

An Exploration of Practice and Preferences for the Visual Communication of Biomedical Processes: Supplementary Material

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This document serves as a supplementary companion to Sec. 5 of our manuscript. While we restricted our presentation of findings in the paper to a synthesis of findings, patterns, and notable exceptions that occurred across all five topics, this supplementary document provides interested readers a deeper layer of topic-specific details on (1) asset scores, (2) attribute rankings, and (3) keywords.

1 Asset Scores

Sec. 3 of the manuscript provides a detailed discussion of the abstraction construct we use to create a common analysis space for all five surveyed topics. In the Fig. 1, 2, 3, 4, and 5 we provide detailed results by topic of selected asset positions in abstraction space and their respective weighted scores. Assets with a star to the right of their label denote that the asset is animated, while assets demarcated in dark blue, light blue, dark red, or pink lines indicate that asset's selection in the 20th percentile of a given scenario. We synthesize and present these results broadly over the five topics in Sec. 5: Asset Scores of the manuscript. **We supply the full resolution source assets in the *assets directory* of the supplementary material package.**

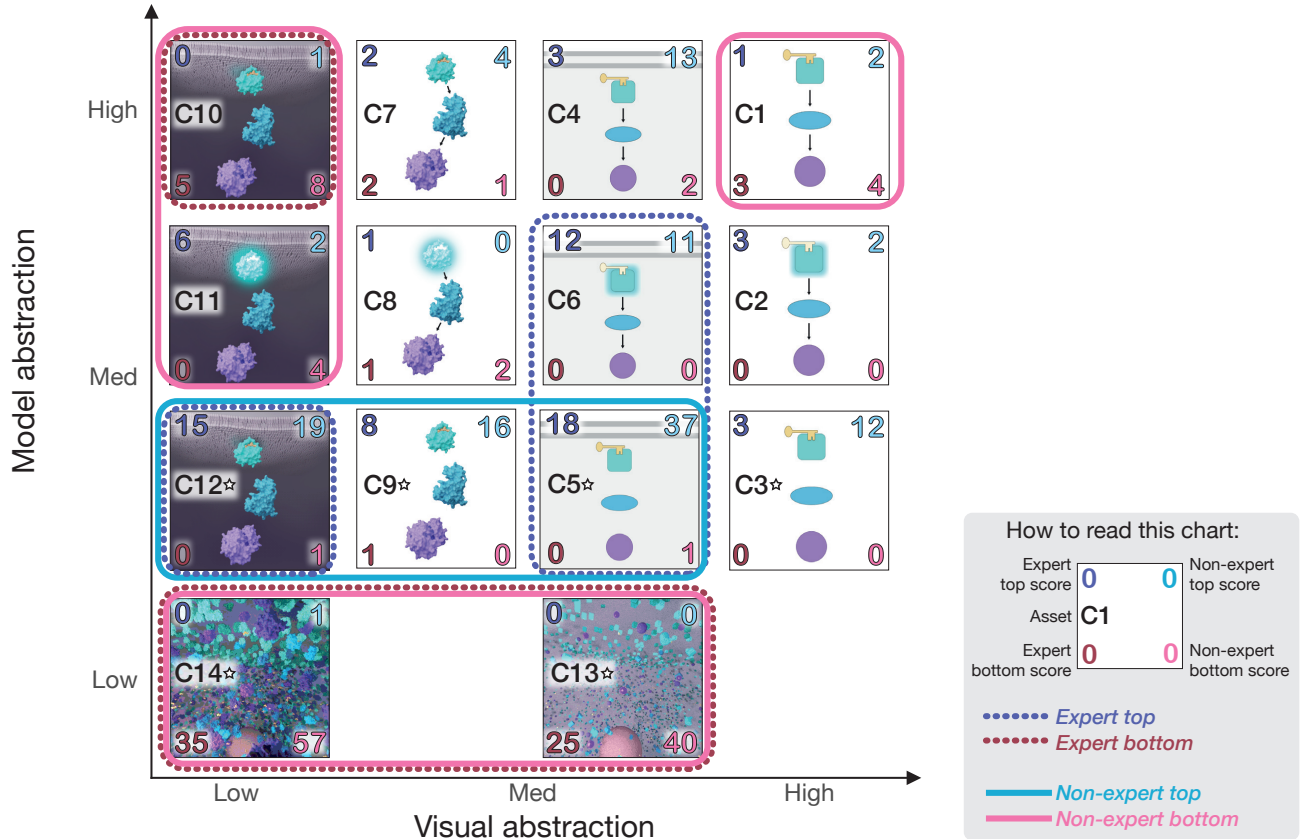


Figure 1: **Signal transduction abstraction space.** We find a distribution of expert and general audience top choices in the middle abstraction space with bottom choices laying at the extremes of the abstraction axes. Asset selection scores for top choices in signal transduction overlap between expert (dark blue) and general audiences (light blue) with choices 5 and 12 as the top-selected assets for both audiences. However, the third choice differs, with choice 6 for experts and choice 9 for general audience. These assets fall in overlapping clusters in the space of medium model abstraction and low to medium visual abstraction. We observe that for both expertise levels the bottom choices fall at the extrema of the abstraction space, with the lower left abstraction space cluster containing choices 13 and 14. These assets are selected as the bottom choice for both audiences by a large margin. We see an outlying expert bottom selection, choice 10, residing in the upper left extreme region of the abstraction space. This overlaps with a second general bottom choice cluster, which includes choices 10 and 11. A last outlying general bottom choice asset resides in the opposite upper right corner of the abstraction space.

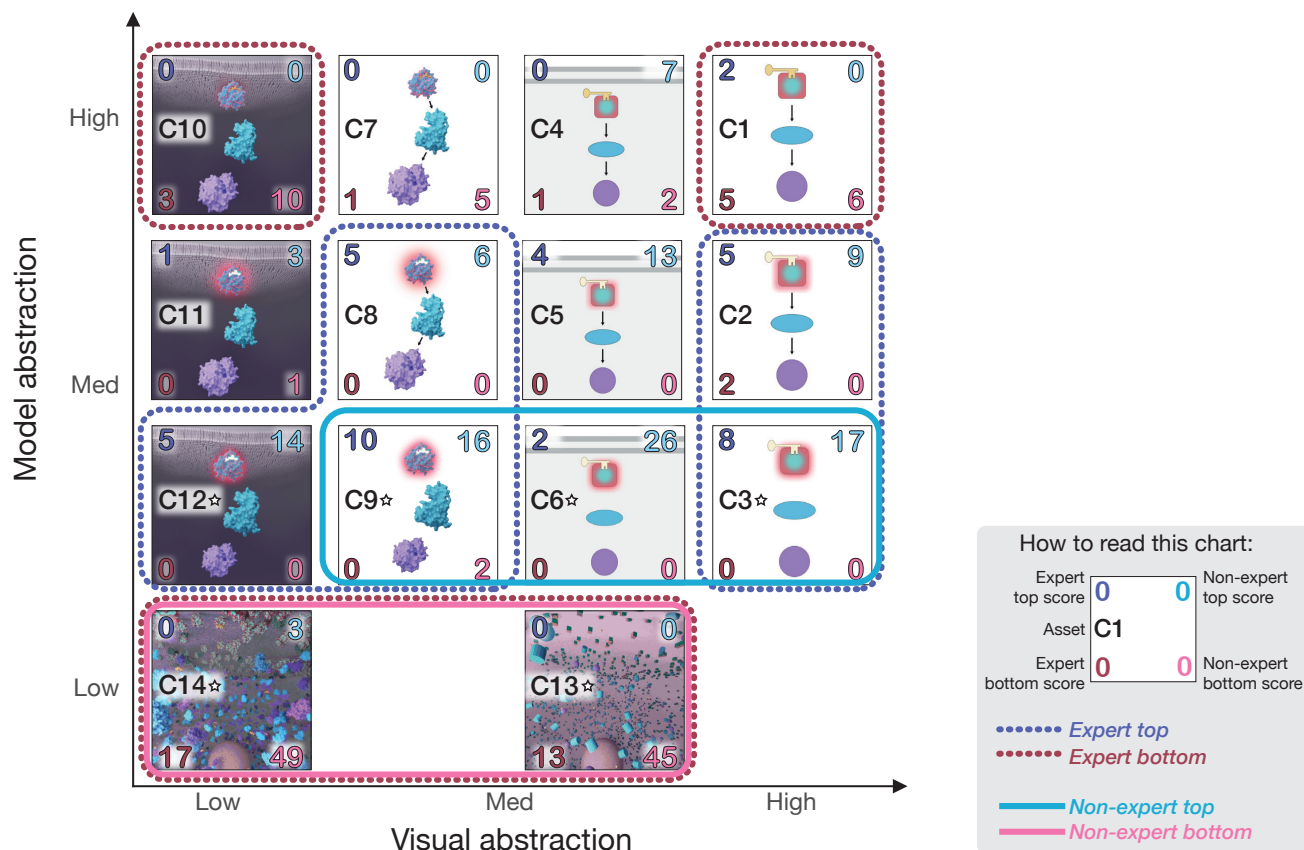


Figure 2: **Constitutive activation abstraction space.** We find a similar abstraction space distribution of audience selections as we find in signal transduction. Top choices for both audiences again lie in the medium model abstraction space, although they now spread across the full visual abstraction axis. We see a degree of overlap in top choices between expert and general audiences, with two expert clusters and one general audience cluster. The expert clusters extend higher on the model abstraction axis than the general audience cluster. Looking at scores specifically, we see the expert topmost selection is choice 9 (realistic molecules with no contextual background), while the topmost general selection is choice 6 (abstracted molecules with a primitive background). Bottom selections for both expert and general audiences fall at the extrema of the abstraction space, with again a cluster of choices 13 and 14 as the most frequently-chosen bottom choices in both expert (dark red) and general audience (pink) scenarios. The general bottom choices are more focused in this topic with only one cluster, while the expert bottom choices include the cluster of choices 13 and 14 as well as two outlying assets. These outliers are choice 10 in the upper left corner of the abstraction space, and choice 1 in the upper right.

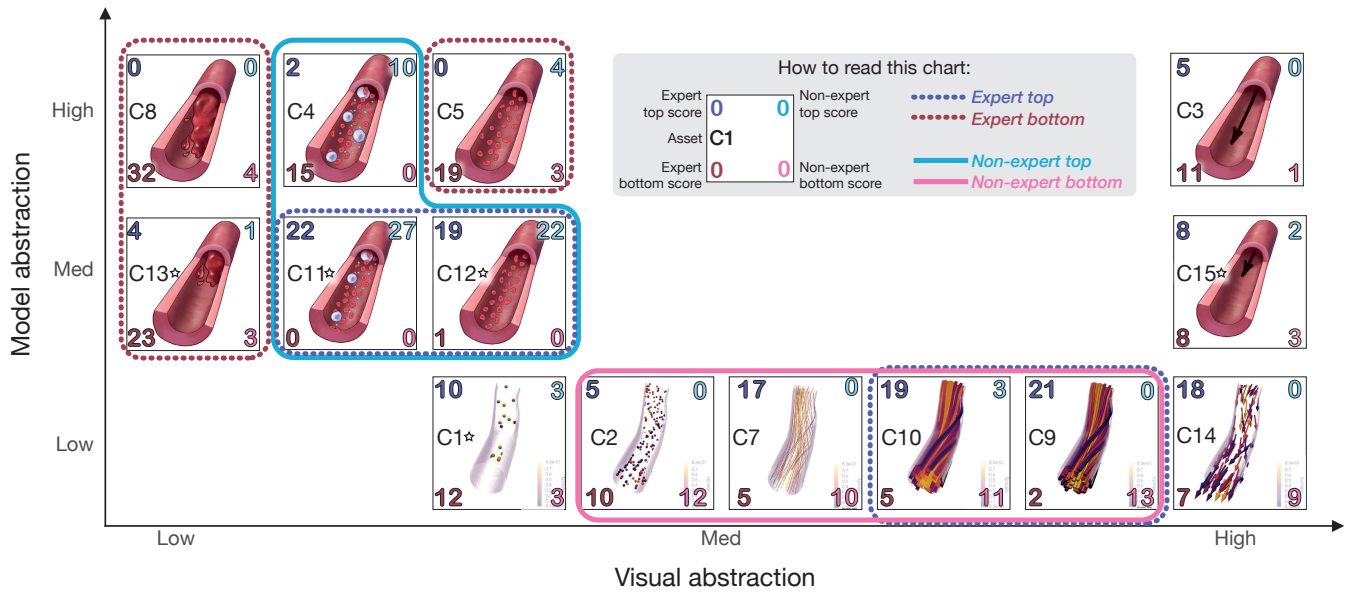


Figure 3: **Blood flow abstraction space.** We find two clusters of top 20th percentile selections for experts (dark blue), with choices 11 and 12 forming one cluster and 9 and 10 forming a second cluster. As in signal transduction and constitutive activation, the general audience cluster overlaps partially with the expert audience selections, although the overlap is only with the top left cluster. This general audience top selection cluster additionally includes choice 4, which is higher on the model abstraction axis while remaining in the low-medium range of the visual abstraction axis. General audience bottom choices (pink) again show a dislike of low model abstraction assets with a cluster containing choices 2, 7, 9, and 10 that is low on the model abstraction axis and in the medium range of the visual abstraction axis. Expert audiences again show a dislike of extrema, with a cluster of bottom choice selections comprised of choices 8 and 13 (dark red) in the upper left of the abstraction space. Choice 5 is an outlying expert bottom choice, and lies high on the model abstraction axis and on the low-medium range of the visual abstraction axis.

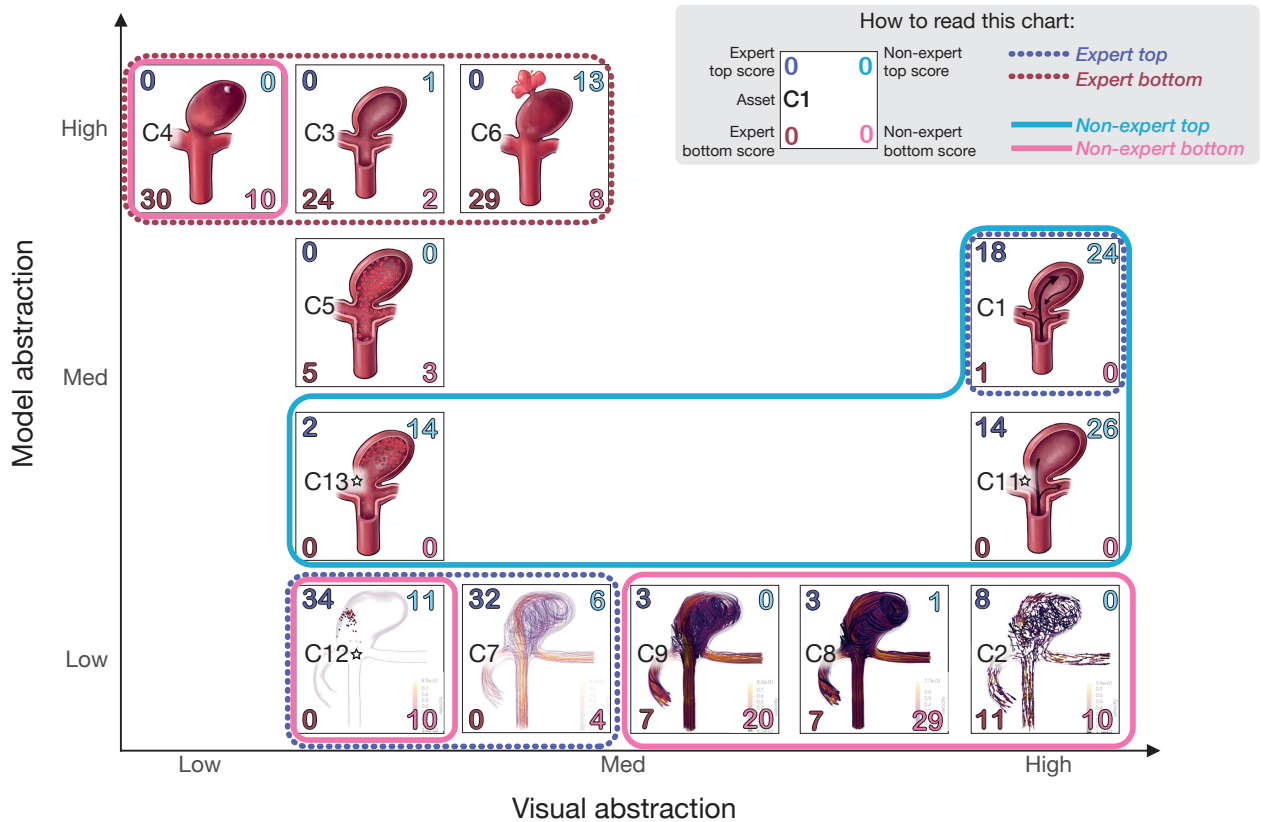


Figure 4: **Aneurysm abstraction space.** We find a similar cluster pattern for aneurysm as in the other topics, with both audiences tending to dislike of extrema and a preference for assets with moderate abstraction along one or both axes. One slight exception to this is the cluster of expert topmost choices that lies low on model abstraction and in the low-medium range on the visual abstraction axis. Similarly, an outlying expert top choice as choice 1, which lies to the upper middle-right of the abstraction space. However, neither of these is at the extreme edge of the abstraction space. We again see a degree of overlap in top selections for both audiences, with choice 1 falling into the general top choice cluster along with choices 11 and 13. This cluster spans the medium range of the model abstraction axis and the low-medium to high range of the visual abstraction axis. Bottom choices clusters for both audiences include extreme parts of the abstraction space. The expert bottom choices form one cluster at the top left of the abstraction space, similar to that of blood flow. The general bottom choices are more distributed, with a large cluster forming in the lower right corner of the space that extends to the medium range of the visual abstraction axis. Two outlier assets for the general bottom choices include choice 4, which lies in the upper left corner of the space and overlaps with the expert bottom cluster, and choice 12, which lies in the lower left region of the space and overlaps with the expert top choice cluster.

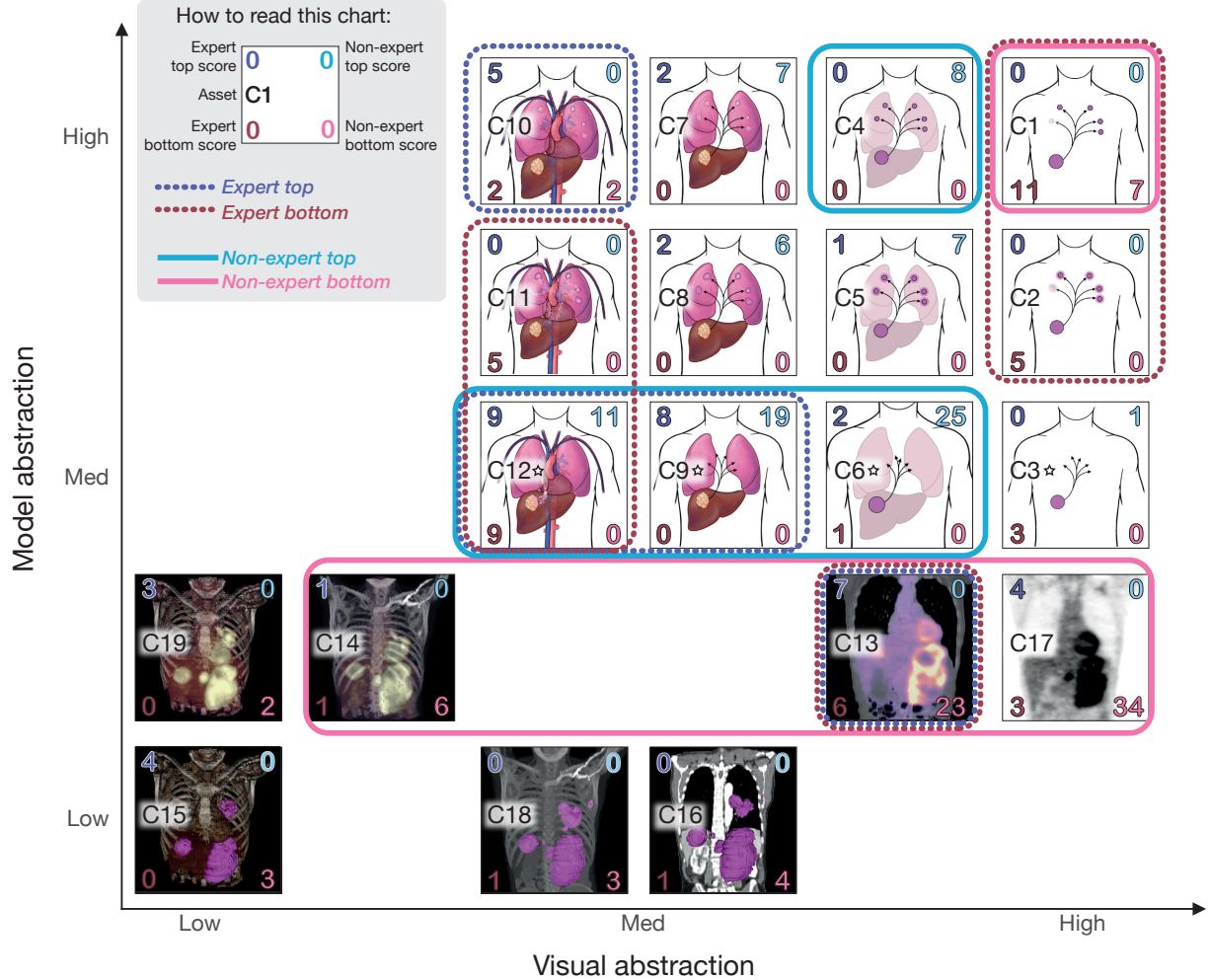


Figure 5: **Metastasis abstraction space.** We see a generally higher preference for assets in the middle of one or both abstraction axes and dislike of assets at axes extrema. Notable exceptions to this are choices 12 and 13, which were selected both as the top and bottom choices for the expert scenario. We discuss possible reasons for this selection overlap in the paper. In this middle abstraction space we observe that experts tended to prefer a slightly lower visual abstraction than the general audience, with similar preferences for model abstraction in the medium to high range. This is exemplified as well in the top choice outliers, choice 10 for experts and choice 4 for general audience. We see a large general bottom choice cluster low on the model abstraction axis, with the previously mentioned choice 13 overlapping this cluster as both an expert top and bottom choice. An outlying bottom choice for the general audience and a second cluster for expert bottom choices sits at the top right of the abstraction space, which is consistent with participant preferences against extreme edges of the space.

2 Attribute Rankings

The following asset ranking figures provide additional topic-specific details on asset attribute rankings that we discuss in Sec.: Attribute Rankings and Sec. 6 of the manuscript. Fig. 6, 7, 8, 9, 10 represent attribute rankings for each respective topic. As in the previous figure set, assets with a small star to the right of their label indicate that the asset is animated. In these figures we excluded assets that were never selected as either the top or bottom choice for a given audience scenario.

For each figure, we array assets along the x-axis by their combined attribute ranking values for both general (light blue) and expert (dark blue) audiences. For each asset we show the asset's average ranking value for (1) aesthetics, (2) accuracy, (3) communication success, and (4) visual clarity. In these figures we depict only those assets that were selected as either the top or bottom-most choices for a given expert or general audience scenario. Assets with only light blue bars indicate that the asset was only selected as the top or bottom choice for a general audience scenario. Assets with only dark blue bars correspondingly indicate that the asset was only selected for an expert audience scenario.

Interestingly, we note that the order of assets by their respective attribute ranking scores does not always directly correspond to their asset selection scores. We discuss some of these possible differences in preferences and evaluations of assets for the two audience levels in the manuscript.

Signal Transduction Average Rankings by Asset

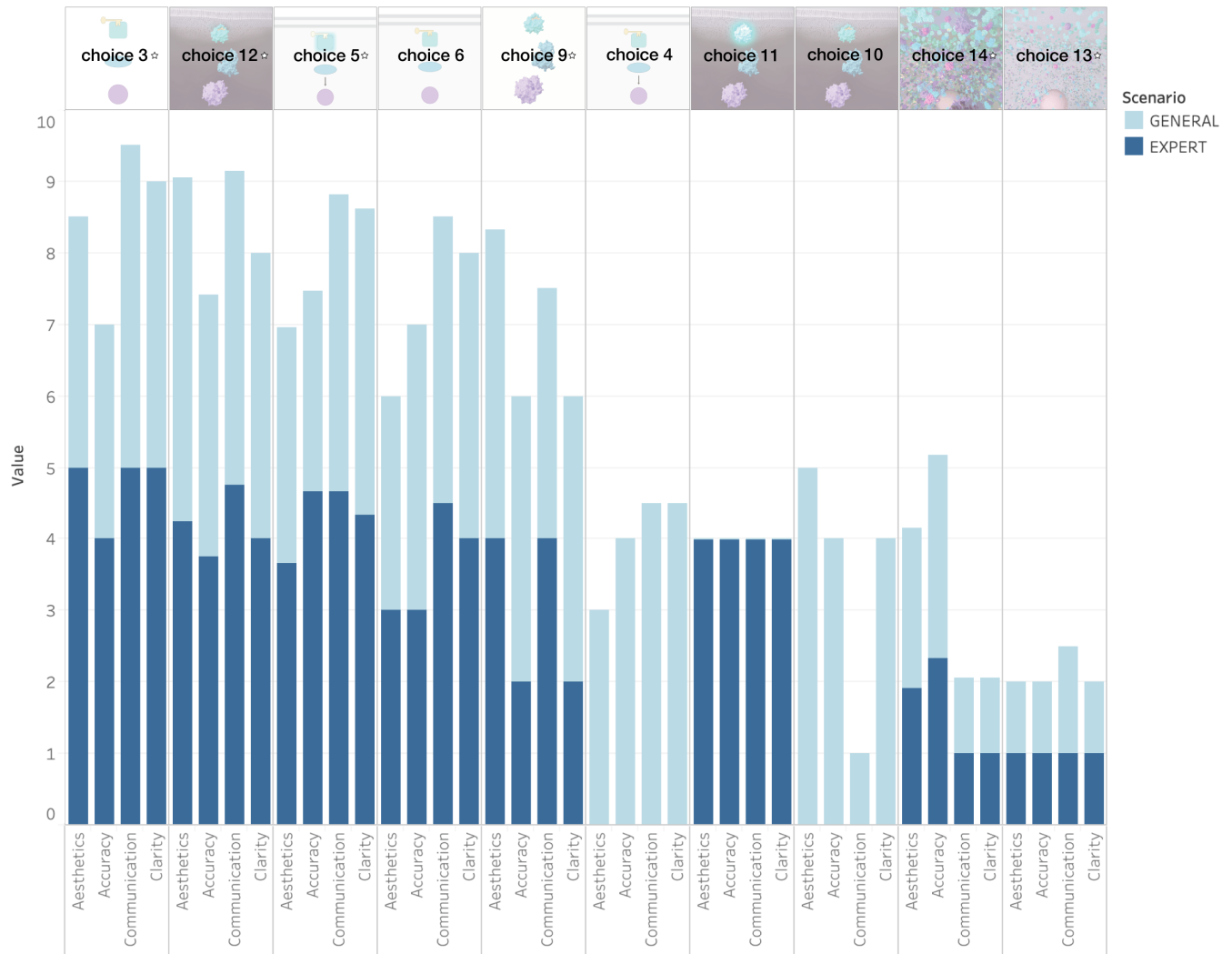


Figure 6: **Signal transduction attribute rankings.** Detailed breakdown of average aesthetics, accuracy, communication, and clarity rankings for assets selected as the top or bottom choice for an expert (dark blue) and general (light blue) audience.

Constitutive Activation Average Rankings by Asset

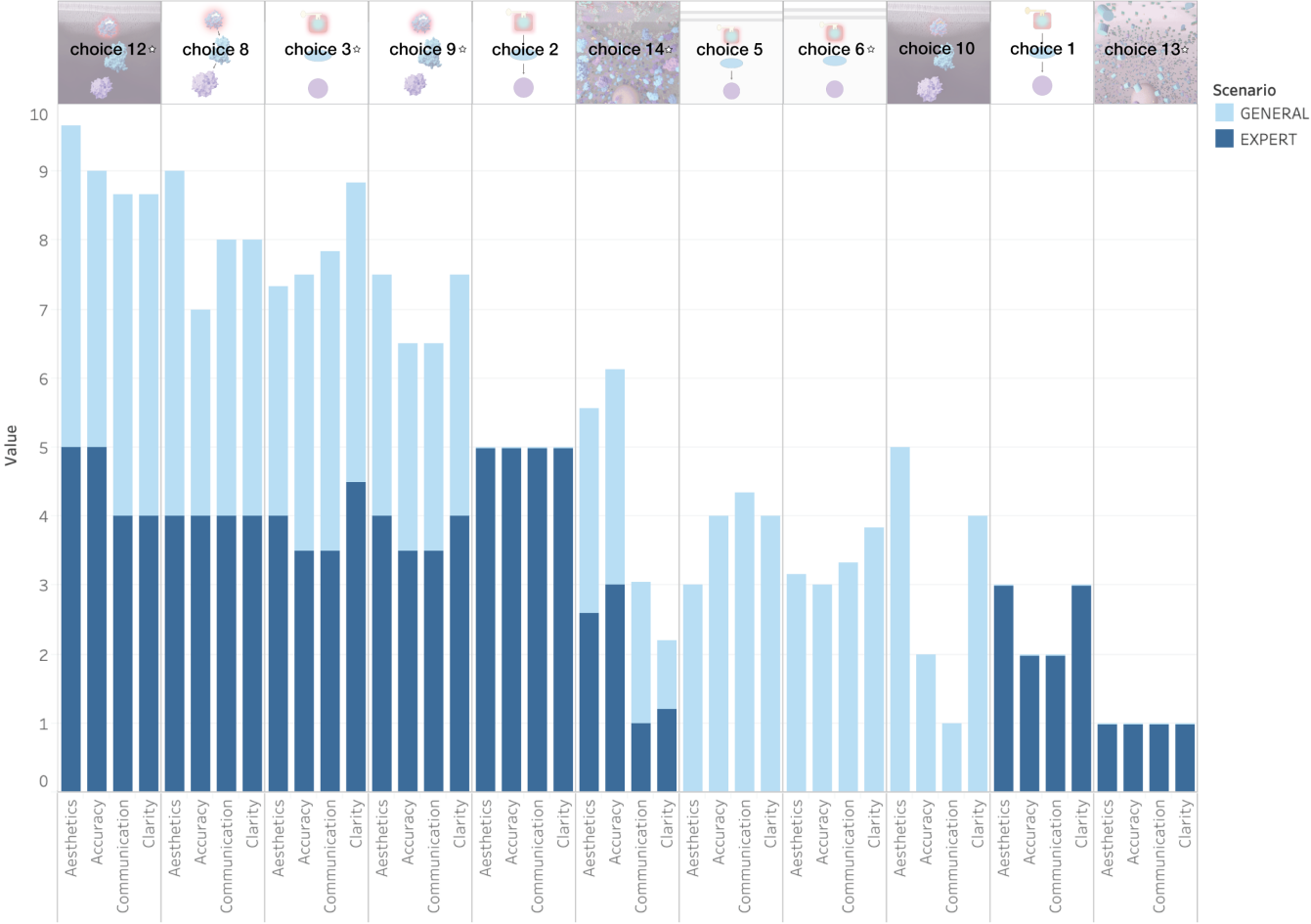


Figure 7: **Constitutive activation attribute rankings.** Detailed breakdown of average aesthetics, accuracy, communication, and clarity rankings for assets selected as the top or bottom choice for an expert (dark blue) and general (light blue) audience.

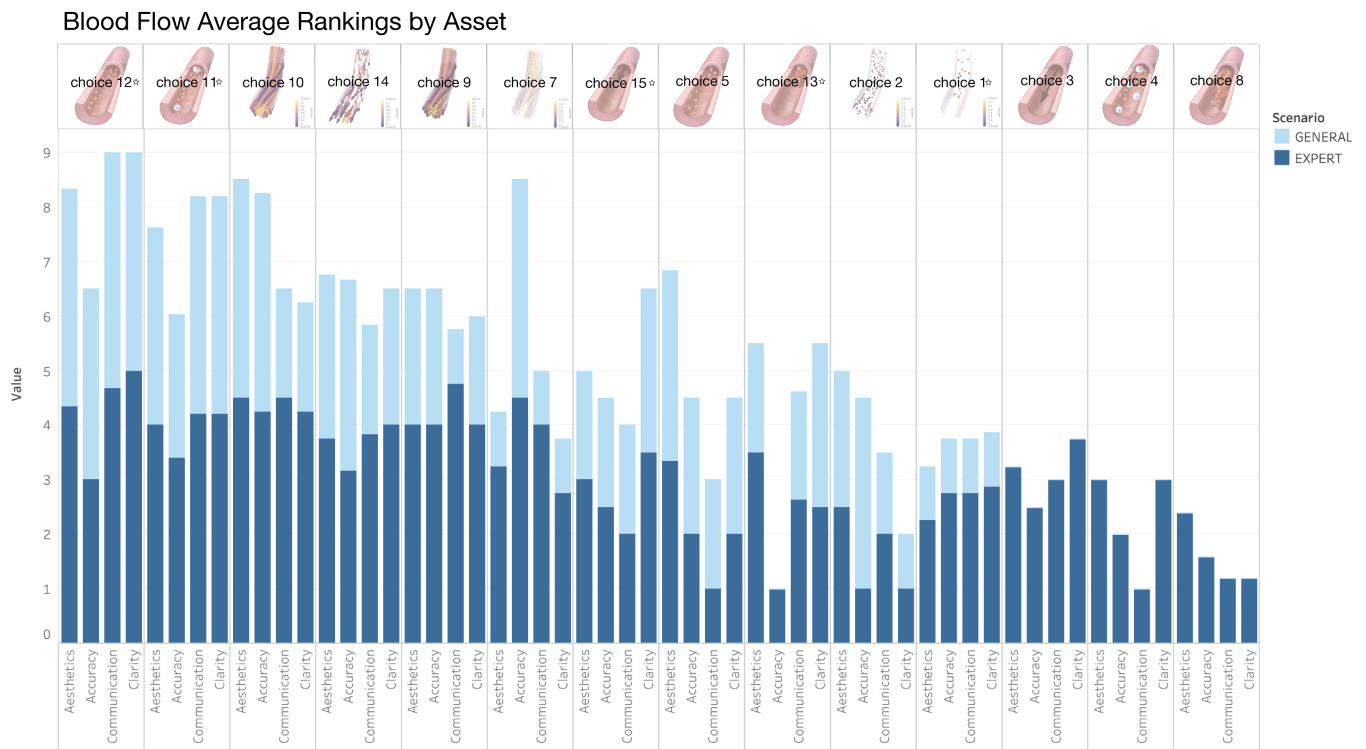


Figure 8: Blood flow attribute rankings. Detailed breakdown of average aesthetics, accuracy, communication, and clarity rankings for assets selected as the top or bottom choice for an expert (dark blue) and general (light blue) audience.

Aneurysm Average Rankings by Asset

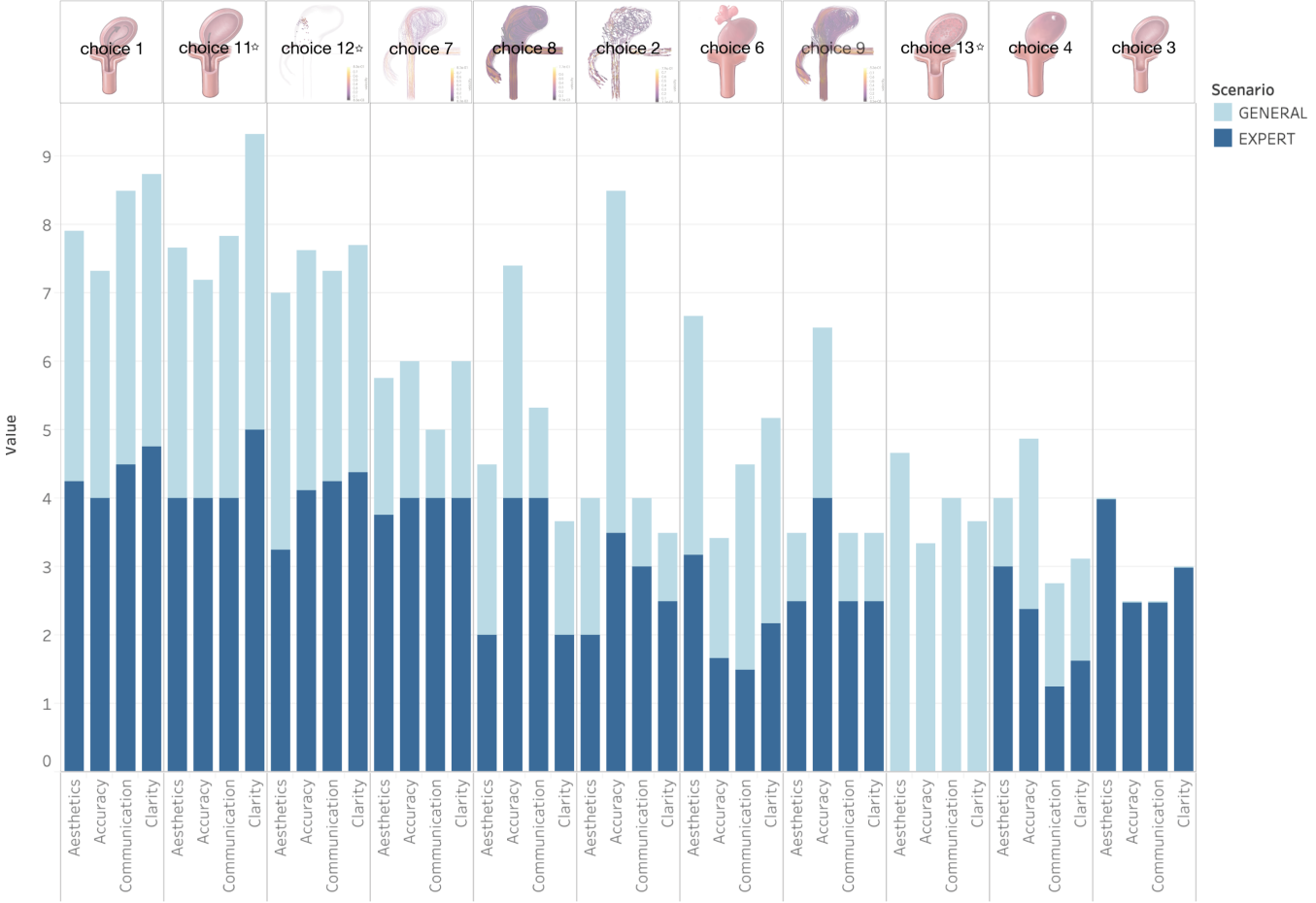


Figure 9: **Aneurysm attribute rankings.** Detailed breakdown of average aesthetics, accuracy, communication, and clarity rankings for assets selected as the top or bottom choice for an expert (dark blue) and general (light blue) audience.

Metastasis Average Rankings by Asset

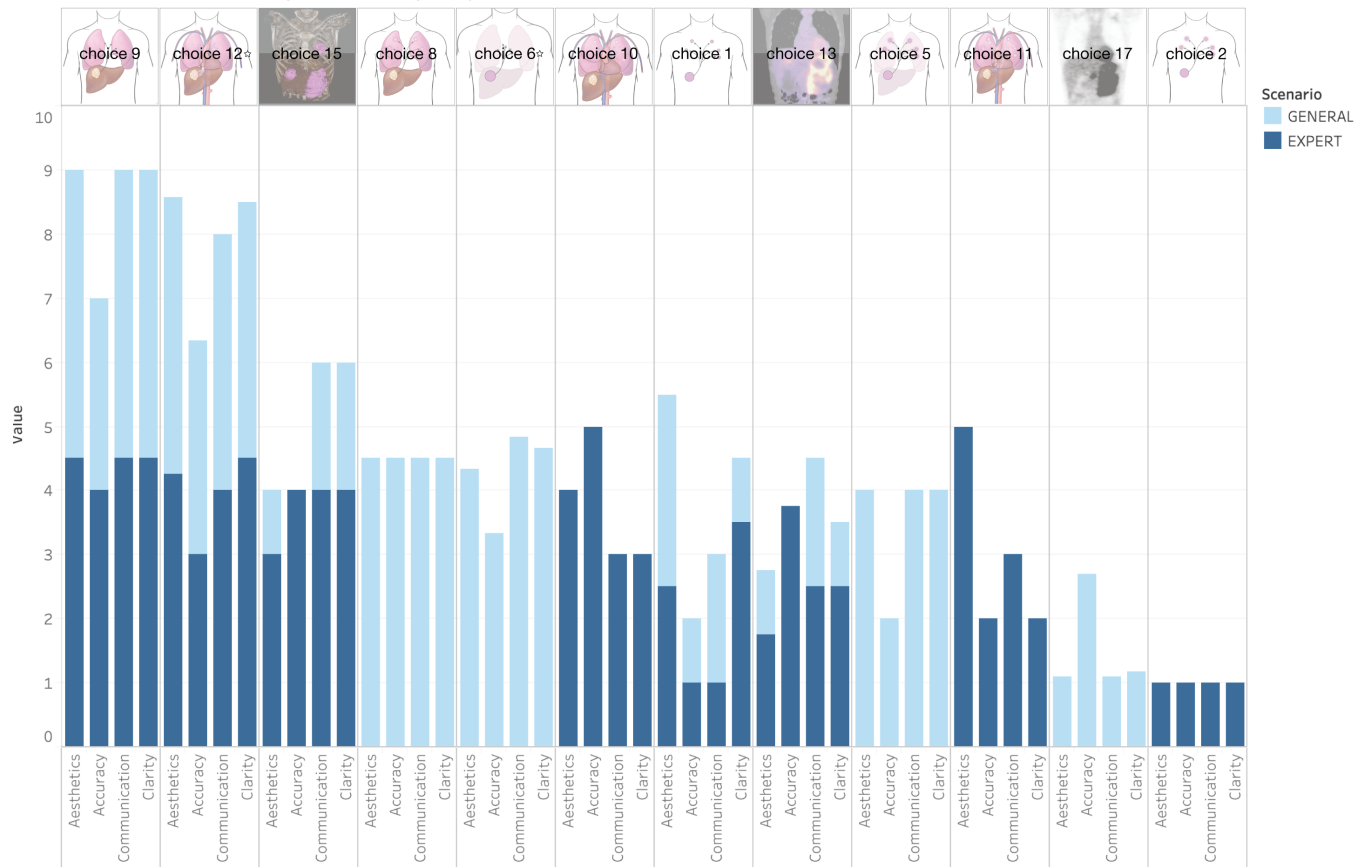


Figure 10: **Metastasis attribute rankings.** Detailed breakdown of average aesthetics, accuracy, communication, and clarity rankings for assets selected as the top or bottom choice for an expert (dark blue) and general (light blue) audience.

3 Keywords

Tables 1 and 2 detail the top 20th percentile of keywords chosen by expert and general audience survey participants to describe their top and bottom choices for each topic scenario, respectively. We synthesize these keywords across all topics and represent their selection frequency in (Fig. 11) for expert audience top and bottom selections as well as general audience top and bottom selections. This figure is an enlarged version of the same figure included and discussed in Sec. 5: Keywords and Comments and Sec. 6 of the manuscript.

Topic	Expert	General
Signal Transduction	(1) Informative, (2) Easy to read, Clear (2-way tie)	(1) Easy to read, (2) Clear, (3) Informative
Constitutive Activation	(1) Easy to read, (2) Informative, Clear (2-way tie)	(1) Easy to read, (2) Informative, (3) Clear
Blood Flow	(1) Easy to read, (2) Clear, (3) Informative	(1) Easy to read, (2) Informative, (3) Pretty
Aneurysm	(1) Informative, (2) Clear, (3) Easy to read	(1) Easy to read, (2) Informative, (3) Clear
Metastasis	(1) Informative, Clear, Easy to read (3-way tie)	(1) Easy to read, (2) Informative, (3) Clear

Table 1: 20th Percentile **Top** Choice Scenario Keywords by Topic

Topic	Expert	General
Signal Transduction	(1) Confusing, Distracting (2-way tie), (2) Excessive	(1) Confusing, Distracting (2-way tie), (2) Excessive
Constitutive Activation	(1) Confusing, Distracting (2-way tie), (2) Excessive	(1) Confusing, Distracting (2-way tie), (2) Excessive
Blood Flow	(1) Simplistic, (2) Inaccurate, (3) Misleading	(1) Confusing, (2) Distracting, (3) Precise
Aneurysm	(1) Simplistic, (2) Misleading, Pretty (2-way tie)	(1) Confusing, (2) Accurate, Detailed, Distracting, Excessive (4-way tie)
Metastasis	(1) Inaccurate, Misleading (2-way tie), (2) Simplistic, Easy to read (2-way tie)	(1) Visually unappealing, (2) Confusing, (3) Accurate

Table 2: 20th Percentile **Bottom** Choice Scenario Keywords by Topic

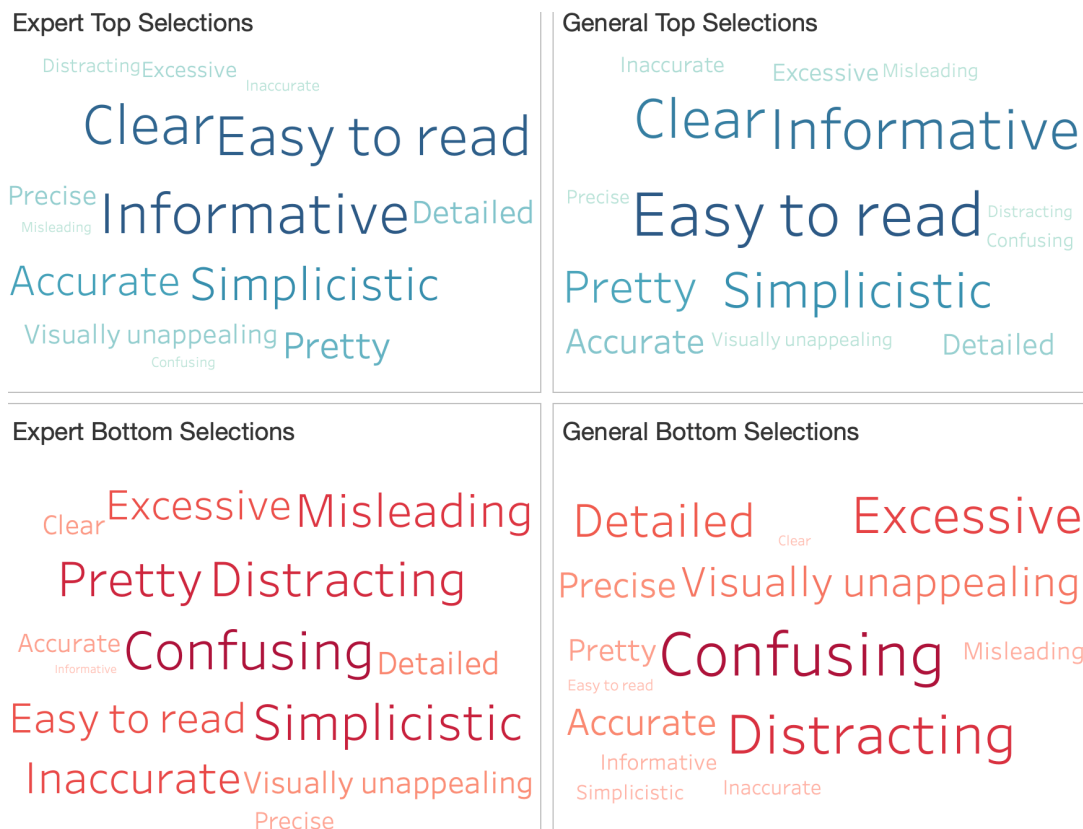


Figure 11: **Keyword cloud.** Word cloud depicting keyword selection frequency for top expert audience scenario selections (top left), top general audience scenario selections (top right), bottom expert audience scenario selections (bottom left), and bottom general audience scenario selections (bottom right).