our cross-sectional design precludes establishing temporal precedence. Nevertheless, our analytical approach was grounded in a causal inference framework using Directed Acyclic Graphs (DAGs), explicitly developed to represent hypothesized causal structures among variables and to identify confounders for appropriate model adjustment (Tennant et al., 2021; Shahar & Shahar, 2013). DAGs do not themselves prove causality; rather, they formalize causal assumptions and guide statistical control to minimize bias. In line with recent longitudinal evidence, the relationship between digital competence and cognition is likely bidirectional, with cognitive capacity predicting sustained digital engagement, and digital participation, in turn, supporting cognitive performance through stimulation and social interaction (Zhao et al., 2024; Wieczorek et al., 2024; Yu & Fiebig, 2020). Therefore, our use of the term “protective factor” reflects a hypothetical causal role within the DAG framework rather than an empirical claim of causality.

Concerning the inverse association between digital competence and verbal learning, as well as the plateau observed in cognitive reserve (CR), we emphasize that these patterns are consistent with evidence showing domain-specific and non-linear relationships. Digital engagement often produces stronger effects on executive and attentional functions than on memory performance, depending on the nature and complexity of digital activities (Kim & Han, 2022; Wang et al., 2024). Likewise, cognitive reserve effects have been shown to exhibit diminishing returns beyond certain thresholds, with variations across cognitive domains and demographic groups (Nelson et al., 2021;

Opdebeeck et al., 2016; Lövdén et al., 2020). Thus, the apparent plateau in our findings is coherent with current models describing cognitive reserve as a dynamic and heterogeneous construct rather than a uniform protective factor.

We also acknowledge the reviewers' point concerning potential digital inequalities. We fully agree that while digital competence can serve as a pathway to cognitive resilience, it can also become a source of disparity when access and training are unequally distributed. Evidence consistently shows that digital exclusion is linked to poorer cognitive and psychosocial outcomes (Wang et al., 2024; Seifert, 2020), while social technology enhances well-being only when access is equitable and socially meaningful (Cotten et al., 2013; Chopik, 2016). Our interpretation of digital competence as a protective factor therefore presupposes equitable access, contextual support, and inclusive intervention design to prevent the amplification of existing inequalities.

Concerning the comments about the cross-sectional design and longitudinal dynamics, we fully recognize that our study cannot establish causal directionality. However, it complements the longitudinal literature by delineating theoretically grounded associations and structural pathways that future studies may test empirically. Prior longitudinal research supports reciprocal associations between digital engagement and cognitive function, suggesting that Internet use and cognitive health reinforce each other over time (Yu & Fiebig, 2020; Zhao et al., 2024; Chen et al., 2024). We thus view our work as a foundation for future prospective and multi-cohort investigations designed to validate these mechanisms.

We also believe that scientific dialogue, especially in emerging fields such as digital competence and cognitive aging, benefits from methodological transparency and theoretical clarity, both of which we aimed to promote in our study. We are sincerely grateful to Dr. Sathian and colleagues for their valuable observations, which have helped us further refine our methodological framing and interpretation. We fully acknowledge the inherent limitations of cross-sectional research and agree that longitudinal, multi-cohort studies are essential to deepen understanding of how digital competence and cognitive reserve interact across aging. We hope this exchange strengthens scientific dialogue and contributes constructively to advancing knowledge in this important area.

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