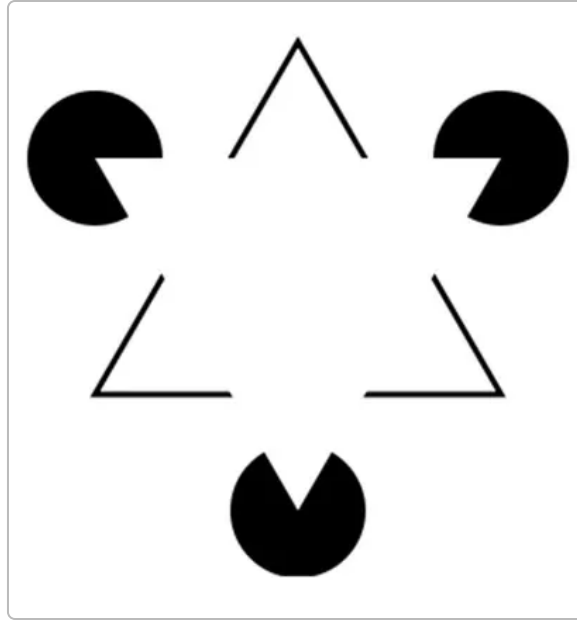


Symbolic Geometry as Cognitive Interface (A Textual Holography Basis)

Embodied Spatial Metaphors in Thought and UI Design

Human cognition is deeply rooted in spatial and geometric metaphors. We constantly describe abstract concepts in terms of space and shape – we speak of “*close friends*” vs “*distant acquaintances*”, “*inner circles*” of people, or someone with “*higher status*” being “*above*” others ¹. Crucially, research shows these are more than figures of speech: they reflect how our minds structure information. Psychologists have found that people mentally map social relationships onto physical space; for example, individuals literally drew routes closer to cartoon “friends” than “strangers” in an experiment, indicating that friendship was implicitly associated with spatial closeness ². Likewise, words related to power (“master” vs “servant”) are recognized faster when their position on-screen matches the vertical metaphor (high-power words appearing higher up) ³. Such findings support the *embodied cognition* view that understanding abstract ideas (social rank, friendship, etc.) engages the same neural and perceptual frameworks as interacting with the physical world ⁴ ⁵. In other words, we simulate geometry and space in our brains to grasp meaning – “*imagining and doing use a shared neural substrate*” ⁵. This has direct implications for interface design: aligning UIs with intuitive spatial metaphors can make information feel more “natural” to users. For instance, interfaces that visually arrange elements in concentric circles (e.g. an “inner ring” of priority contacts around a user’s avatar) might tap into the innate “*inner circle*” mental model and be instantly understood.

Moreover, humans are wired to seek and complete patterns, which is why simple geometric cues can evoke rich mental images. A classic example is the **Kanizsa triangle** illusion below – three “Pac-Man” shapes and three angle marks are automatically perceived as a bright triangle, even though no triangle is drawn. Our brains instinctively impose a coherent geometric form on the fragmented input. This demonstrates how readily we form mental imagery from symbolic or partial geometry, essentially “*filling in*” the shape ⁶. Such tendencies suggest that presenting information in suggestive geometric layouts could spur users’ imagination or comprehension by leveraging the mind’s pattern-completion habits.



The Kanizsa triangle illusion: our visual system perceives a triangle (pointing up) that isn't actually drawn. The mind projects geometric order onto scattered symbols, reflecting an innate drive to organize visual input.

On a broader cultural level, spatial cognition in language and interface is also shaped by one's writing system and environment. Psycholinguistic studies reveal that people often map sequences (time, numbers, etc.) according to their reading/writing direction. For example, native English speakers (who read left-to-right) nearly always arrange timelines left-to-right, whereas Arabic speakers (right-to-left readers) show a reversed or mixed orientation on the "mental timeline" ⁷ ⁸. Even numeric thinking is affected: English and French readers tend to imagine smaller numbers on the left and larger on the right, but Arabic readers exhibit the opposite bias ⁷. These differences emerge from thousands of hours of training the eyes and hands in a particular direction ⁹ ⁸. The lesson for interface design is that spatial metaphors may not be *universally* interpreted – designers should consider users' cultural reading habits. Nonetheless, the core principle stands: all users, regardless of culture, leverage spatial cognition to make sense of information. By consciously using *embodied* geometric metaphors – such as arranging content in familiar spatial patterns (e.g. a timeline following their habitual reading direction, or hierarchical layers stacked vertically to denote "higher" vs "lower" importance) – interfaces can communicate abstract relationships in a cognitively congruent way. We effectively "speak" the mind's language by using geometry as an interface to meaning.

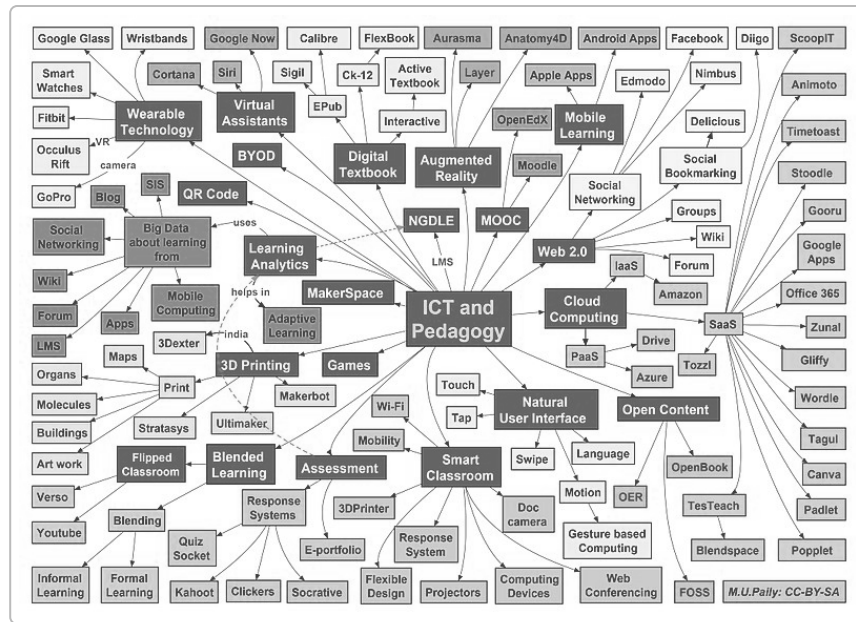
Typography, Layout, and Mental Imagery in Reading

Text is traditionally linear, but its layout and typographic style can greatly influence how readers process and visualize information. One key insight from cognitive psychology is that *mental imagery* enhances comprehension and memory – if readers form pictures in their mind of what the words describe, they tend to understand and remember better. Design choices that encourage such mental imagery or deeper processing can thus improve outcomes. For instance, using **visual stimuli in tandem with text** exploits the well-known *picture-superiority effect*: people remember images far better than words alone ¹⁰. According to dual-coding theory, images get stored in memory both as a visual representation *and* a verbal label, whereas plain text only encodes verbally ¹¹. This means adding even simple icons or geometric shapes to accompany text can create multiple memory traces. "*Pictures can communicate concepts better than words*

alone,” and even when reading text, our minds will generate imagery if prompted ¹². In practical terms, an interface that presents information with iconography or structured visuals (like diagrams or mind maps) gives the user’s brain more hooks to latch onto than a text-only list.

Beyond images themselves, the **layout** and formatting of text can affect cognitive processing. Research in psycholinguistics and HCI has shown that certain typographic interventions influence recall. A striking example was the development of **Sans Forgetica**, a font designed by academics to be *slightly harder to read* on purpose. The idea was that the added difficulty (a “*desirable difficulty*”) would force readers to engage more deeply and thus remember better. Initial reports claimed this disfluent typeface improved word recall by around 10–15% ¹³. However, subsequent rigorous tests found *no significant memory benefit* for Sans Forgetica over normal fonts ¹⁴ ¹⁵. While the specific font may not have lived up to its hype, the larger point remains: **typography** can alter our reading behavior and mental effort. Studies have documented that unusual or complex fonts can slow reading but sometimes enhance accuracy due to increased attention ¹⁶ ¹⁷. In other cases, well-designed familiar fonts (e.g. a clean **sans-serif** for small screens) can reduce cognitive load and improve readability ¹⁸ ¹⁹. Thus, the visual form of text isn’t neutral – it interacts with our cognitive systems. Good design can guide the reader’s eye and mind: headings, line breaks, and whitespace chunk information into meaningful units, and this structural *geometry* of text can aid memory by organizing content into spatially distinct regions (much like how a well-structured outline or a table makes data more memorable by **mapping** it onto a grid of sections).

Critically, research confirms that **information formatting impacts retention**. One review notes that typography affects not just aesthetics but emotional response, behavior, and “*information retention and memory as well*” ²⁰. For example, text layout experiments have shown that multi-column formats, line lengths, or screen arrangements can change reading speed and user preferences (though comprehension often remains similar within reasonable ranges) ²¹ ²². What does improve memory is when the format encourages readers to actively engage or organize the material. A powerful demonstration is the use of **mind maps** as a study tool. Mind maps force a non-linear, radial arrangement of keywords around a central idea, often with branching lines and sometimes images. This spatial, graphical layout has been empirically shown to boost recall. In a controlled trial, students who used mind mapping to study a text scored about 10% higher on recall tests a week later compared to those using their own normal study methods – despite the mind map group initially feeling less “motivated” by the unfamiliar technique ²³. Researchers noted that if motivation were equal, the mind mappers might have achieved an estimated 15% better retention ²⁴. The improvement was specifically evident in long-term memory ²⁵. The mind map’s combination of **visual-spatial layout** (radial branches) and concise text cues likely engages dual coding (visual + verbal) and encourages the brain’s natural associative networking ²⁶ ²⁵. In essence, it’s an external “textual hologram” – a 2D geometry of concepts that mirrors how our brains link ideas.



A concept mind map illustrating the relationships among ideas (here, topics in educational technology). Key terms are placed around a central theme in a radial network. Such layouts leverage spatial organization, color, and keywords to aid mental visualization and memory ²⁵.

Another age-old technique underscores the same principle: the **method of loci** (or memory palace). This ancient mnemonic involves imagining information placed in a familiar spatial layout (e.g. along a walk through one's house). By mentally "walking" that geometric path, one can recall a large amount of material in order. The method of loci works because humans have excellent *spatial memory* for locations, honed by evolution, even if our memory for abstract facts is fallible ²⁷ ²⁸. It effectively converts arbitrary data into an imagined geometric interface – the rooms, corners, and landmarks of the mind's eye – achieving remarkable recall performance (memory champions routinely memorize hundreds of items this way ²⁹ ²⁸). Modern cognitive research confirms the efficacy of this spatial encoding; it creates a richer network of cues by tying information to a structured layout in the brain's spatial memory systems ²⁸. These examples illustrate that arranging text or ideas in space – whether on paper, a screen, or in one's imagination – can yield a *holographic* effect on memory, where the structure itself encodes meaning and context. For designers and educators, the takeaway is to utilize layouts that encourage active mental mapping: diagrams, structured notes, and interactive spatial interfaces can all serve as "external memory" scaffolds that lighten cognitive load and improve retention by aligning with how we naturally visualize information.

Radial Symmetry, Grids, and Sacred Geometry in Interfaces

Certain geometric patterns hold special cognitive and practical value when designing interfaces. **Radial symmetry** – arrangements around a center point – and grid structures are prevalent both in nature and UI design because they resonate with our perceptual strengths. Humans are highly sensitive to symmetry; we detect symmetrical shapes quickly and find them aesthetically pleasing and memorable ³⁰ ⁶. Studies on visual search find that beyond a moderate complexity (e.g. a pattern repeated 6 times around a circle), radial symmetry pops out to observers even more readily than mirrored left-right symmetry ³¹. This means interfaces using radial layouts can leverage an innate "salience": users may grasp a radial diagram's gist faster or recall its structure more easily because the uniform repetition provides multiple redundant

cues. Symmetrical layouts also create a sense of order. As physicist Alan Lightman eloquently put it, *"Symmetry represents order, and we crave order in this strange universe... Symmetry is simplicity and elegance."* ³² . In UI terms, a symmetric design (if not overdone) can make an interface feel intuitively organized and balanced, reducing cognitive friction for the user.

One practical application is the **radial (pie) menu**. In HCI research, pie menus (circular menus with options arranged in wedges around a center) have been found to outperform traditional linear dropdown menus in both speed and accuracy. The geometric advantage is twofold: Fitts's Law tells us that large targets close to the cursor are faster to hit, and in a pie menu every option is an equidistant, big wedge in a given direction ³³ ³⁴ . Novice users benefit from the self-revealing circular layout, while experienced users quickly develop muscle memory for the gesture direction of each option (up, down-right, left, etc.) ³⁵ ³⁴ . Empirical comparisons showed about a *15% reduction in selection time and significantly fewer errors* with pie menus versus linear menus ³³ ³⁶ . Visual search within a well-designed radial menu can also be faster after a learning period, since users no longer scan down a list but move immediately in the known direction of the command. This illustrates how embracing a **circular layout** – a simple geometric form – can harness both perceptual symmetry and embodied motor memory to enhance usability. Similarly, many data visualization UIs use radial designs (e.g. sunburst charts, radial timelines) to convey hierarchical or cyclical information. When used appropriately, these take advantage of our ability to spot patterns in circles (like seeing all segments at once around a loop) and often can compactly represent relationships with an appealing symmetry.

Grid layouts are another geometric tool with cognitive benefits. A grid imposes straight-line symmetry and regularity (typically horizontal/vertical alignment). From a usability perspective, grids create predictable "slots" for content, aiding scannability and comparative memory. For example, a well-known case is the periodic table of elements – essentially a grid where position encodes properties – which helps chemists memorize relationships through spatial placement. In everyday UI, grids are seen in icon layouts, dashboards, and card collections. Users can leverage spatial memory to recall where on a grid an item was. Studies confirm that people build an imprecise but useful memory of object locations on screens, so keeping icons or menu items in consistent grid positions allows returning users to navigate by recall rather than search ³⁷ ³⁸ . As an NN/g usability report explains, spatial memory lets a person "remember that *the control I need is in the top-right corner*" without re-reading labels ³⁹ ⁴⁰ . This only works if the design upholds **stable geometry** – i.e. interface elements shouldn't shuffle around unexpectedly. Designers are encouraged to maintain consistent layouts and use clear visual boundaries (sections, panels) as landmarks ⁴¹ . By doing so, users form a mental map of the interface's grid. Over time, this turns into rapid, almost subconscious navigation (similar to how you eventually remember where tools are in a physical kitchen) ³⁹ ⁴² . In short, orderly grids reduce cognitive load by aligning with the brain's knack for spatial organization and recall.

Finally, many interfaces implicitly or explicitly draw on **sacred geometry** – timeless shapes like circles, triangles, hexagons and spiral patterns that have symbolic resonance across cultures. These forms (often endowed with radial or reflective symmetry) tend to evoke harmony and focus. For instance, the **mandala**, a circular geometric pattern used in many spiritual traditions, has found therapeutic use in psychology. Coloring or meditating on mandalas (which feature concentric shapes and symmetrical patterns) has been shown to improve focus, working memory, and mood in both children and adults ⁴³ ⁴⁴ . One study reported that even short mandala-coloring interventions significantly boosted participants' attention spans and executive functioning compared to control activities ⁴³ . The concentric structure "*draws the eye to the center*" and likely induces a state of organized thought, providing "*structure within the person's thoughts*" as

one art therapist described ⁴⁴. In design terms, incorporating such **center-focused**, radially balanced elements can have calming, clarity-enhancing effects on users. For example, some modern apps arrange option icons in a circle around a central button (reminiscent of a mandala) to emphasize a core action and equidistant choices. Users often report these UIs feel “*neat*” and “*engaging*”, which aligns with the notion that “*we find satisfaction in the repetition of patterns*” and symmetry ³². Even a simple hexagonal grid (inspired by honeycombs, a naturally efficient symmetric structure) can be aesthetically pleasing and intuitively suggest modularity or equality among elements. It is no coincidence that such shapes are recurrent in design frameworks – they appeal to something deep in human perception. As one science writer noted, our brains evolved in a world of symmetric stimuli (flowers, faces, starry skies), so “*if nature is symmetrical, then so is our mind*” to an extent ⁴⁵. While the “**sacred**” connotations of geometry may be philosophical, the practical upshot is that basic shapes like circles, squares, and grids carry psychological weight. They can signal meaning (e.g. a circle might imply unity or continuity) and can facilitate mental visualization by providing a familiar scaffold.

In conclusion, treating symbolic geometry as an interface means designing information layouts that converse with the brain’s spatial and visual faculties. By leading with findings from experimental psychology and HCI, we see that leveraging spatial metaphors, mental imagery, and innate shape preferences can greatly enhance user understanding and memory. Then, through typographic and design techniques – from mindful font choices to radial menus and grid systems – we can support those cognitive processes. The evidence spans eye-tracking and reaction-time studies to memory tests and usability trials: all point to the benefit of structuring information in alignment with how people *embody* and *visualize* ideas. A well-designed UI might be described as a kind of “**textual hologram**” – each part (be it a word, icon, or segment of layout) contributes to a larger multi-dimensional picture in the user’s mind, much like a hologram where every fragment encodes the whole image. By emphasizing radial symmetry, grids, and other simple geometric forms in our interfaces, we create not just visually pleasing designs but **cognitive frameworks** that users can intuitively navigate, remember, and even emotionally resonate with. The marriage of geometry and text in interface design is essentially a partnership between external structure and internal thought – a partnership that, when done thoughtfully, can amplify comprehension and transform information into insight.

Sources: The analysis above is supported by research and examples from cognitive psychology, human-computer interaction, and design studies, including Gallese & Lakoff’s work on embodied metaphors ⁴, experiments on spatial-social mapping ² and congruency effects in word recognition ⁴⁶, dual-coding and picture-superiority findings ¹¹, typography and memory studies ²⁰ ¹⁴, mind mapping experiments in education ²³, pie menu performance trials ³³ ³⁶, and observations on symmetry and attention both in nature and design ⁶ ⁴⁷. These sources are cited in-line to provide empirical backing for each claim made.

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