



Bottlenecks

Aligning UX Design
with User Psychology

David C. Evans

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ALIGNING UX DESIGN WITH USER
PSYCHOLOGY

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ISBN-13 (pbk): 978-1-4842-2579-0
DOI 10.1007/978-1-4842-2580-6

ISBN-13 (electronic): 978-1-4842-2580-6

Library of Congress Control Number: 2017932384

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For brothers and sisters

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About the Author



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Prologue: Memetic Fitness

In this series of essays, we seek a better understanding of why some digital innovations and experiences engage us deeply and spread widely, and why others do not, drawing upon the lessons of 100 years of psychological science.

Our fundamental assertion is this: digital innovations must survive the psychological *bottlenecks of attention, perception, memory, disposition, motivation, and social-influence if they are to proliferate*. Our **receptivity** to your inventions in this way determines whether we engage with them and recommend them to others—or not.

Who are we? We are your customers, your users, and your audience. *You* are entrepreneurs, designers, developers, publishers, and advertisers. This series is only worth reading if we can talk with you directly in a first-person plural voice. But this is the usability feedback you always dreamed of, because we are also dedicated students of psychology. Perhaps you were too busy coding in your dorm room or even dropping out to raise venture funding to fully digest this body of theory. But if you read on, it's because you now realize that our psychological receptivity to your offerings is the difference between success and failure. For just as chemistry is the science behind good cooking, psychology is the science behind good design.

The key lesson of this piece is that our nervous systems are radically bottlenecked, and the retinæ of our eyes are only the first of several constrictions. Our capacity for memes is wide and deep, but it is filled through a tiny pipette, one at a time. We are built this way for our protection. We can't afford to have our brains colonized by memes that take more than they give. Offsetting the sheer number of memes in the information age is our supremely adapted ability to ignore things that, in our words, suck. Our psychological bottlenecks are simultaneously the challenge you must overcome to succeed and our protection from exploitation.

■ **Key Point** *Who are we?* We are your customers, your users, and your audience. *You* are entrepreneurs, designers, developers, publishers, and advertisers. This series is only worth reading if we can talk with you directly in a first-person plural voice.

So let's begin. A **meme**, if we may define it properly for you, is an idea, an invention, a *particle of culture* ranging from the simplest to the most complex, whose diffusion through a population can be observed. You are probably familiar with this word, but its original meaning went far beyond LOL cats and political gaffes to encompass almost everything you are involved in creating. The term was born in this 1976 passage by sociobiologist Richard Dawkins, which is worth reading in detail:

[A]ll life evolves by the differential survival of replicating entities. The gene, the DNA molecule, happens to be the replicating entity that prevails on our own planet. There may be others. If there are, provided certain other conditions are met, they will almost inevitably tend to become the basis for an evolutionary process...

I think that a new kind of replicator has recently emerged... The new soup is the soup of human culture. We need a name for the new replicator, a noun that conveys the idea of a unit of cultural transmission, or a unit of *imitation*. "Mimeme" comes from a suitable Greek root, but I want a monosyllable that sounds a bit like "gene." I hope my classicist friends will forgive me if I abbreviate mimeme to *meme*... Examples of memes are tunes, ideas, catch-phrases, clothes fashions, ways of making pots or of building arches. Just as genes propagate themselves in the gene pool by leaping from body to body via sperms or eggs, so memes propagate themselves in the meme pool by leaping from brain to brain via a process which, in the broad sense, can be called imitation.ⁱ

Endowing the term *meme* with the weight that Dawkins intended (he went on to discuss the memes of entire religions),ⁱⁱ we will use it to refer to any invention or work product in whose proliferation you are invested. This may be your app, your web site, your bot, your game, your blog, your design, your interface, your tweet, your newsletter, your movie, your book, your song. All the ads, logos, charts, infographics, tools, reports, spreadsheets, and "solutions" you've ever made for your company or your clients. Include too your digital identity, your posts, your pictures, your dating profile, and your résumé.

In the past, few of you could afford to spread your memes through the scarce and expensive communications channels like TV, radio, recording studios, and publishing houses. The bottlenecks were in media then, but not anymore. Because the internetⁱⁱⁱ reaches us all and launching memes through it is easy and inexpensive, it has not only devalued the old broadcast channels, but it has caused an explosion of content. Look at just one platform, smartphone apps,

where by 2015 there were 1.6 million apps on Google Play, 1.4 million in the Apple App Store, and by some estimates, over 9 million apps and web sites on the Facebook Developer Platform.^{iv} This has pushed the bottlenecks out to us, the end users, whose nervous systems must play a much larger role in separating the meaning from the noise.

But history, even ancient history, has repeatedly witnessed such explosions of innovation, and scholars are quite familiar with what happens as they run their course. Studying early multicellular life in ancient shale fossils, archaeologist Stephen Jay Gould described what he called the **Cambrian explosion**. This was a brief period 570 million years ago when evolution burst forth with the most numerous, interesting, fancy, and bizarre animal phyla our planet has ever seen (Figure 1). “This was a time of unparalleled opportunity,” Gould wrote, “Nearly anything could find a place. Life was radiating into empty space and could proliferate at logarithmic rates...in a world virtually free of competition.”^v



Figure 1. An example of an early phyla in the Cambrian explosion that later went extinct.

But what happened shortly afterward? Most phyla promptly went extinct, except the few vertebrates and arthropods we know today. Gould argued that those that survived made it through key ecological bottlenecks, whereas most did not.

Fast forward to the Facebook epoch, and Cameron Marlow, who pioneered Facebook’s data science team, referred to the same *Cambrian explosion* to describe the history of apps on the Facebook platform (Figure 2).^{vi} Mere months after this niche opened in 2007, developers launched hundreds of

thousands of apps and games on it. But almost as quickly as they were created, most “died” for lack of attention and use, and only a few proliferated and dominated.

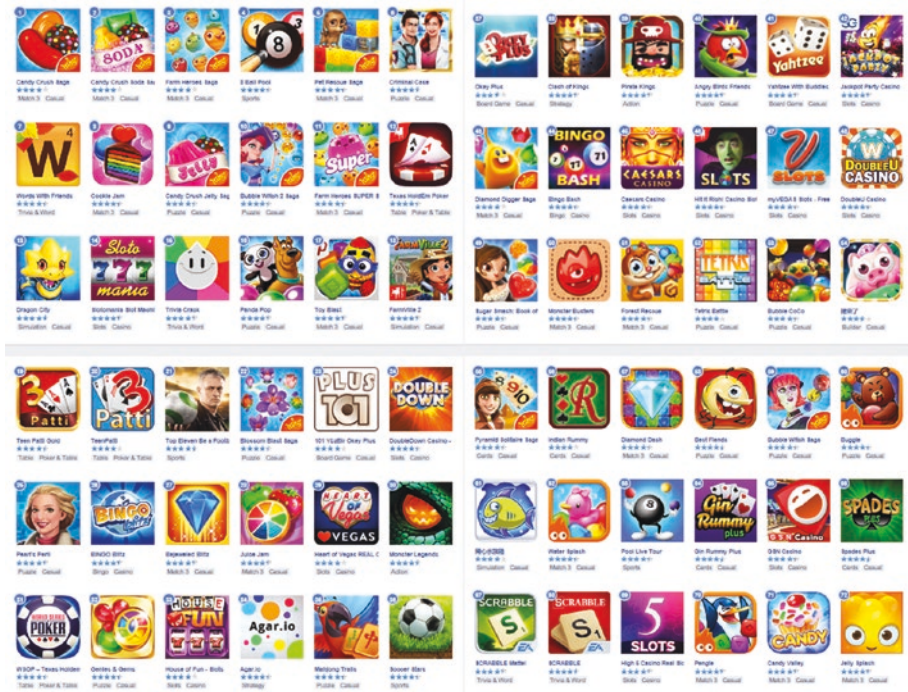


Figure 2. The explosion of apps on the Facebook platform.

Could may have been looking at prehistoric sea bugs, but he saw a larger pattern when he noted that “rapid establishment and later decimation dominates all scales, and seems to have the generality of a fractal pattern.”^{vii} Indeed, history has shown this metapattern to be true of the early World Wide Web (ultimately dominated by AOL, Yahoo!, and Lycos), social networking (Facebook), productivity suites (Microsoft Office), blog platforms (Wordpress), music streaming (iTunes), video streaming (YouTube), messaging apps (Skype, WeChat), and smartphone operating systems (Android, Apple).^{viii} As such, there is every reason to expect that “rapid establishment and later decimation” will be repeated among the platforms that are just emerging: bots and chatbots on messaging and voice platforms, in-car infotainment systems, the internet of things, and augmented-reality content.

This is why you must understand your users, and the psychological bottlenecks we employ to ensure that we expend our time and energy only on useful memes. The memes that are optimized for receptivity will go on to

dominate, while those that are misaligned with human nature will be selected against and ultimately go extinct, suffering the silent, ignored death of most digital inventions.

Dawkins' analogy, that memes are to culture as genes are to heredity, also helps to understand why you put so much effort into your inventions, and what your essential challenge is. You likely already know what it means to strive for genetic fitness: spreading your genes through the population by amassing resources, attracting a mate, raising offspring, and caring for relatives. Dawkins' analogy suggests that you work just as hard to maximize your memetic fitness: spreading your inventions through the culture by attracting attention, retaining it, and encouraging your audience to pass the word. You cultivate your fitness in two separate ecologies like a gambler playing at two tables. In a digital age, fitness may be defined as much by fame as by family, and you make that choice with how you allocate every hour of your day.

But there is yet another, often overlooked, way by which Dawkins' idea of memes helps to understand the diffusion of innovation. His notion *packetizes* your inventions into parcels of energy and meaning, just the way genes packetized our understanding of heritable traits. This helps enormously in tracing the transmission of your work, just as it helped to trace the transmission of genes from parent to offspring.

As such, in this piece we will conceptually follow your meme as it leaves a screen and hits the eye, penetrates a brain, is imbued with meaning, and is retained and used—or alternatively—overlooked, discarded, and abandoned. We will explore the forces that determine whether your meme matches our dispositions and meets our needs and is ultimately recommended to others—or is irrelevant, a disappointment, and detracted from mercilessly in our online comments. Ultimately, the survival of your meme through these bottlenecks is what determines your memetic fitness and whether your work will leap “from brain to brain” and across the globe.

■ **Key Point** Digital innovations must survive the psychological bottlenecks of attention, perception, memory, disposition, motivation, and social-influence if they are to proliferate. Just as chemistry is the science behind good cooking, psychology is the science behind good design.

If the bottlenecked user is our fundamental assertion, then our fundamental assumption is that there exist many good memes worth spreading that fail due to avoidable misalignments with our nervous systems. We are not talking about all the buggy apps and ranting blogs that we kill off quickly with “user-selection” before they can make further demands on our attention. We’re talking about the myriad of fundamentally viable memes that, through some shortcoming or flaw in their design, fail to pass through the bottlenecks that

we use to block out the noise. If you are the author of a truly useful meme, by the end of this series you will learn many concrete ways to improve your work so that we are more receptive to it.

But we offer you our thoughts without altruism. The memes that you build make up the digital tools and environments we use to do our own life's work, provide for ourselves and our loved ones, connect with our peers, and enjoy the creativity of others or express our own creativity. Your memes undergird our mortal existence from birth to death. Only when your business goals satisfy our life goals will success be assured and mutual.

If nothing else, we hope to evoke both innovative new directions in design and fruitful hypotheses for research. Where we have permission, we will refer to actual research studies that we've participated in, sometimes commissioned by tech giants, other times by start-ups, but always on issues where the stakes were high. And to other users like us, we point out that a *meme carrier* can instantly become a *meme creator*, so any of us who has ever tried to raise awareness for anything, from a college app to a killer app, stands to learn from this exercise as well.

With That, We Organized this Book as Follows

If your meme successfully passes through...

Part I

...the bottlenecks of attention...

foveal acuity (Chapter 1) - the tiny area on our retinae required to detect symbols, color and depth

task orientation (Chapter 2) - matching whether we have a goal or no goal

attentional focus (Chapter 3) - the exclusive direction of our attention

Part II

...the bottlenecks of perception...

Gestalt perception (Chapter 4) - instant, pre-cognitive inferences of meaning and function

depth perception (Chapter 5) - the realistic appearance of dimensionality

motion perception (Chapter 6) - the realistic appearance of movement

Part III

...the bottlenecks of memory...

working memory capacity (Chapter 7) - the rapid decay and displacement of information

signal detection (Chapter 8) - ignoring the noise to attend to the signals

long-term memory and habituation (Chapter 9) - ignoring things we've already processed

elaborative encoding (Chapter 10) - failing to recall information that could not be re-activated

Part IV

...the bottlenecks of disposition...

personality (Chapter 11) - matching our stable preferences and tendencies

development (Chapter 12) - addressing the existential questions of our life stage

needs (Chapter 13) - delivering safety, belongingness, status or creativity

fun (Chapter 14) - delivering satisfaction and mirth

Part V

...the bottlenecks of motivation...

schedules of reinforcement (Chapter 15) - timing rewards to maximize engagement

escalating commitment (Chapter 16) - slowly increasing the give and take

approach-avoidance conflict (Chapter 17) - matching whether we are rushing in or backing off

routes to persuasion (Chapter 18) - matching whether we are thinking or feeling

Part VI

...and the bottlenecks of social influence...

social capital (Chapter 19) - risking our reputation to make a recommendation

group polarization (Chapter 20) – extreme opinions in online discussion

social influence (Chapter 21) – actually being influenced by a recommendation

Part VII

...then we will be maximally receptive to it and reward you with a viral cascade that has the potential to reach every last human on the web.

receptivity (Chapter 22) - how our willingness to forward matters more than our connectedness

six degrees of recommendation (Chapter 23) - the possibility of 100% network penetration

Notes

- i. Dawkins, R. (1976). *The Selfish Gene*. Oxford University Press. Pp 191–192. Author's emphasis.
- ii. Dawkins, R. (1976). cont. "Consider the idea of God. We do not know how it arose in the meme pool. Probably it originated many times by independent 'mutation'. In any case, it is very old indeed. How does it replicate itself? By the spoken and written word, aided by great music and great art. Why does it have such high survival value? Remember that 'survival value' here does not mean value for a gene in a gene pool, but value for a meme in a meme pool. The question really means: What is it about the idea of a god that gives it its stability and penetrance in the cultural environment? The survival value of the god meme in the meme pool results from its great psychological appeal."
- iii. We will not capitalize the word *internet* in this work for the same reason we don't capitalize the word *water*; some may lay claim to certain parts of the global flow and insist on a proper noun, but those partitions are as meaningless to memes as the names of rivers are to water molecules. The Associated Press

stopped capitalizing internet in April, 2016. See <http://www.poynter.org/2016/ap-style-change-alert-dont-capitalize-internet-and-web-any-more/404664/>.

- iv. Statista (2016). Number of apps available in leading app stores as of July 2015. Retrieved from <http://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores/>.
- v. Gould, S.J. (1989). *Wonderful Life: The Burgess Shale and the Nature of History*. Norton. P.228.
- vi. Marlow, C. (2009, May 19). System design and community culture: The role of rules and algorithms in shaping human behavior. Panel presentation at the International Conference for Web and Social Media, San Jose, California.
- vii. Gould, S.J. (1989). *Wonderful Life: The Burgess Shale and the Nature of History*. Norton. P.208.
- viii. Bump, P. (2014). From Lycos to Ask Jeeves to Facebook: Tracking the 20 most popular web sites every year since 1996. *Washington Post*. Retrieved October, 2016 from https://www.washingtonpost.com/news/the-intersect/wp/2014/12/15/from-lycos-to-ask-jeeves-to-facebook-tracking-the-20-most-popular-web-sites-every-year-since-1996/?tid=trending_strip_5.

PART

I

The Bottlenecks of Attention

Foveal Acuity

You worked hard to digitize your ideas and send them our way in the form of light and sound. But they must be encoded into neural impulses for your app to work and your business model to succeed. From a business perspective, a meme that never enters a brain is the tree that falls in the proverbial empty forest—it doesn't exist.

To cross the organic boundary into our nervous systems, the first requirement is that it must fall in our line of sight. That statement may be painfully obvious to you, but it is an even bigger pain point for us. Your meme will fail if the light from it only reaches our **peripheral vision** where we can neither read nor see color.

Several billion-dollar examples instantly leap to mind: navigating while driving, video calling, and seeing display ads on web sites. To illustrate, most if not all of the point-of-interest icons designed for this dashboard navigational display are difficult or impossible to be seen or appreciated while driving (Figure 1-1). It was someone's job (maybe yours) to make these memes, like the hamburger icon, or Korean, Italian, and American flags for different ethnic restaurants, but they may never actually enter a driver's brain in the moment when they might be of use.



Figure 1-1. Dashboard display.

Consider closely the back wall of our eyeballs and you'll understand what you're up against. Our **retinae** have a lot of neurons to catch the light, but the **cone-shaped neurons** that let us see color and the detailed edges of characters are concentrated in one tiny area, called the **fovea**, which is opposite our pupils (Figure 1-2).ⁱ Our fovea are amazingly sensitive when we point them your way: we can detect whether or not you're holding a quarter from 90 yards off. But if we're looking just to the right or left of you, our **acuity** plummets to only 30% of what it is when we look straight at you. A little further off, our acuity drops to 10%.ⁱⁱ

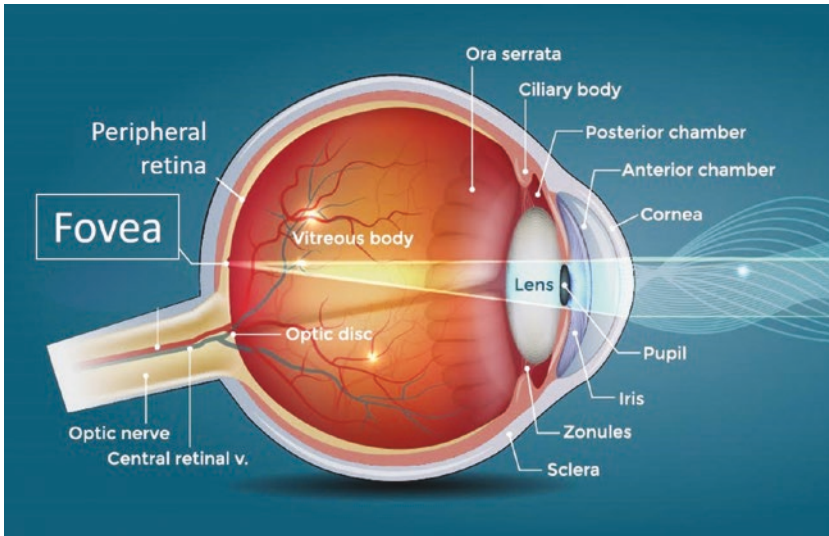


Figure I-2. Diagram of the fovea.ⁱⁱⁱ

What that means for your meme is that we cannot read it if we're looking at a mere six degrees to the left or right. At the typical distance to a screen, we're blind to symbolic information a mere five characters away from where we are focused. Stare at the period at the end of this sentence and count the number of words you can make out past it. Not too many. Perhaps we could read your meme in our peripheral vision if you increased your font size. But you'd have to increase it 400% if we're looking six degrees off, 3000% if we're looking 20 degrees off, and 9000% if we're looking 30 degrees off. Good luck doing that on a smartphone screen or a dashboard display.

■ **Key Point** Your meme will fail if the light from it only reaches our peripheral vision, where we can neither read nor see color.

But even useful memes are impeded by our anatomy if they are not designed in harmony with it. For example, many human-factors experts consider video calling to be among the slowest-spreading meme in the history of tech inventions (Figure I-3). We've had video calling technology longer than we've had microwave ovens or camcorders. And yet, while the penetration of those other inventions is all but complete in developed markets, as are other forms of communication like texting, still only a fraction of us use video calling daily or monthly, if at all.

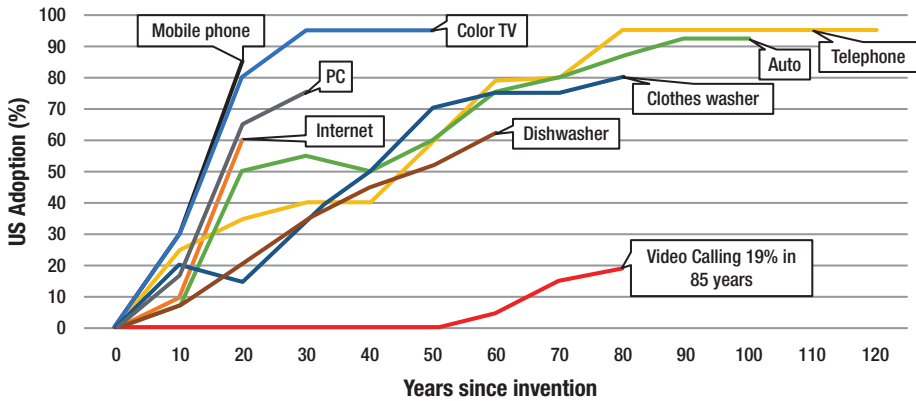


Figure 1-3. Technology adoption rates.^{iv}

Why would this be? Many factors could be to blame, but the 20 degree offset or more between webcams and the eyes of the person we are talking with might be one. Because no one yet has invented a webcam, native or peripheral, that sits *right behind* the monitor, only on top or to the side of it, we never get to look *directly into the gaze* of our friends and family members while we talk (Figure 1-4). Nor do they look into ours, because to do so, we'd both have to look directly into the cameras, at which point we could no longer make out each other's faces. The problem persists even on smaller devices because our foveal acuity is so narrow (Figure 1-5).

Thus we've had *face-to-face* calling for over 85 years, but never quite *eye-to-eye* calling. The best that the top video-calling applications have ever given us is a view of our friends' eyes *looking away from us* as we look at them (although interestingly, their ads never show it this way). This mismatch with human nature has proved to have a very slow rate of adoption, far slower than voice-to-voice calling did before it.

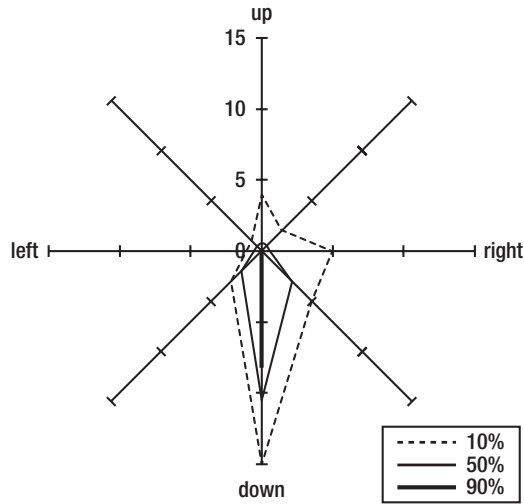


Figure I-4. Sensitivity to gaze direction from Chen (2002). Original caption: “The contour curves mark how far away in degrees of visual angle the looker could look above, below, to the left, and to the right of the camera without losing eye contact. The three curves indicate where eye contact was maintained more than 10%, 50%, and 90% of the time. The percentiles are the average of sixteen observers. The camera is at the graph origin.”^v



Figure 1-5. (a) The typical experience with video calls in which, when we look at others' faces, we see them looking away. (b) Looking into the camera directs our gaze appropriately, but now we can no longer make out each other's faces. This artificial view is shown in most advertising for video-calling services.

Or consider ads on web sites. By 2016, U.S. companies alone were spending over \$30 billion on internet display ads,^{vi} over half of which didn't display on a screen long enough to be viewable (half of their pixels were rendered for less than a second).^{vii} And of those that did, a vast majority were hitting our peripheral retina, where we can't make them out as we read the content elsewhere on the page. We need only point our fovea five characters to the left or right, doing whatever it is we came to do, and your ads were lost on us. Let the sheer waste of that and the lack of ROI sink in as a result of this incredibly powerful psychological bottleneck. Not to mention the inaccuracy of reach statistics, which only measure whether the ad was queried from a server, ignoring whether it landed on a fovea, or even a peripheral retina. This is not the path to memetic fitness, let alone marketing success and profitability.

And then there are our cars, the next big battleground for tech dominance. Whoever prevails in this context must find design solutions to accommodate the fact that we must point our fovea forward out of the windshield while we drive. This is because our fovea are also required for depth perception, something our peripheral vision is incapable of, and thus many states mandate we keep them on the stop-and-go traffic ahead. The problem is that you need to rethink the traditional monitor. Positioned currently where the radio traditionally sits, or on a smartphone held in a driver's hand, it is so far away from our foveal vision that we expose ourselves to real danger in trying to view any of your memes shown there (Figure 1-6). In a 2014 report, the U.S. National Transportation Safety Board listed "visual" and "manual" distractions on their "most wanted list" of critical changes to reduce accidents and save lives (in addition to "cognitive" distractions, which we'll return to later). They specifically referenced "the growing development of integrated technologies in vehicles" and its potential to contribute to "a disturbing growth in the number of accidents due to distracted operators".^{viii}



Figure 1-6. Dashboard display challenge. Most design elements on dashboard displays will be unreadable by drivers focusing on the traffic ahead unless they are projected onto the windshield.^{ix}

Certainly, if self-driving cars proliferate, then the entire interior of cars can be redesigned and turned into a media room or a productivity center (which will spark its own platform for competing memes). The speed by which this technology proliferates will depend on the incidence of fatal crashes, like the 2016 accident by a self-driving Tesla, and on whether drivers will legally be allowed to let their attention wander.^x

But for those of us who continue to drive, whether out of economics or the pace of change, our retinal anatomy would predict that our windshields will become our monitors, where your digital memes will be displayed. Clearly, they must not compete with the things we need to see outside the car, but instead augment them. The first memes to warrant display on windshields will make