The Persuasive Impact of Augmented Reality

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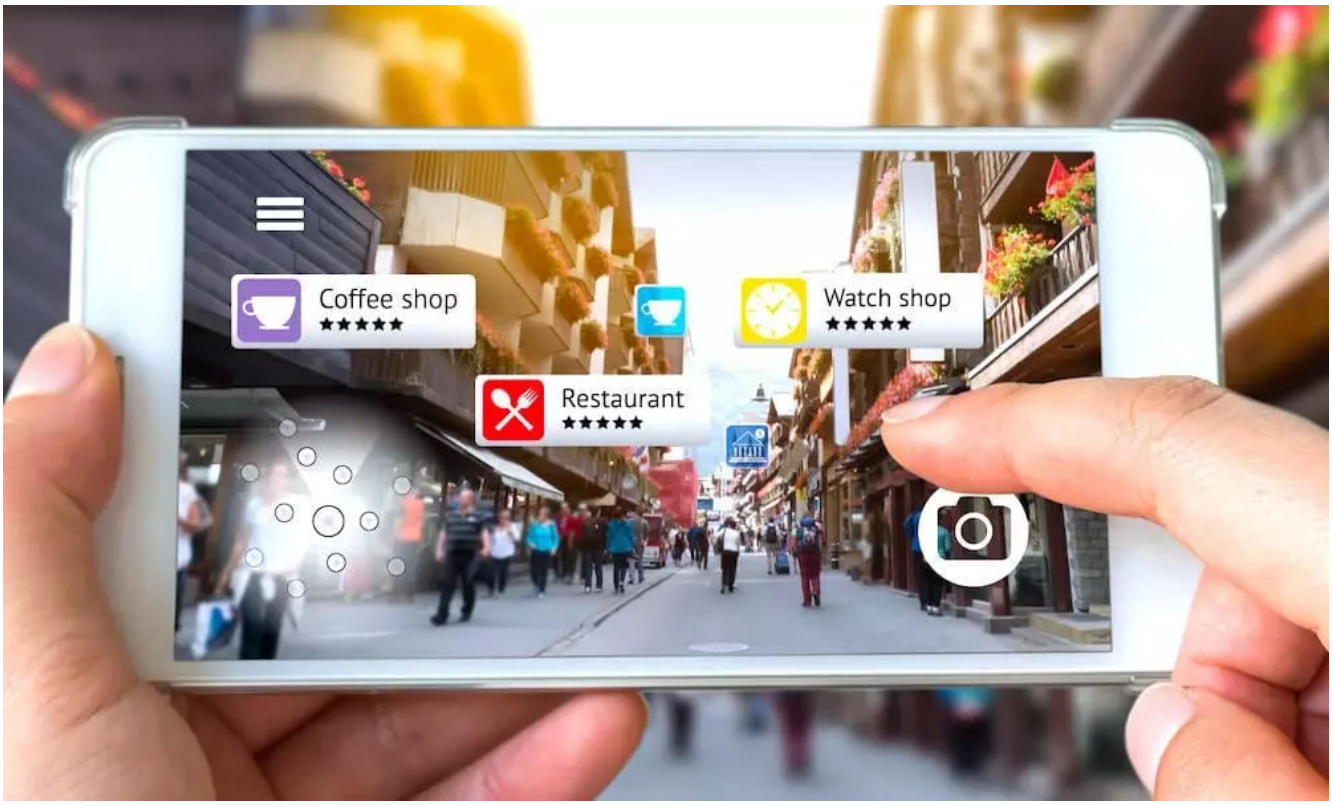
Brain-Based Model: The Persuasive Impact of Augmented Reality

Augmented Reality (AR) applications are unique in that they project virtual information into the user's physical environment. This blending of real and virtual changes the level of impact and persuasive power of the experience. Traditional models of persuasion that focus on technology affordances or information processing overlook the importance of unconscious and instinctual level filtering and cognition on decision-making and, therefore, on attitude and behavior change. This essay argues that the triune brain model, increasingly adopted in marketing, leadership and design, is a more effective heuristic for understanding and designing to incorporate persuasive principles in AR.



Introduction

Technology is redefining our understanding of the persuasion equation. Until recently, the elements of persuasion were attributed to communication rhetoric; computers and technology were not seen as persuasive experiences independent of message [1]. The ubiquity of computers, tablets, and mobile devices that are increasingly customizable and interactive has drawn attention to the power of technology, devices, and objects to communicate experience, identity, and emotion [2]. Human contact remains the most effective means of persuasion, but technology can go beyond what people can do, by virtue of technology's portability and concomitant ability to be unrelentingly present and

persistent as long as the power supply lasts. These potentials make understanding persuasion principles fundamental to the design of effective human computer interaction and interactive experience, such as augmented reality (AR).

Persuasion has been the topic of inquiry since Aristotle [3] and the definition continues to be debated [4]. The field of Captology, the study of computers as a persuasive technology, defines persuasion as the active endeavor to change another person's attitudes or behavior [1]. In the context of technology and human-computer interaction (HCI), persuasion is an intentional structure or action to influence, not an accidental side effect or the result of deceitful manipulation or coercion.

Prior to the public adoption of the Internet, the persuasive power of most software and technology received little attention [5]. This has changed as increasingly sophisticated technologies and lower cost and access barriers have enabled the society-wide adoption of the Internet and mobile and social technologies. By March 2012, over 80% of Americans owned a cell phone and 46% of Americans owned a smartphone, up 35% over the previous year [6]. Recent ITU estimates suggest that as of 2011, cellular coverage is available to 90% of the world's population, or 6.9 billion people [7]. Technologies continue to become more mobile, more customizable, and more interactive, and therefore, inherently more persuasive [8, 9]. Nowhere is this trend more apparent than in augmented reality applications.

Understanding the persuasive factors in the user-technology eco-system is a necessary component of design and development because both the adoption and outcome rest on the ability of the device attributes and content to influence user attitudes and behavior. It is also important to acknowledge that as the field of immersive technologies grows, it will be essential to address the intentional inclusion of implicit and explicit persuasive mechanisms and content to responsibly address inherent ethical and moral issues [10]. This can only be done by integrating psychology and ethics into the development and design process.

There is an implicit goal in every human-technology interaction. Persuasive design can be subtle, such as design structures that help people to navigate effectively on a website, or overtly purposeful, such as software or device-supported time management. All levels of interaction will also have a halo effect, influencing psychological and subjective factors, such as an individual's self-confidence and efficacy from an increased sense of competence and accomplishment [11, 12].

Growing user control and expanding technological capabilities that allow the delivery of rich content and social connectivity increase the potential for persuasive experiences. Accordingly, AR applications are highly persuasive technologies, as they enables the on-demand addition of virtual information to a user's sensory perceptions and create opportunities for immersion, simulation, and interaction [13, 14].

Brain-Based model of persuasion

The critical component for persuasion is engagement—the ability to attract and keep attention—no matter what the technology. All physical and psychological experience, including our ability to notice and attend, is first filtered and then constructed by subconscious sensory processing systems [15], therefore persuasion, as the outcome of attention, starts in the brain [16, 17].

The triune model of the brain

In the 1960s, the neuroscientist and physician Paul MacLean proposed the triune, or three brain hypothesis [18] that has been increasingly adopted by the fields of marketing ('neuromarketing'), design, and leadership [19-23] . While simplistic relative to the physical complexity of the human brain, this model highlights instinct-, emotion- and identity-driven motivations and provides an accurate and useful framework for understanding and triggering human response to different stimuli and experiences [24-27]. I suggest that the three-brain model is a powerful approach for understanding the persuasiveness of AR, because AR applications integrate virtual information with direct multi-sensory experience and create multiple conscious and unconscious entry points of engagement and influence.

Unconscious and conscious thought: instincts, emotions and identity

The human brain evolved new capabilities over the millennia by layering functional areas on to its physical mass. The result is a composite of evolutionary progress [28]. MacLean's three-brain model links the differences in the behaviors from each major functional area to the evolution of animal life, arguing that the brain effectively has three parts that are representative of their stage of evolution: the reptilian or old brain, the emotional center or mammalian brain, and the neocortex of new brain, as illustrated in Figure 1 [29].

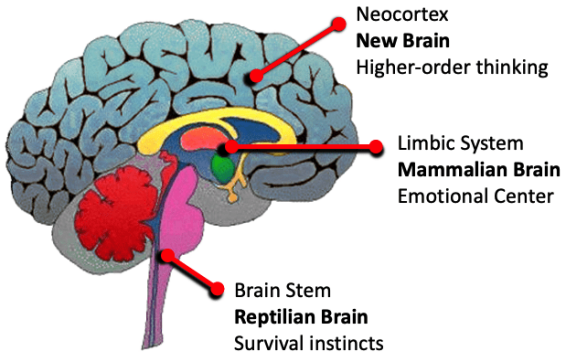
The most primitive sections of the brain, the reptilian brain and the mammalian brain, operate subconsciously. The reptilian brain, comprised of the brain stem, mid brain and basal ganglia, is the oldest and most primitive. It controls instinctive physical behaviors, such as breathing, as well as survival-related responses such as aggression and fear. Although primitive, the reptilian brain is highly sensitive to proximity, self-relevance, reward, and threat. It continually monitors the environment for potential danger by assessing change, and identifying patterns and familiarity.

The emotions were the next functions to develop in the brain. The mammalian brain is the emotional center located in the limbic system, which includes the amygdala, hippocampus, hypothalamus and other structures. It mediates social emotions such as attachment, liking, love, pride, guilt, shame, and scorn as well as behaviors related to maternal nurturing and play [30-32]. Where the reptilian brain responds to primitive, physical-survival instincts, the mammalian brain supports the survival of the organism through socially-based emotional response and the drive for social connection. Together, the reptilian and mammalian brains are responsible for instinctive responses that activate multiple physical and emotional systems for quick reactions, such as fight or flight or protecting offspring [33].

The third part of the three-brain model is the neocortex. The newest, evolutionarily speaking, the neocortex is what distinguishes humans from other mammals [34]. It is the center for conscious thought, such as conceptual, higher order learning, language, problem-solving, sequential thought such as planning, and the ability to have conscious awareness of a 'self' and identity that are central to concepts such as self-esteem, self-efficacy, and agency [17].

Figure 1. Triune Brain Model

These distinctions in functionality represent the dichotomy between primitive brains' unconscious holistic cognition derived from sensations, bodily symptoms, drive and emotions [35], and the 'new' brain's conscious analytical, linear processing of information. Where the unconscious brain speaks the language of image and feelings and can experience only the present, the neocortex consciously processes information as what Bertrand Russell famously described as 'knowledge by description'



versus 'knowledge by acquaintance,' or knowledge that results from judgment and interpretation rather than from direct sensory awareness [36]. This is a relevant distinction for AR as technology becomes more experiential.

Theoretical links

The triune brain theory can be mapped to several psychological theories of information processing and persuasion. The unconscious versus conscious processing of information in the triune theory is analogous to William James' [37] theory of awareness as a composite of the focused attention, or nucleus, and the unattended awareness, or fringe. The preconscious processing of the reptilian brain can also be equated with Daniel Schacter's [38] implicit knowledge — things we know that are not in awareness — and with Ulric Neisser's [39] investigation of attended and preattended content. It can also be seen as the difference between direct perception and information 'pickup' as applied to visual perception by James J. Gibson [40].

Comparably, dual pathways theorist Chaiken's [41] Heuristic-Systematic model posits that people process information in both systemic and heuristic ways where systemic processing is attended and intentional and heuristic processing involves patterns and cues that unconsciously influence a decision. The Elaboration Likelihood Model (ELM) similarly proposes multiple routes for message processing [42, 43]. In the ELM model, commonly applied in marketing research, messages received in the central route receive careful scrutiny and evaluation, where messages received in the peripheral route are not consciously processed but may exercise significant influence in unpredictable ways [44].

The benefit of the brain perspective

The triune brain model, unlike dual pathways persuasion models, places the emphasis on the relative influence of the conscious/direct versus unconscious/peripheral pathways to persuasive processes. The triune model stresses the dominance of the reptilian brain in information filtering and subsequent research has supported this contention, demonstrating that initial preconscious processing is responsible for as much as 95% of decision-making [24, 45]. Thanks to the philosopher Descartes, we are culturally predisposed to think of the brain and body as separate [17, There is ample evidence, however, that thoughts, emotions and the body are mutually influential [16]. Advances in neuroscience and brain scan technologies, however, support the application of the triune brain model to understand how motivation, trust, and attitude change can activate the brain. Researchers have applied fMRI (functional Magnetic Resonance Imaging) and measured the level of neurotransmitters, such as oxytocin, in the blood to track the way the brain receives and responds to different messages and images, such as puppies, babies and even Twitter retweets [21, 30, 47]. Studies show that stress

interferes with sleep and digestion, that petting a dog lowers blood pressure [48], and that when one person smiles at another, it improves the mood of the receiver through mirror neurons that trigger a smile and that resultant dopaminergic reward systems in return [49, 50].

Psychologist Jonathan Haidt [51] provides a useful visual metaphor of an elephant and a rider to illustrate the imbalance of power between the brain's instinctive responses as the giant elephant and the conscious brain's abilities as the small rider to control attitudes and behavior. While the separate systems of the brain are inextricably linked through the continuous communication of neurotransmitters, the strength of instinctual processing at the unconscious level dictates most decisions and actions [34].

No matter their origin, persuasive effects operate at multiple levels simultaneously, from motivating initial product engagement and ease of use (e.g., can an individual easily and effectively use a device?) to specific targeted behavior or attitude change (e.g., will this help the individual achieve a goal, such as an eating healthier?). Fogg makes the distinction between macro level persuasion that has a distinct persuasion-based outcome goal, such as smoking cessation, compared to the micro level persuasion that is inherent in usability design that increases productivity and enhances the subjective experience, such as self-efficacy, of the user [1]. At any level, the goal or desired outcome of an application is for an individual to process a persuasive communication so that it becomes internalized into his/her core belief system to achieve an attitude or behavioral change at some level. For this to happen, however, communication experience must adequately engage the initial filtering system of the primitive brain and trigger the arousal system at the instinctual level. Based on the three-brain model, this can only happen if it has immediate relevancy and embodies a threat or reward.

Augmented Reality

AR uses technology to augment real world environments by overlaying virtual information, on demand, that expand the user's sensory perceptions with the three-dimensional registration and integration of digital data [52]. The persuasive power of AR lies in its ability to create immediacy and relevance by shifting the loci of control and interaction through situated simulations within the control and environment of the user. Combining visual simulation of data in situ creates and enhances meaning and engagement [53]. The on-demand, self-generation of the experience promotes positive affect. The threat or reward is, to some degree, content dependent, however, the act of generating the virtual overlay creates a micro persuasive effect of increased self-efficacy for the user and triggers a reward response in the brain at more than one level [54].

The AR experience, once cumbersome and costly, is now increasingly accessible at little or no costs to nonexpert users through applications on smartphones and computers. Companies such as Total Immersion and Metaio are racing to develop AR platforms and applications for customer demand to incorporate AR experience into everything from product visualization and marketing [55], therapeutic interventions [56], education [57], tourism [58], to AR events, games and entertainment [59, 60]. The continuing development of increasingly robust mobile devices has untethered AR technology, increasing mobility and the sense of user control through enabled compass functions and GPS-based and object recognition-based experiences .

In contrast to virtual reality, whose mass adoption is limited by its relatively intensive equipment and immersive requirements and frequent individual resistance to 'simulated reality' [61], AR is additive, layering virtual information over the real world, allowing it to be displayed in a spatial context [62], creating less cognitive dissonance and, therefore, easier adoption. The combination of mobility and cognitive ease, along with the increasing focus on 'qualitative customer experience' predicts that the rising trend AR use will continue. As AR applications become widely applied, it will be increasingly important to understand the way the brain engages with AR applications to effectively and responsibly integrate persuasive design experiences.

Applying brain-based guidelines

The triune brain model suggests three main areas of focus for targeting design and analysis, one for each level of the brain: instinctual responses, emotional responses, and identity responses. They can function independently, but, given the inter-relatedness of the brain, are more often simultaneous and mutually reinforcing.

As described above, the primitive reptilian brain is only focused on information that directly impacts survival: immediate relevance followed by reward or threat.

Relevance and reward

Recognition and immediacy determine whether information in the environment will trigger the attention of the primitive brain. Human brains are wired to notice indicators of danger; this includes change and contrast, things that are new or unusual, emotionally as well as perceptually. As the reptilian brain scans the environment for patterns and movement, the appearance of an AR simulation with rich media produce novelty and change, enhance attention and physical arousal, and make delivered information more salient, memorable, and actionable [21].

Once information is attended, cognitive processing continues by comparing new information to previous experience to determine the level of reward or threat. The more familiar the information, the less likely it is to trigger a threat response, and the more likely the brain is to interpret the stimuli as positive or being of value. Content is perceived as self-referent and suggests similarity in addition to relevance delivers increased perception of value [63]. Historically, our likelihood of survival was increased by affiliating with those things most familiar to us, from people to environments. The ability to self-reference and self-identify leads to a favorable evaluation of a product or experience no matter what the quality of content logic or information. Similarity increases relevance and positive perceptions, or 'liking' [13, 64, 65]

AR applications are on demand, enhancing the sense of control (safety) and personal investment (identity) [66]. The content is, by definition, self-relevant because it is pulled to the user on demand, not pushed as in traditional advertising. Useful and accurate content provides a solution to a problem or question, creating a sense of safety and enhanced self-efficacy. Additional preferences give the user control over how the information is displayed. The user has choice over exactly where, with whom, and on what device to activate and experience the information. The sensation of success and control by the reptilian brain is processed as reward and triggers positive emotions (pride, happiness) through the dopamine system [67] and is translated by the conscious brain as successful, personal validation and efficacy (identity) [68, 69].

Emotion

AR has the ability to tap multiple levels of emotion by linking the affect in present experiences with triggers from virtual experiences. Visual representations are the most effective ways to trigger emotions. Over 50% of the cerebral cortex is devoted to visual processing [70]. The visual system evolved with the haptic nervous system and, therefore, a large proportion of tactile signals trigger the visual cortex [71, 72]. Virtual responses activate the same neural networks as real experiences, recalling all associated sensory and emotional memories, thus virtual overlays will meaningfully enhance emotional and somatic experience [70]

Social connection

Social needs are some of the most powerful forces in persuasion. Humans are neurologically-wired to seek social attachment [73]; they are acutely sensitive to social perceptions, inclusion, acceptance and rejection [74].

The pattern-seeking reptilian brain looks for meaning in the environment and is particularly attuned to the arrangement of shapes suggesting human faces. This socially-oriented biological predisposition also causes humans to attribute personalities and motivations to others, both humans and nonhuman, such as animals and objects [75]. Consequently, people are not only able to see human faces in everything from the moon to potato chips and attribute complex emotions to pets, but the act of anthropomorphizing even inanimate objects, such as computer devices creates a genuine emotional attachment and enhances the persuasive effect [76].

The human predisposition to attribute human characteristics to objects and devices suggests that AR applications can leverage social rules and dynamics when they successfully reinforce human attributes and interactions, such as the social conventions of praise or support enhanced by the proximity and blended reality of content projected into the user's physical space. The reptilian and mammalian brain responses, biologically driven to seek affiliation, interpret these as genuine social behaviors and social exchange, activating the powerful persuasive effects of the rule of reciprocity, that we must return favors to others, and social validation, that we are valued by others in our group [13].

The mobility of AR also allows for collaboration among users locally and virtually. Connected to social networks, AR applications can leverage the impact of social proof, that people are influenced by what others around them do, and affiliation or social identity, that we are similar to others we value. Researchers have shown correlations between behavior change and neural activity in regions involved in monitoring social perceptions and have affirmed the role of social factors in the persuasion process [77, 78]. Behavior change is correlated with increased neural activity in areas involved in memory, attention, visual imagery, motor execution and imitation and affective experience. This is consistent with theories of social learning and persuasion suggesting that behavior change can result in social norms into self-concept [77], underscoring the roles of safety, connection, emotion and identity represented by the three brain theory.

Identity

The new brain categorizes and interprets the information it receives from the unconscious brains in order to commit it to memory for future recall. AR can have powerful impact on conscious cognition through the psychological experiences that enhance identity: self-efficacy, competence and validation [11, 79]. Successful experiences retrieving and manipulating data and being able to act successful

and pleasurably result in goal achievements. Sense of reward can be minor, such as ease of use or finding a local coffee shop, to larger milestones such as achieving weight loss. The positive achievements will be reflected both in self-image and in product appreciation and loyalty [12].

Persuasion using narrative

The most powerful method for coherently engaging all levels of the brain is through narrative. 'Story' may sound unscientific, but stories (or narratives) are how the human brain organizes information. Stories create authentic human experiences and they are how humans have passed online culture, knowledge and social norms from generation to generation throughout history. Narratives leap frog the individual attributes of technology by creating a holistic experience that engages the brain at all levels: instinctive, emotional and identity [80, 81]. The experience of narrative immersion inhibits cognitive challenge and increases the potential for persuasive influence. AR is inherently a narrative experience because, beyond the content, the act of engagement brings AR into the user's reality and personal story.

Stories take place in the imagination but they are a multisensory experience. The brain processes imagined experiences using the same physical and neural mechanism as real ones, creating genuine emotions and sense of place in AR applications [82].

Cognitive psychologists use terms such as schemas, scripts, cognitive maps, mental models, metaphors, and narratives to describe the processes individuals use, consciously and unconsciously, to construct meaning and integrate our experience so it can be stored in memory [e.g., 83, 84, 85]. In order for something to be committed to memory, it has to have context in a linear structure that can be enriched and linked with multisensory information, for example, 'A happened, then B,' or 'C happened with D because of E.' Isolated facts are not retained; stories are the mnemonics for memory retention, creating neural networks for future recall and reactivation.

The creation of a narrative allows an individual to find the shared meaning (relevance), connection (emotion) and step into an experience as a character (identity). This is what creates an immersive experience and enable the ability to feel empathy and envision new opportunities for ourselves, while simultaneously reducing negative cognitive response and increasing positive affect [86].

Narrative transportation theory describes persuasion as a function of an individual's ability to process information and messaging in the context of narrative [87] that also supports self-referencing. Self-referent processing is the cognitive process by which each person compares new information to his/her existing memories, beliefs, feelings, and experiences in order to give it context and meaning [64]. When information is salient, i.e. it can be linked to self-referent meanings, it has been shown to enhance learning, memory, and recall [e.g., 88].

AR is the ultimate 'product placement' because it links real life with virtual objects and stories [63]. Persuasion research has primarily focused on consumer processing of rhetorical product messaging (ads) rather than examine the narratives within which the placements occur. With narrative transportation and AR, however, the user has the opportunity to lose him/herself in story with the product as a companion on the journey [89-91]. Green and Brock argue that mental immersion is persuasive because it leads to disinhibiting of the critical thinking functions and heighten affective responses [92, 93]. In other words, it activates and engages the primitive brain levels that are driving

decision-making. Escalas confirmed this where audience members were able to imagine themselves as the 'star' of the narrative [14]. Heightened affective responses led to more favorable evaluation of the experience, ad, brand or product.

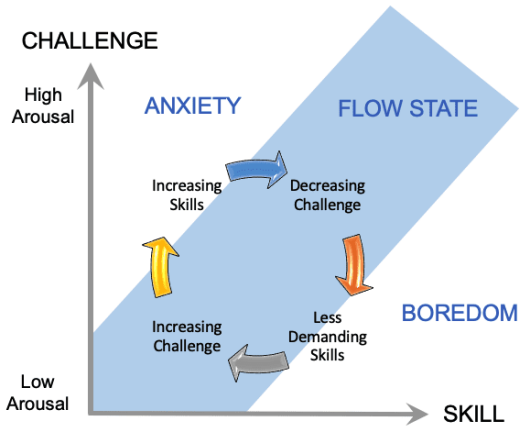
Persuasion and optimal experience

The triune brain model can also be used to contextualize persuasion in the theory of optimal experience as defined by Csikszentmihalyi in his theory of Flow [94]. Flow is the state of complete engagement where the challenge of an activity matches the skills of the user at the level that requires effort and concentration yet is within the boundaries of the user's capabilities [see also, 95]. This balance creates a zone of "flow" that increases opportunities for persuasion by inhibiting cognitive opposition and creating positive affect.

Brain-Based Model View of Flow Theory

Maintaining flow requires balancing the challenge of an activity with the requisite skill level for successful accomplishment, as shown in Figure 2. Imbalance results in either boredom or anxiety and disrupts the feelings of flow. Applying the triune brain model lets us conceptualize the flow process as a primitive balance between threat and reward. The challenge of an activity must be difficult enough to achieve arousal to generate attention and concentration of the reptilian brain without escalating arousal to a level that is perceived as a threat to survival. The skill and challenge equilibrium must work within the zone that enhances self-efficacy to trigger the dopaminergic reward system and bolsters identity and self-esteem at the conscious level. Challenges that overwhelm skills threaten identity and self-competence, triggering the threat response unconsciously which is interpreted as dislike and frustration, consciously [96].

Figure 2: Brain-Based Model View of Flow



Unconscious negative experiences create a cognitive challenge to individual identity. This cognitive dissonance is resolved by preserving a positive sense of identity and attributing the negative experience to the activity, application or experience [97]. The flow state can also be equated to narrative immersion with similar impact on persuasive effects [98, 99].

Implications for design and development

The application of the triune brain model of persuasion has implications for design decisions throughout the development process as summarized in Table 1. Designing for the brain means following the neurological processing path in order to align design decisions with innate biological priorities and attention hurdles. In other words, start with old brain considerations.

Old brain design considerations

1. Use emotion.
2. Trigger multiple senses using image and use visual rather than textual cues. Images are processed 40 times faster than other sensory input.
3. Highlight the pain and gain. Fear of loss is often as persuasive as possibility of gain.
4. Provide a clear path to task accomplishment and reward to avoid uncertainty and fear of failure.
5. Make everything user-centric and personal.

New brain design considerations

1. Once the old brain is engaged, the new brain will respond to stimuli that impact identity enhancement. To integrate new brain considerations:
2. Provide skill-building opportunities with responsive feedback to shorten the behavior-reward circuit and increase self-competence.
3. Integrate success markers to provide social validation and trigger the brain's reward systems.
4. Allow for participation, content creation and collaboration to create social reciprocity and a sense of personal commitment through ownership.
5. Build in a narrative structure to engage old and new brain processes simultaneously by triggering emotions and creating empathy, ownership and presence.

Table 1. Brain-Based Design Guidelines

OLD BRAIN	NEW BRAIN
Emotions	Skill-building
Visual images	Responsive feedback
Pain and gain	Participation, ownership
User-centric, personal	Social collaboration
Certainty	Empathy
Narrative	

Conclusion

There are several persuasion models. Because the human brain filters and processes most information unconsciously, the triune brain model provides a clearer framework for evaluation of the experiential and social characteristics of AR. Traditional dual processing models fall short because they don't provide a heuristic for the relative imbalance of power of unconscious versus conscious processing on persuasion and decision-making. Unlike other media technologies and applications, the features and structure of AR applications take advantage of this imbalance of power by allowing new information to be delivered to the user's environment upon demand as he/she moves about the world. The ability to merge the virtual information with real experience enhances the ability to persuade by delivering relevance and newness. The brain enhances the power of AR because it unifies and amplifies the combination of sensory input overlaid on the real world. AR also provides positive affect through introduction of media rich channels, and enhances individual sense of self-competence and identity through the successful manipulation of information in situ. The three-brain model gives designers, developers, and media strategists an effective heuristic to understand and apply the principles of persuasion in order to leverage the unique capabilities of AR for effective applications that deliver meaningful user experience. [1] B. J. Fogg, G. Cuellar, and D. Danielson, "Motivating,

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