A critical review of cognition and perception research Involving map projections

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Abstract:

Map projections are both fundamental to maps and confusing to map readers. Yet, in comparison to other cartographic themes such as color use or symbolization methods, sparse research has examined peoples' cognitive and perception of map projections. This presentation explores scholarly literature published since the 1960s that examined peoples' cognitive and perceptual understanding of map projections. Map projections present challenges to virtually everyone who uses them. Some of the challenges include selecting a map projection, specifying map projection parameters, and understanding distortion patterns. Broadly speaking, cartographic inquiry has addressed many topics in cognition and perception related to map design and map use; yet research focused on map projections remains scarce. With respect to our review of research specific to distortion, we also present a discussion of some broader work evaluating "location" in cognitive maps, as it generally connects to the issues of how map projection distortion influences the development of our cognitive maps.

For our study (Kessler and Battersby, 2023), we reviewed published research that focused on cognition and perception studies involving map projections. In collecting these articles, we relied on two criteria: Articles were published in English and included experiments where one or more cognitive or perceptual tasks (e.g., estimation) involved the map projection as a factor or a projection related concept (e.g. distance distortion). Based on these criteria, we sourced 27 research articles. Table 1 summarizes the number of articles that were selected across the decades from the 1960s to the present. The earliest cognitive map projection related research that we found was Mackay (1969) whose work focused on perception of conformality of projections. Since that study, the number of publications focusing on cognitive aspects of map projections has increased.

1960s	1970s	1980s	1990s	2000s	2010s	2020s
1	1	4	5	4	10	2

Table 1. The number of research articles collected for our review by decade.

Generally, these cognitive- and perceptual-based studies examined peoples' understanding of the map projection properties (area, distance, and direction, aesthetics, periphery, location, and shape) or the inherent distortion that results from the map projection process. While the properties and distortion are topics commonly discussed when learning about map projections, research suggests that these topics are not conceptualized and/or internalized equally. This is true with respect to direct (perceived) interpretation of information on maps and in retrieval of spatial information from cognitive maps. These basic map projection properties served as an organizational framework for evaluating the experiments, their content, and results found in each article (e.g., we grouped and discussed articles together that involved experiments with area distortion).

Despite the conclusions reported by these studies, we noted three general concerns that may diminish the accuracy of results from research in this area. First, included in these studies were map projection-specific terminology or properties critical to the experiment and analysis that may be misunderstood by researchers and/or participants. Second, study participants were largely homogenous. Third, most of the studies were not designed for replication or reproducibility.

Given our critique of these 27 studies, we offer six suggested considerations for those who are interested in conducting new cognitive and perceptual map projection research.

(1) **Research framing**
Studies need to be more aware that the field of cognitive and perceptual research has advanced considerably since Piaget and others that have been cited in existing research as foundational to the methodology.

(2) **Seek the advice of experts**
Many researchers have not had formal training in cognitive and perceptual human subjects' research. We suggest seeking assistance from those with expertise in cognitive research design and map projections. This is particularly true with respect to framing the questions and developing the tasks.

(3) **Pilot your study with projections in mind**
Piloting the experimental design can provide insight into the tasks and framing stimulus questions allowing the researchers the opportunity to critically evaluate whether the participants fully understand what questions are being asked, the appropriateness of the terminology being used in the questions, and whether the questions yield the desired outcomes.

(4) **Go beyond the convenience sample**
If researchers are genuinely wanting to learn more about the range of perspectives on map projections, researchers need to be more inclusive than reliance on relatively small convenience samples of college-age students.

(5) **Spherical vs planar surface**
The experimental tasks should be designed to learn which surface (Cartesian or sphere) the participants used during the experimental tasks, or the tasks should be designed so that the participants are directed to use a specific surface.

(6) **Replication**
Studies need to be replicable to confirm and validate the claims made in our research.

References

Fritz C. Kessler & Sarah E. Battersby (2023): Cognition and perception of map projections: a literature review, *Cartography and Geographic Information Science*, DOI: 10.1080/15230406.2023.2195683

Mackay, J. R. (1969). The perception of conformality of some map projections. *Geographical Review*, *59*(3), 373–387.