A case to study the relationship between data **visualization readability** and **visualization literacy**

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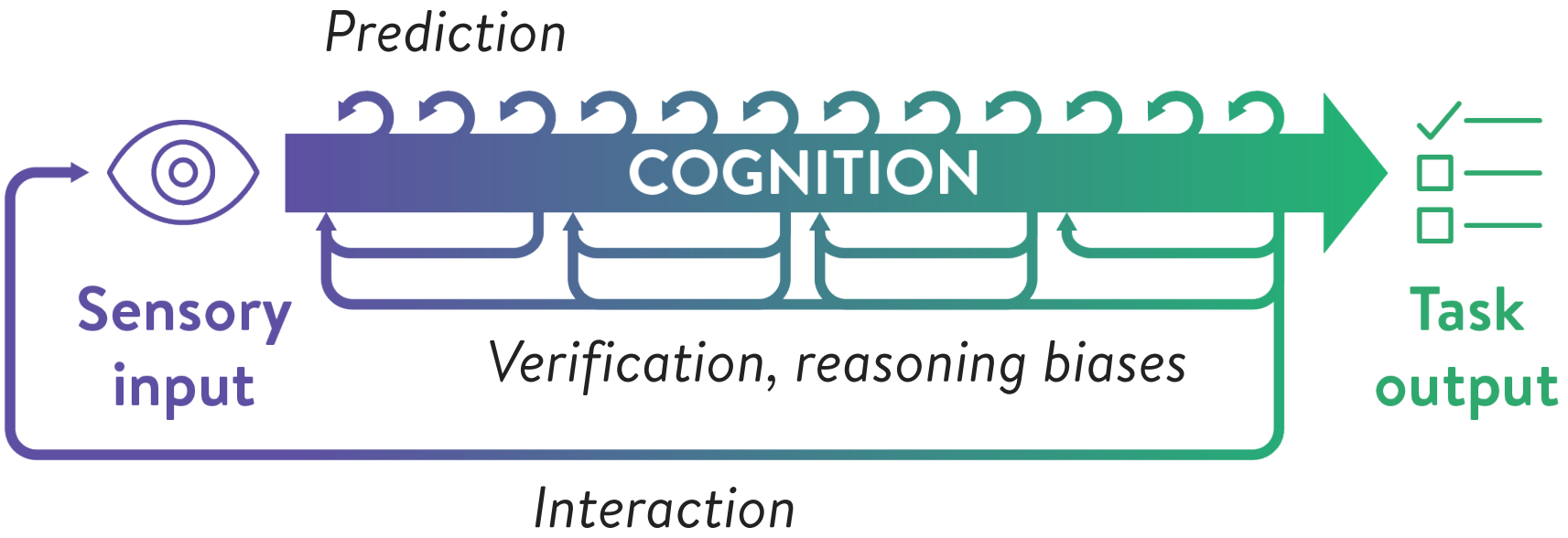
LITERACY
READABILITY

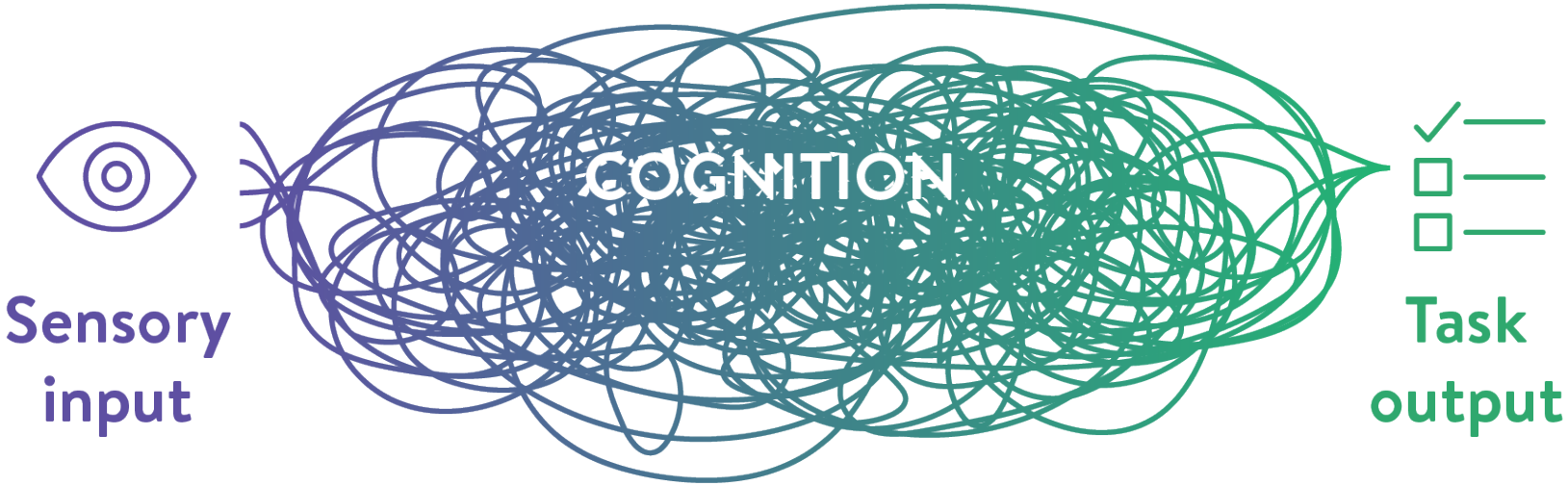
READABILITY

Viewer's cognitive processes in data visualization

Viewer's cognitive processes in data visualization



Viewer's cognitive processes in data visualization



Viewer's cognitive processes in data visualization

> The cognitive process of converting visual encodings into meaningful pieces of information.

A.-F. Cabouat, T. He, P. Isenberg, and T. Isenberg, "Pondering the reading of visual representations." Jun. 23, 2023. Accessed: Oct. 13, 2023. [Online]. Available: https://inria.hal.science/hal-04240900

A working definition of readability in visualization

READABILITY

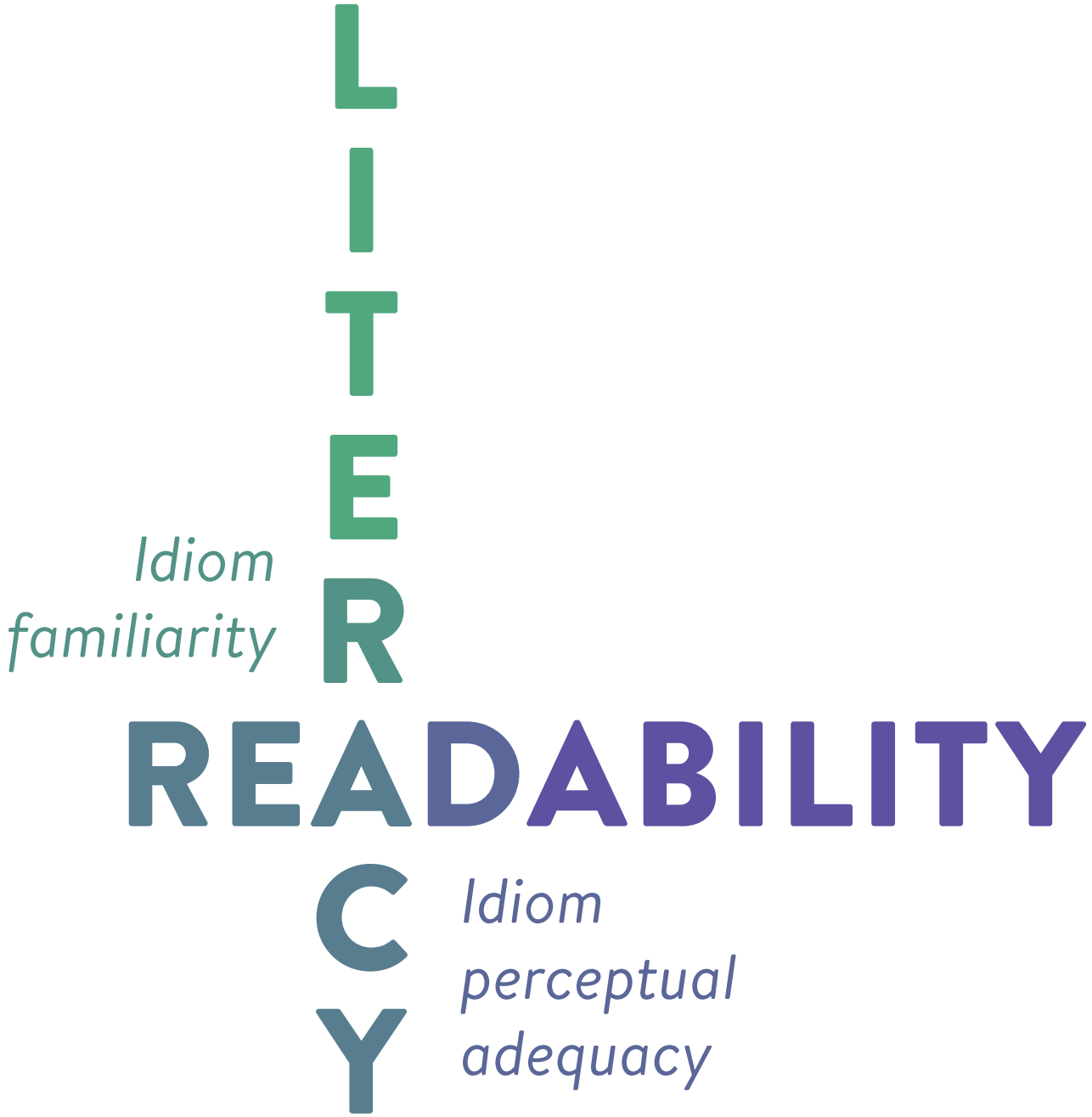
How easy this information retrieval is for a given person and context.

READING

The cognitive process of converting visual encodings into meaningful pieces of information.


LITERACY
READABILITY


LITERACY
Decode
Read
READABILITY

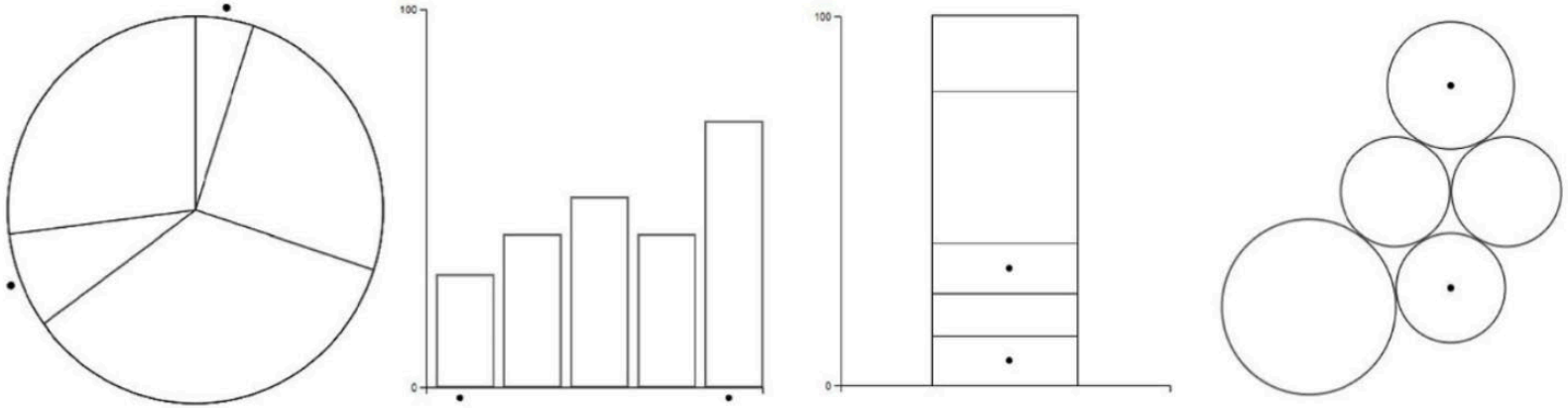


Idiom = visualization type (e.g., line graph, bar chart, node-link graph, bubble chart…)

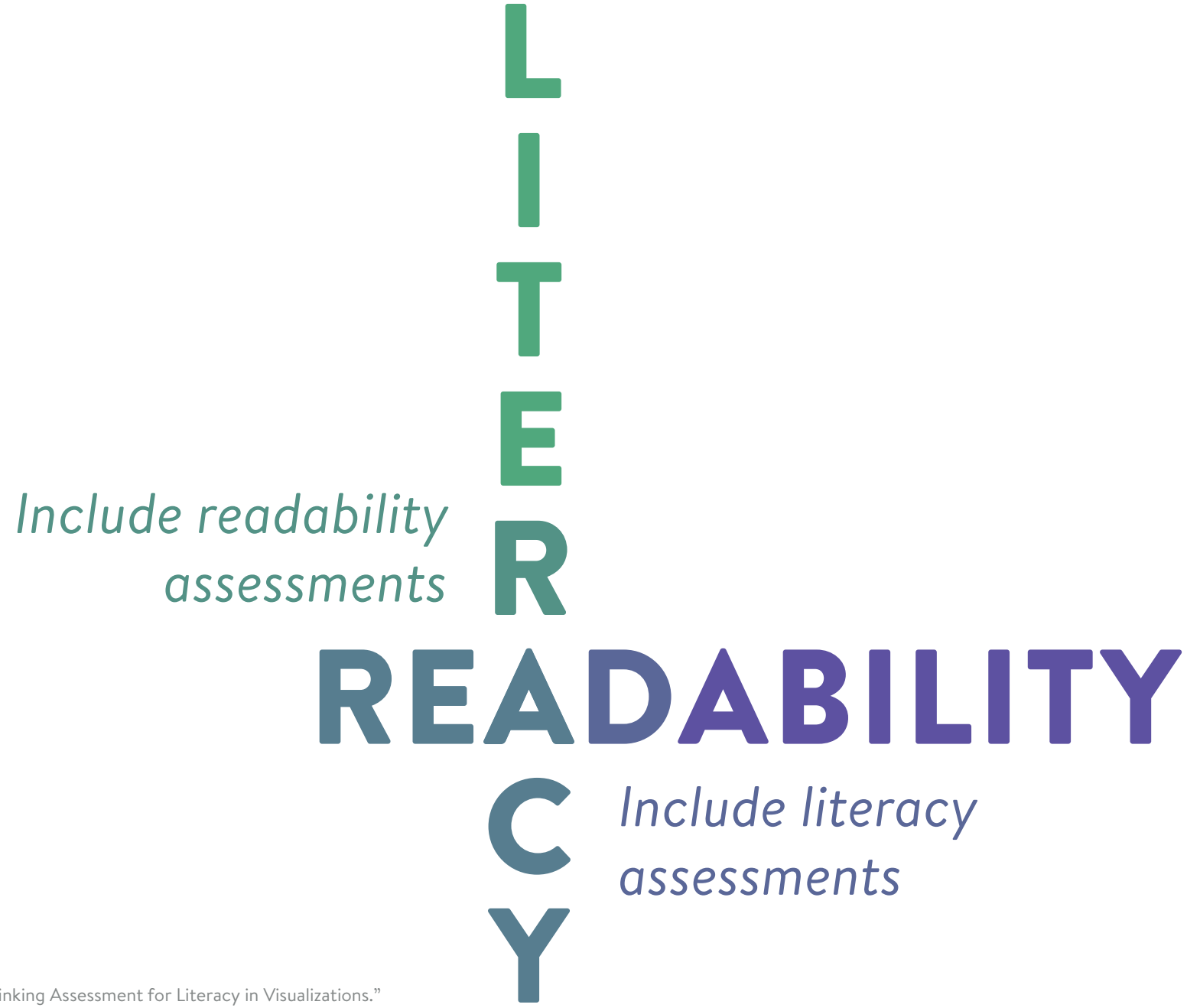
T. Munzner, *Visualization Analysis and Design*. 2014.

Idiom familiarity

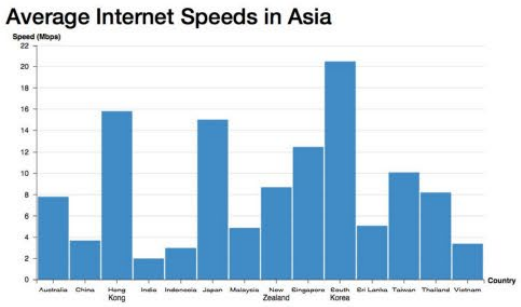
Idiom perceptual adequacy



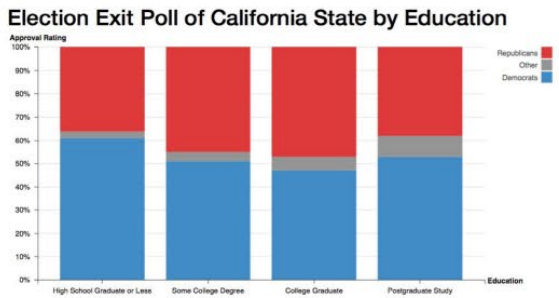
W. S. Cleveland and R. McGill, “Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods.” 1984. doi: 10.2307/2288400.
Reproduced in (among others):
J. Heer and M. Bostock, “Crowdsourcing graphical perception: using mechanical turk to assess visualization design.” 2010. doi: 10.1145/1753326.1753357.
R. Davis *et al.*, “The Risks of Ranking: Revisiting Graphical Perception to Model Individual Differences in Visualization Performance.” 2024. doi: 10.1109/TVCG.2022.3226463.



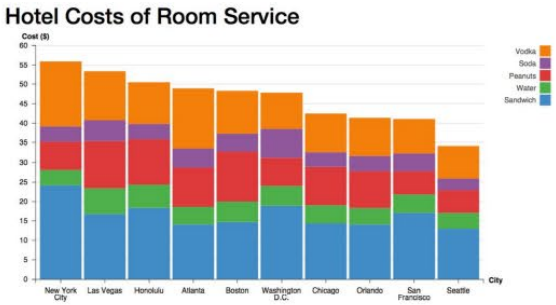
We call to expand from works such as
L. W. Ge, Y. Cui, and M. Kay, "CALVI: Critical Thinking Assessment for Literacy in Visualizations." 2023. doi: 10.1145/3544548.3581406.



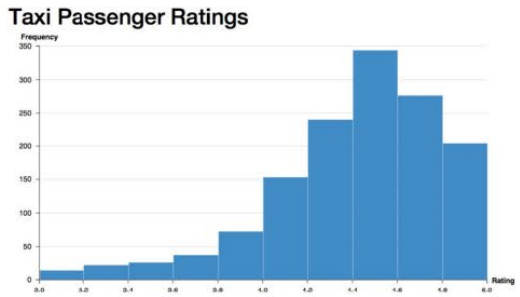
Bar chart



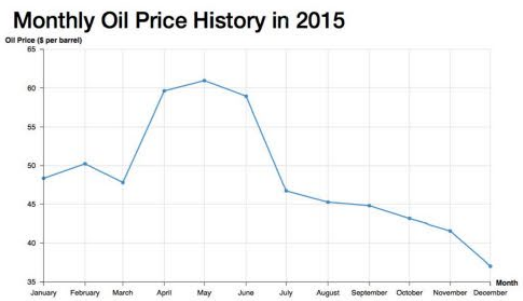
100% stacked bar chart



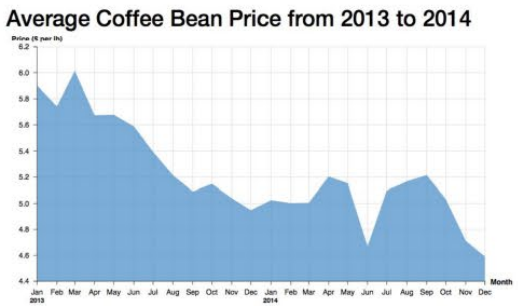
Stacked bar chart



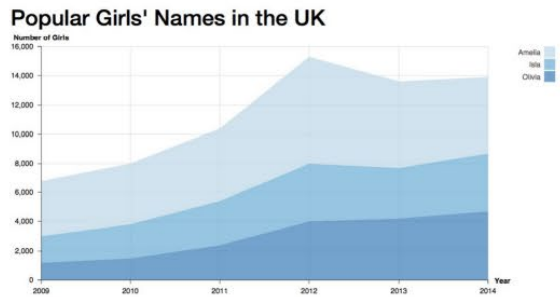
Histogram



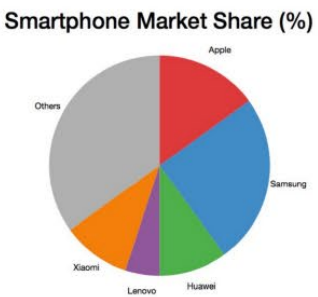
Line chart



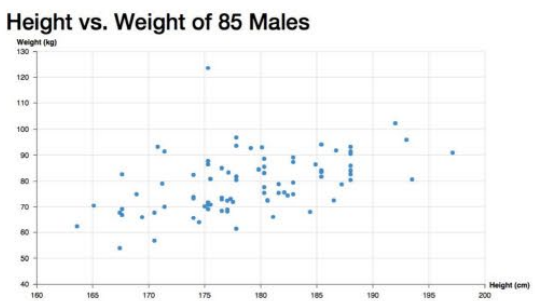
Area line



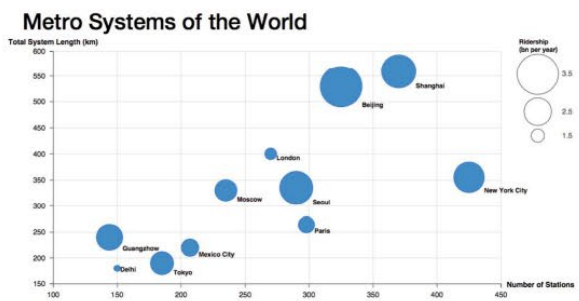
Stacked Area Line



Pie chart



Scatterplot



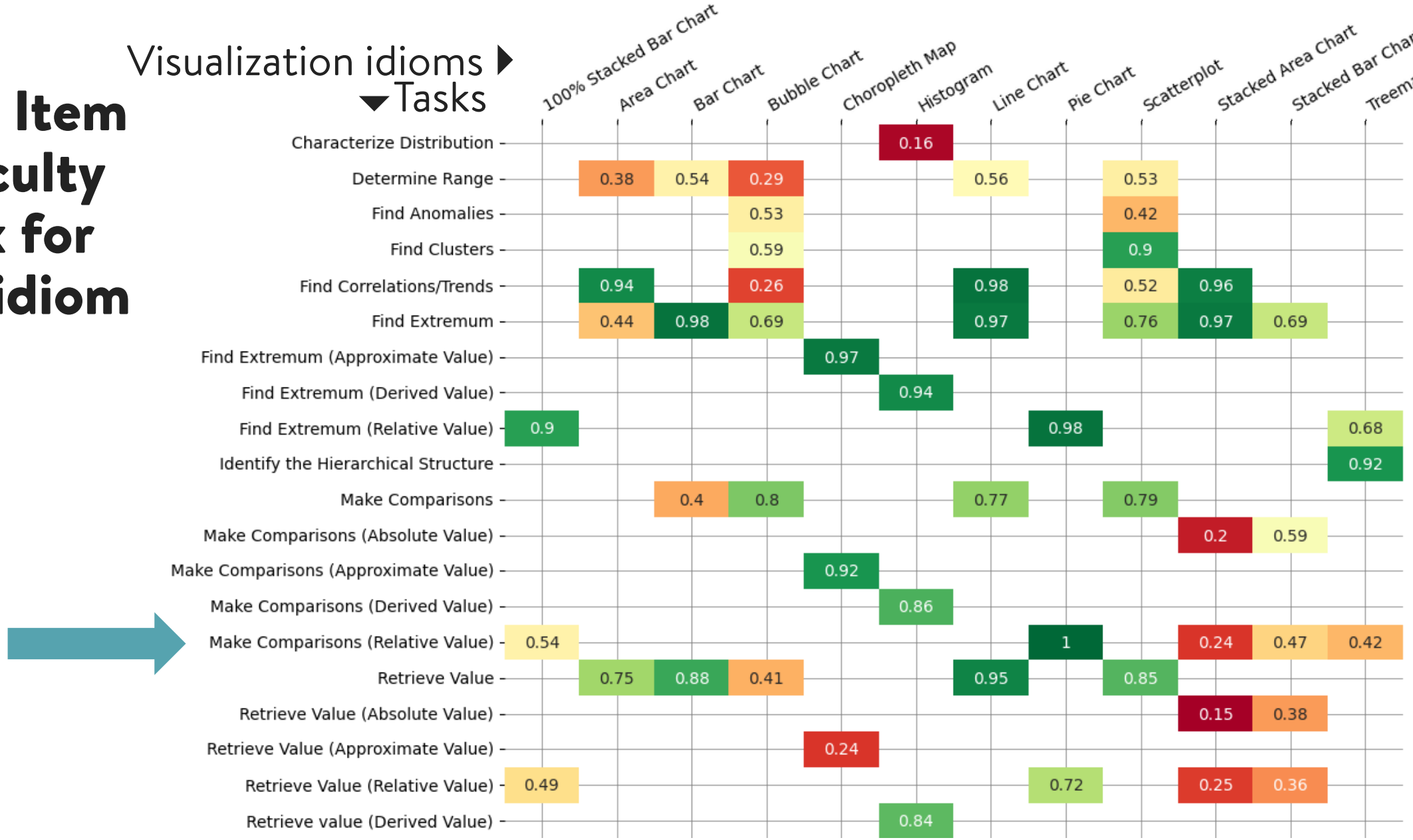
Bubblechart

Choropleth map

Treemap

S. Lee, S.-H. Kim, and B. C. Kwon, "VLAT: Development of a Visualization Literacy Assessment Test." 2017, doi: 10.1109/TVCG.2016.2598920.

VLAT Item Difficulty Index for task-idiom pairs

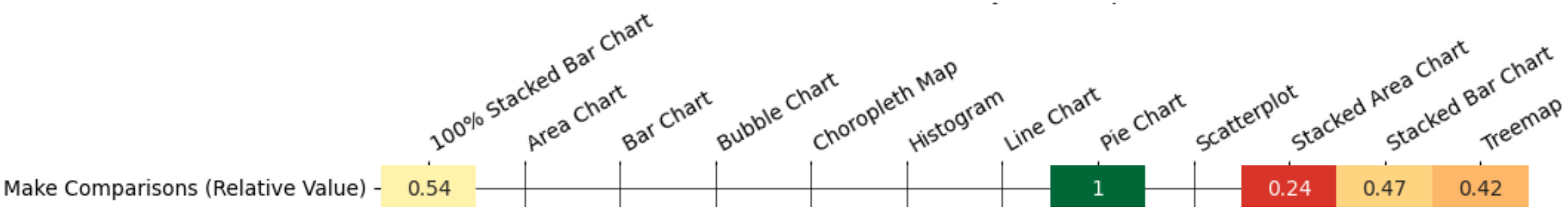


S. Lee, S.-H. Kim, and B. C. Kwon, "VLAT: Development of a Visualization Literacy Assessment Test." 2017, doi: 10.1109/TVCG.2016.2598920.

Category X's value is higher/lower than that of category Y's (at position P or in range R).

- ❑ True
- ❑ False

Make Comparisons (Relative Value)



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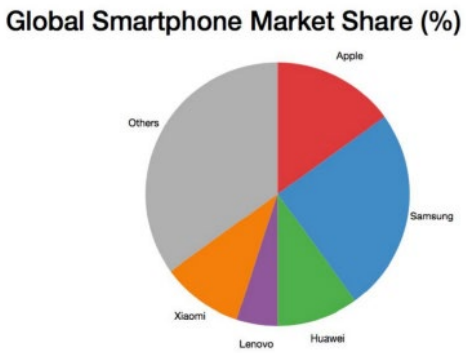
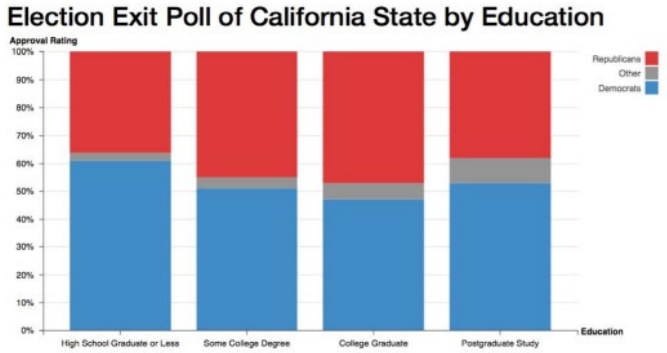
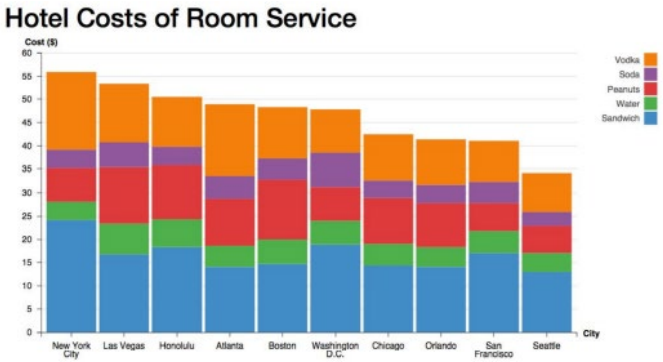
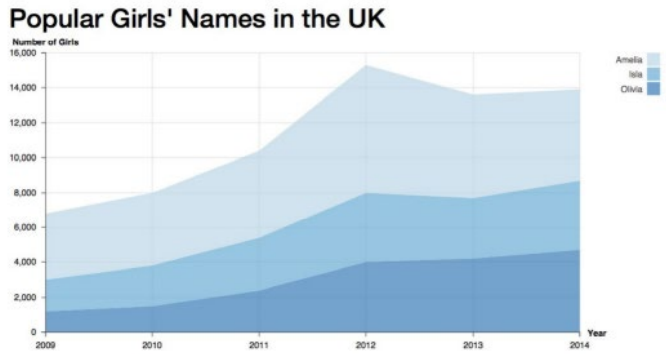








Category X's value is higher/lower than that of category Y's (at position P or in range R).

- ❑ True
- ❑ False

Make Comparisons (Relative Value)

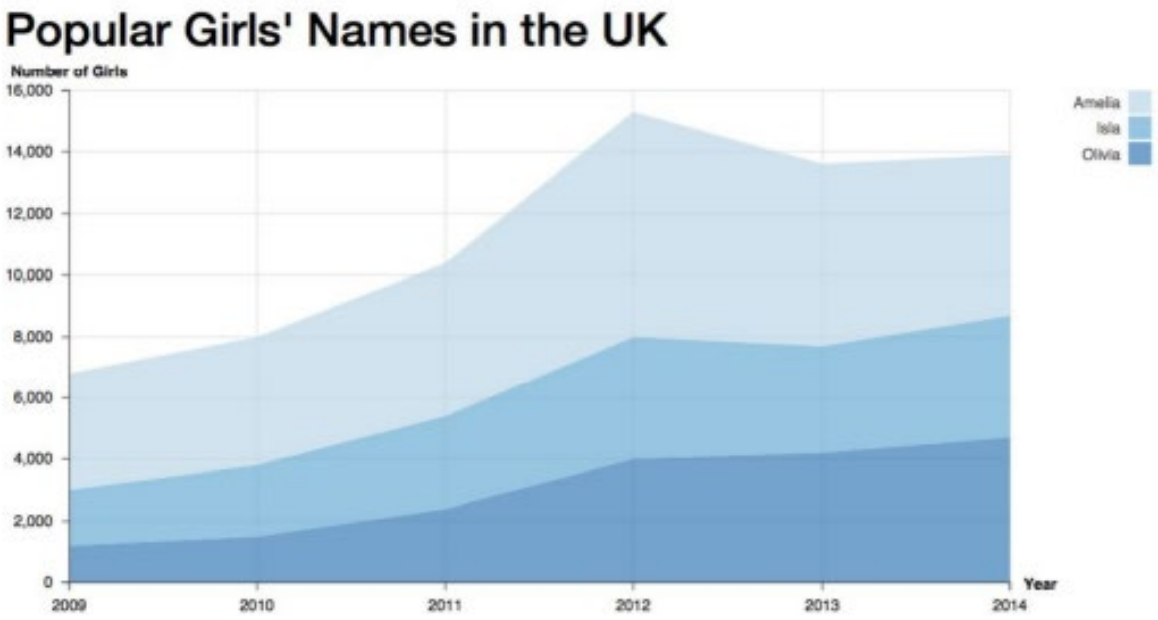
Idiom	Difficulty index	Category in VLAT
Pie Chart	1	Easy
100% Stacked Bar Chart	0.54	Moderated
Stacked Bar Chart	0.47	Hard
Treemap	0.42	Hard
Stacked Area Chart	0.24	Hard

S. Lee, S.-H. Kim, and B. C. Kwon, "VLAT: Development of a Visualization Literacy Assessment Test." 2017, doi: 10.1109/TVCG.2016.2598920.

Is this task's difficulty dependent on a skill, or something else?

The number of unique visitors for Amazon was more than that of Yahoo in 2010.

Over the course of years between 2009 and 2014, the number of girls named 'Isla' was always more than 'Olivia'.



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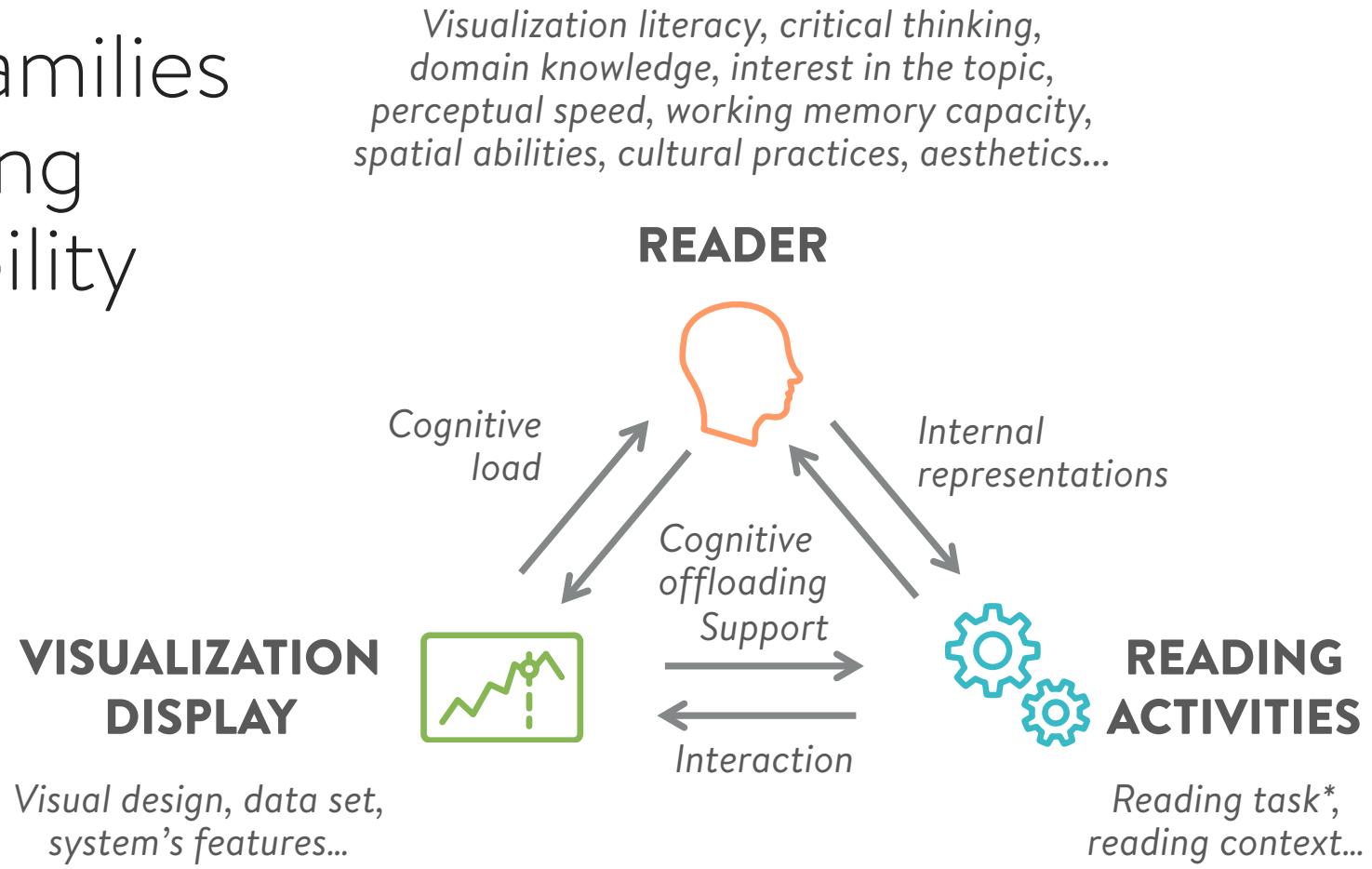
Treemap	0.42	Hard
Stacked Area Chart	0.24	Hard

S. Lee, S.-H. Kim, and B. C. Kwon, "VLAT: Development of a Visualization Literacy Assessment Test." 2017, doi: 10.1109/TVCG.2016.2598920.

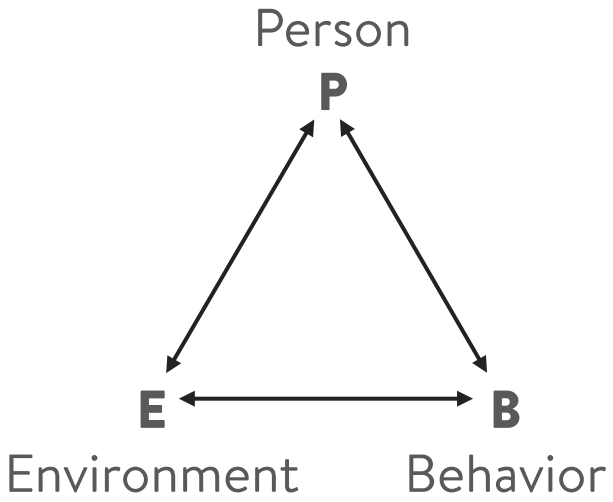
Three interacting families of factors influencing visualization readability



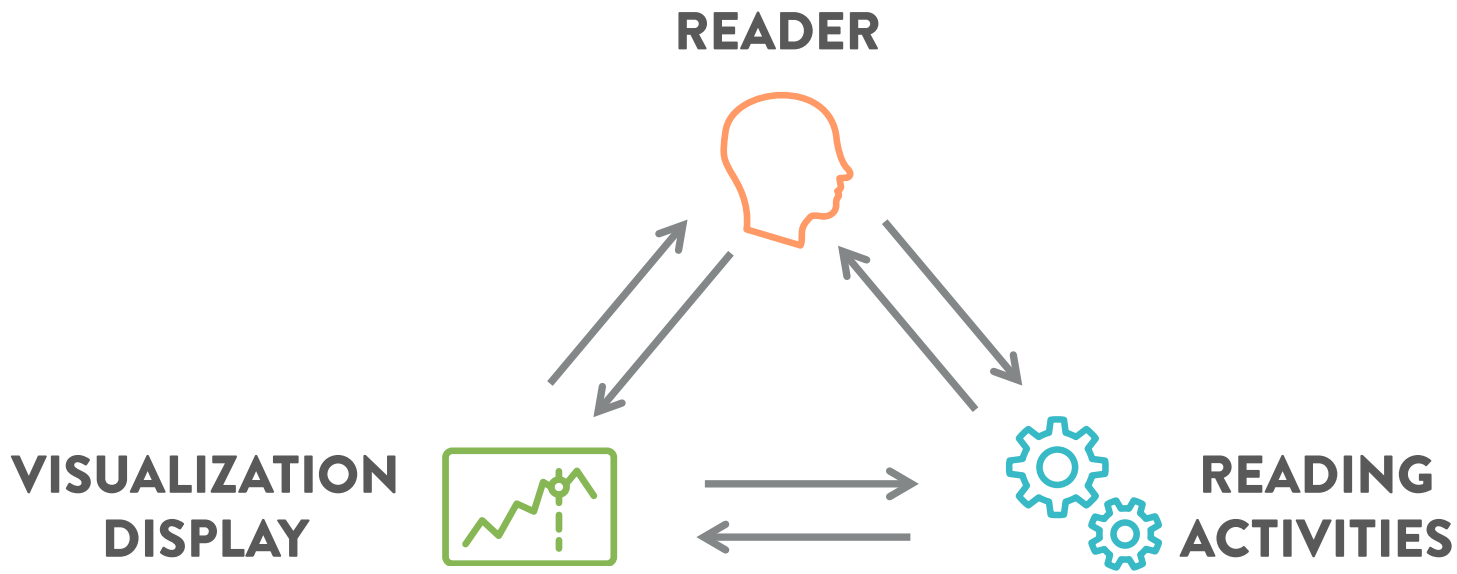
*Low-level task in the sense of Amar et al. (2005)

D. Albers Szafir, R. Borgo, M. Chen, D. J. Edwards, B. Fisher, and L. Padilla, Eds., *Visualization Psychology*. 2023. doi: 10.1007/978-3-031-34738-2.
L. M. Padilla, "A Case for Cognitive Models in Visualization Research : Position paper." 2018. doi: 10.1109/BELIV.2018.8634267.
M. Hegarty, "The Cognitive Science of Visual-Spatial Displays: Implications for Design." 2011, doi: 10.1111/j.1756-8765.2011.01150.x.
P. A. Carpenter and P. Shah, "A model of the perceptual and conceptual processes in graph comprehension." 1998, doi: 10.1037/1076-898X.4.2.75.
S. Pinker, "A theory of graph comprehension." 1990.
R. Amar, J. Eagan, and J. Stasko, "Low-level components of analytic activity in information visualization." *2005.* doi: 10.1109/INFVIS.2005.1532136.

A triadic reciprocal causation representation

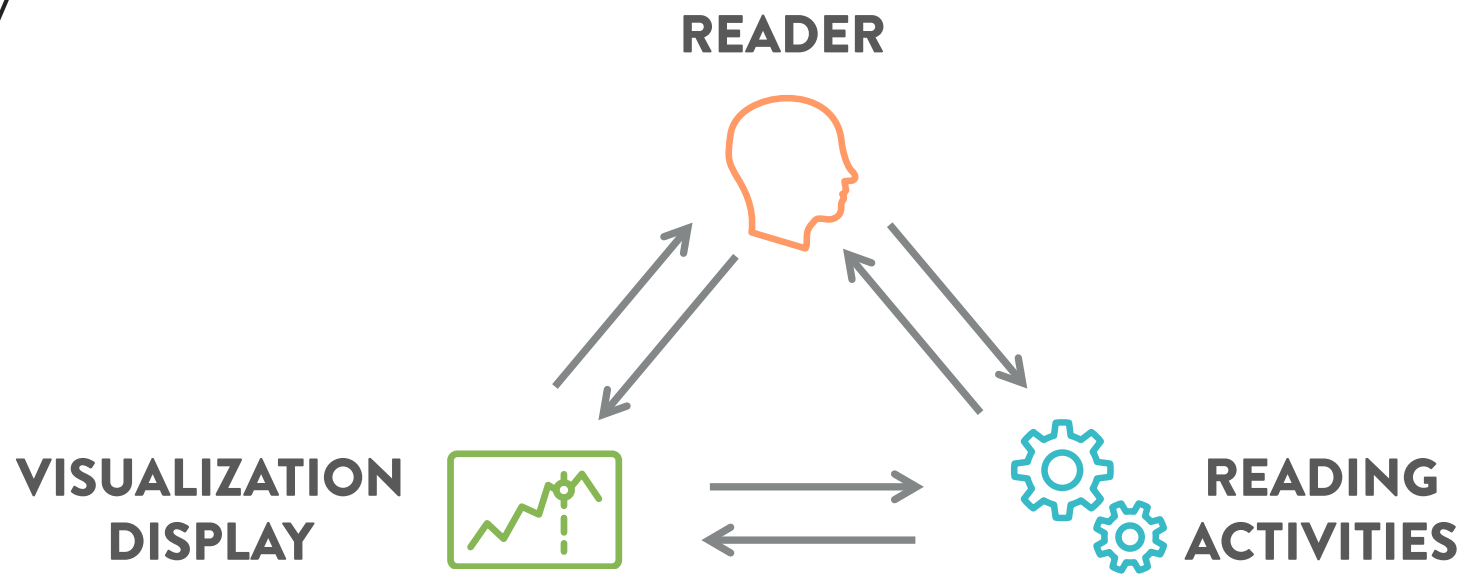


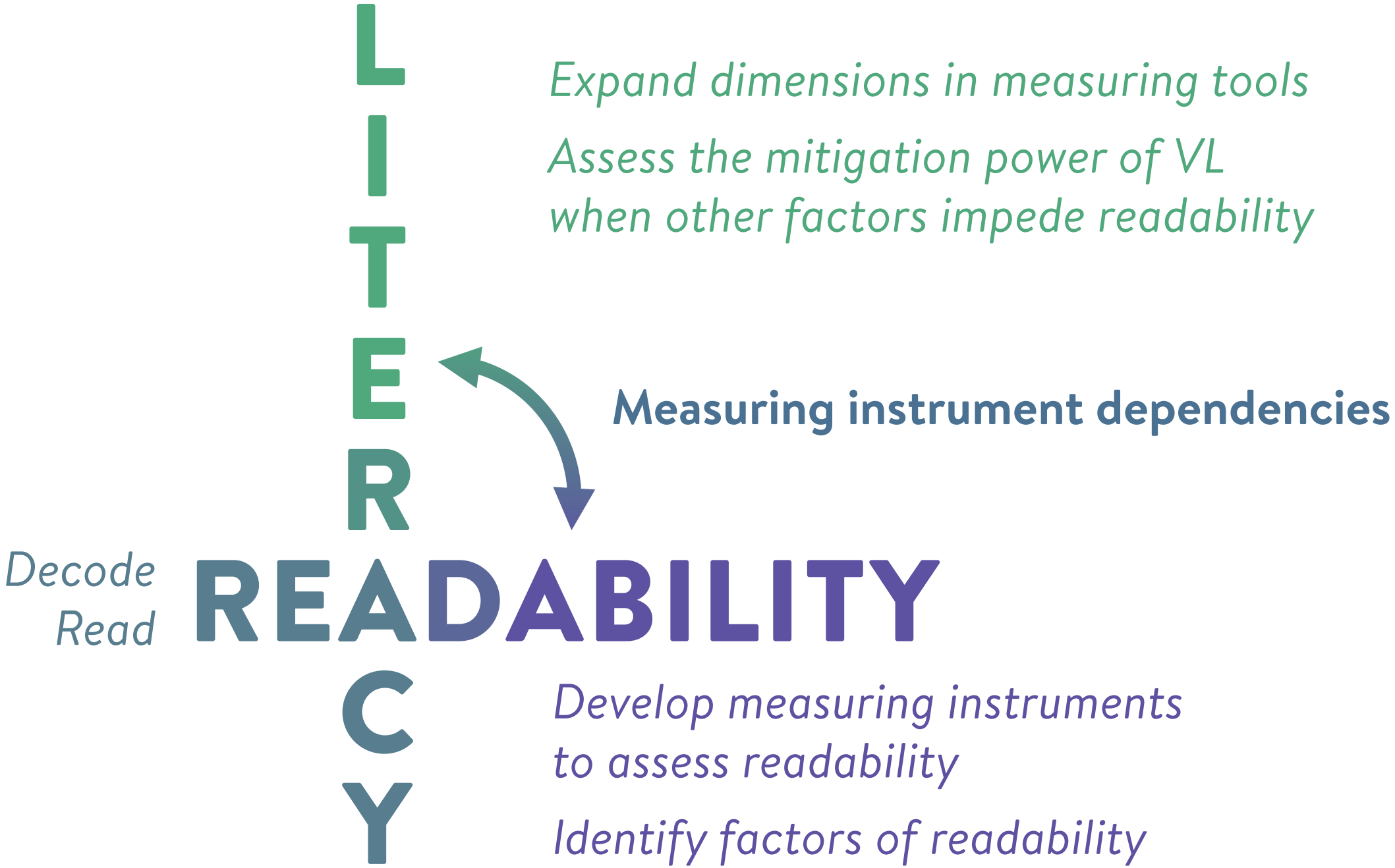
Reciprocal determinism
in Bandura's Social Learning Theory, updating Lewin's equation ***B = f(P,E)*** *and subsequent view of interactions*

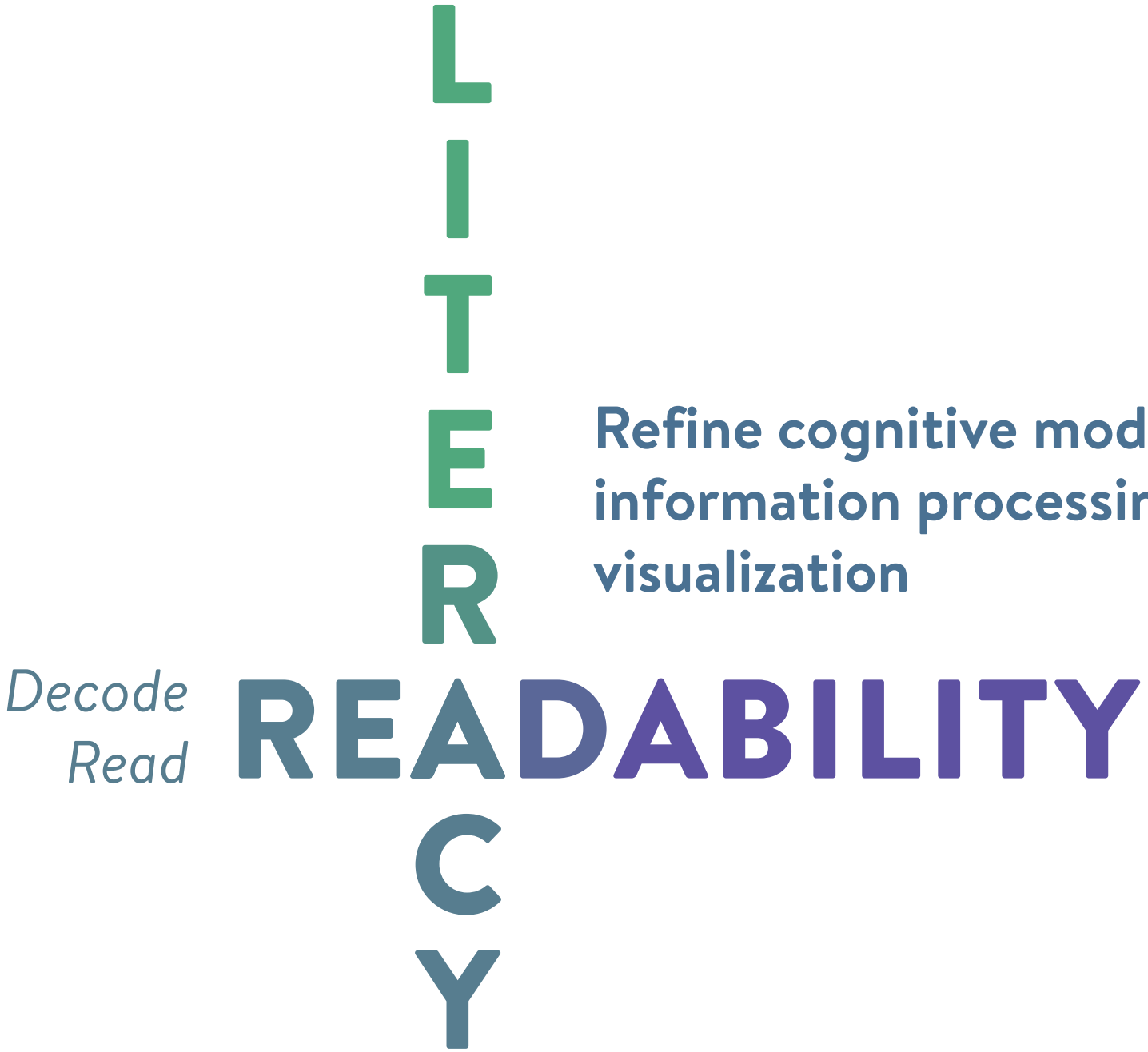


A. Bandura, "The self system in reciprocal determinism." 1978, doi: 10.1037/0003-066X.33.4.344.

Visualization Literacy is likely to be a significant factor of readability




LITERACY
Expand dimensions in measuring tools
Assess the mitigation power of VL
when other factors impede readability
Measuring instrument dependencies
Decode
Read
READABILITY
Develop measuring instruments
to assess readability
Identify factors of readability


LITERACY
Refine cognitive models of information processing in visualization
Decode
Read
READABILITY

THANK YOU