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Examining the nexus of design, motion, and the mind to inform effective moving character creation.

Context:

Character design for motion is used in all fields in which there is a depiction of a being with the illusion of life, whether they exist in the physical world (robotics, puppetry, costuming), or in the pictorial or virtual world (animated cartoons, games, avatars). Effective characters are those that engage with the audience, player, or user in a contextually expected way, avoiding an uncanny, incongruous sensibility to their appearance or movement, and reinforcing their intended role in the story, game, or product interface. A character's purpose, to entertain, communicate, or interact, will generally inform their design and movement style and range.

Characters are utilized and designed by professionals in many varying fields, to varying success. Well funded Hollywood studios with access to professional character designers will occasionally make a film with characters that fail to effectively engage with audiences because of how they look or how they move. Roboticists struggle to avoid the "uncanny valley" of robot designs that appear to resemble humans closely, but are off-putting. Massive tech companies struggle to impress the public with "metaverse" characters that are bland, legless, human avatars, and wonder why.

With so many high-profile character design failures and the ongoing struggle to design appealing characters for a variety of purposes, is it possible that an examination of qualities of designs might reveal clusters of successful design choices in certain contexts or usages? Additionally, could an examination of the ingrained reasons in the human psyche which cause us to engage with characters and stories in the first place lead to better design choices? Are there clues at the nexus of design, motion and the human mind where we might recognize patterns that tend to be associated with successful character design for motion?

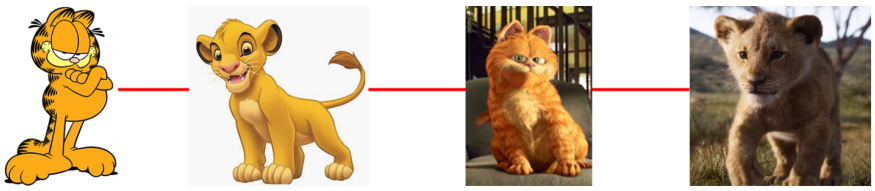
To investigate whether useful patterns might be discovered, data may be gathered and analyzed. The potential subjectiveness of defining design qualities and degrees of variation across widely different characters is a concern. Distinct categories need to be defined with common scales in

order for data to be recorded and compared. Useful categories of a character design to examine include 1) the degree of relative cartoon abstraction to representational realism, and the degree of relative iconicity to detail, 2) regarding the style of character movement, the relative degree of limited motion to fluidity, and the relative degree of unnaturalness to naturalness, 3) the degree of relative anthropomorphism (humanness of mind and humanness of form), 4) the degree of relative cuteness to grotesqueness, and the degree of relative mundanity to fantasticness. With these qualities assessed for a variety of characters, an attempt might be made to correlate certain qualities in relation to audience/user appeal and engagement versus disinterest or uncanny disgust. Each of these qualities will be defined in the following sections, along with discussion of popular examples and how their design qualities may have impacted their audience engagement and success as designs in context of their purpose.

Cartoon Abstraction to Realism, Iconicity to Detail

Professional character designers have sets of aesthetic rules and guides to create appealing characters that communicate personality traits and clearly identifiable forms in relation to other characters in the same world context. For example, an ensemble cast of characters would be designed with clearly contrasting shapes and sizes which would create immediately recognizable differences in their silhouettes to better help audiences immediately recognize each character. [Bancroft, 2008] Additionally, designers will use the psychological elements of shape language to communicate qualities of characters instantly. For example, sharp, angular shapes will be incorporated into the design of a villain, while round, soft shapes will be used for a friendly, comforting character. Large top-heavy characters with broad shoulders and thick arms may seem to be caricatures of the real world equivalent of a strong, powerful person, but shape-language will also routinely be applied, and the character will be designed with squared-off features that further enhance the sense of solidity and toughness. The use of these design archetypes allow designers to “match designs with how they want a player to interpret their characters, whether it is in a congruent way (e.g., a bad guy who looks evil) or an incongruent way (e.g., a bad guy who looks innocent, non-threatening and friendly).” [Pradantyo et al., 2021] Designers also tend to use familiar design elements that become cliched through their repetition. For example, the large expressive eye designs common across feature animated characters from Disney,

Dreamworks, Pixar, Blue Sky, Illumination, and more might lead an audience to believe that there are no other possible designs to choose from. Similarly, the lead character in any number of video games for mature (adult) users tend to be designed with similarly more realistic facial proportions and small eyes. Cartoon shows designed for infants, toddlers and young children typically have characters with the largest eyes. Does eye size appear to relate to the intended audience age, with largest eyes indicating juvenile contexts, and realistically small eyes indicating adult contexts? Does this hold true for robotics or avatar design? If realistic sized facial proportions are one extreme on the cartoon abstraction to realism scale, and they tend to be used in adult-targeted media such as violent video games, can we conclude that popular expectation is that realism tends to be mature, and cartoon abstraction tends to be juvenile? Not quite, as the entire world of adult-animated series demonstrates that cartoon-abstraction, big eyes and all, are also targeted to adult audiences. Examples include *The Simpsons*, *Family Guy*, *Bob's Burgers*, and many more look-alike cartoon series that establish their own similar design cluster. One thing in common that these large-eyed and adult series have is that they are all designed to be comedy shows. Perhaps then, if a show is intended to be adult, and of dramatic nature, could it be concluded that large expressive eyes are not typical? Thousands of dramatic adult series from Japan and others influenced by anime would disagree, as they often have characters with large expressive eyes designed in a different style than the typical adult comedy shows or children's shows.



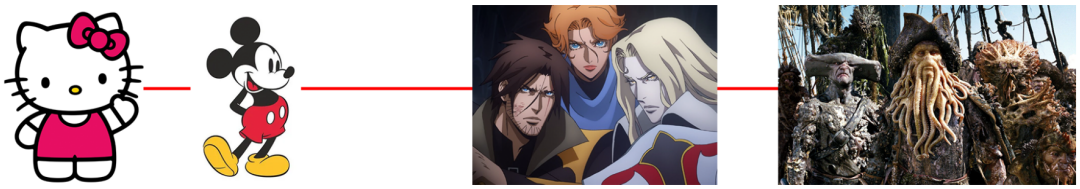
Examples of the categories are useful to help define what the scales represent. On the axis of cartoon abstraction to realism, realism represents the end of the spectrum where realistic human characters from video games and the photo-real human characters from films like *The Polar Express*, and the "live-action" remakes of Disney 2D films such as *The Lion King* exist. One generally accepted rule that designers consider, or should consider, is that realistic character designs make suspension of disbelief harder to maintain, and therefore observers find it more difficult to emotionally connect with them to the degree possible with stylized characters. [Zell et al., 2015] The human characters in *The Polar Express* were criticized for their dead-looking eyes and expressions, which is not a criticism that more cartoon-abstracted films ever tend to receive.

Additionally, roboticists have found that the closer that robots approach realistic human design, the more danger there is of the robot falling into the *uncanny valley*. One way of describing the uncanny valley theory is that when observing a highly human-like robot that looks almost human, but with something off in design or movement, it makes thoughts of death more accessible, leading to perceptions of uncanniness and eeriness of such robots. [Koschate et al. 2016] Others have described the uncanny valley as the sense of unease deeply ingrained in the human brain when confronted with a diseased or dead being, perhaps ingrained as an evolutionarily positive instinct to avoid potential illness from proximity to said being. Emotional responses to robots and animation vary considerably between observers which complicates the development of quantitative measures of the uncanny valley. [Ho et al., 2016] In theory, a perfect, life-like robot could avoid the uncanny valley, but only if its movements were perfectly human-like, and its expressions were expected and natural in context.

Both the examples above of uncanny human-like robots and dead-eyed 3D animated realistic human characters should be a well-established warning to current designers, and yet projects continue to be produced that flirt with uncanny design that creates unease, which by definition does not inspire character-empathy with the audience. Empathy is the process of falling-into another, often considered a form of self-other overlapping that optimizes interaction. [Mattiassi et al., 2021] Critiques of the realistically rendered 3D character lions, panther, bear, etc. in the often misdescribed "live action" Disney films *The Lion King* and *The Jungle Book*, were less about the unease the characters inspired, and more about the lack of expression, exaggeration, and color that were abundant in their 2D predecessors.

Cartoon abstraction describes designs that may be recognizable as a "man" or "dog," etc., but when looked at objectively, they do not resemble their real world equivalents. Goofy the bipedal man-dog (with human intelligence and the gift of speech) and Pluto the quadrupedal dog-dog (limited to dog intelligence and vocalization) both exist in the same cartoon universe, and neither look exactly like a dog or a man. "Artists rely on stylization to increase appeal or expressivity, exaggerating or softening specific features." [Zell et al., 2015] Stylization grants character designers flexibility beyond what is limited by reality to enhance the appeal or expressiveness of the characters, particularly in the case of cartoons. [McCloud 1993] McCloud also posits that the more specifically real design is, the less potential it has for a viewer to "become" that character thorough empathy, whereas the more iconic a character is designed, the

more a viewer may "become" that character as its iconic features create an open vessel for filling with the viewer's own identity. Snoopy is a beagle, but his rounded head/snout is a flattened graphic that does not rotate in 3D space in any realistic fashion nor resemble a dog's face. Similarly, Mickey Mouse's famous ears are circular, rotate around the top of his head instead of in dimensional space, and in no way resemble the ears of an actual mouse. Other forms of cartoon abstraction include creatures that only vaguely represent anything real visually, but we accept as conceptually human-like characters. Many Muppet characters are vaguely human or animal-like, or classified as monsters, for example.



On the axis of iconicity to detail, an iconic design is one that has detail reduced to minimal effect, typically using dot eyes and a line for a mouth. The smiley face represents one of the most iconic designs of the human face possible. Characters with famously iconic designs include Hello Kitty and other characters from the Japanese studio Sanrio, and the Peanuts characters including Snoopy and Charlie Brown are relatively iconic as well. Low-polygon 3D characters and emoji faces tend to the iconic.

On the other end of the spectrum, characters with a lot of detail include some 3D animated characters that are fully textured and painted with realistic nuance or modeled with thousands of flowing hairs and skin with individual pores and freckles. If drawn, a detailed character tends to have extensive *line-mileage*, or an exceptional amount of lines that define it. Many Japanese anime productions favor relatively detailed designs, as do a variety of independent productions, whereas American television animation tends to the iconic side of the spectrum for budgetary reasons on the reasoning that simpler designs cost less to animate.

Limited motion to fluidity, unnaturalness to naturalness

Animation practice has guidelines for effective motion design of characters that include principles of exaggeration (caricaturing physics and emotions), restraint (pauses and timing), and easing to avoid machine-like movements. [Thomas et al., 1995] The range of motion style will

vary depending on the context, with cartoon-like exaggeration and realistic movements each being expected in different genres and formats. Motion capture of live actors is recorded for some characters, typically for video games, but also for some visual effects heavy feature film characters. When ultra-realistic motion capture of human actors is translated to animated characters, typically that motion data must be refined and "cleaned-up" of excessive, constant movement or unfocused movement. The realism of motion capture is similar to the way that rotoscope (tracing of live-action acting with drawing techniques) creates a specific movement style that is identifiable when compared to hand drawn animation or stylized animation. Often the combination of realistic movement paired with non-realistic design will contribute to an uncanny feeling.

On the axis of limited motion to fluidity, limited motion is typically seen in television animation or stop motion or other hand drawn methods. Limited motion is typified by frequent held, static pose frames with few moving elements, such as a mouth talking or eyes blinking. *The Flintstones* or *The Rocky and Bullwinkle Show* were two animated series featuring limited motion. At the opposite pole of that axis is fluid motion, or fluidity. Fluid motion is typically seen in 3D CGI characters since that technique utilizes computer interpolation between key poses. In other words, animators pose the character in key positions, and the computer fills in the motion between, which allows the character to be completely fluid as a live-action character. Fluid motion is also seen in characters in major 2D animated films with budgets that can support the extensive amount of effort that is required to hand draw enough frames to create that fluid effect.

On the axis of natural motion to unnatural motion, natural motion could be described as realistic motion that moves as expected in context. Unnatural motion includes physics that feel wrong, accidental, or are intentionally abstracted from reality, including cartoony abstraction or

horrific lurching, which in context, can be desirable, but usually for horror-inducing purposes, such as the movement of a zombified corpse. The aforementioned technique of using motion capture of real, live actors as the basis for the animated movements of video game characters will often paradoxically create an uncanny, unnatural movement style: the realism of the movement looks unnatural when mapped on to the 3D CGI characters designed to look dramatic and "real," as it is their falling short of realness that emphasizes the effect that they are dead puppets animated by some unseen recording of real life.

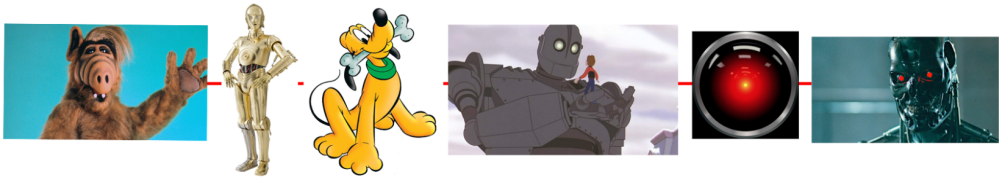
Anthropomorphism of mind, form

In most cultures, one finds representations including the lifelike and human-like features of non-living or non-human objects. [Boyer 1996] Anthropomorphism is the imbuing of humanlike qualities to nonhuman objects, AI agents, and creatures, specifically including higher-order emotions and thinking. In a sense, all depictions of humans are anthropomorphized in the brain; pictures, films, drawings, regardless of human subjects, are representations of reality, not reality itself, and yet the brain creates a concept of their humanness. The same process of identifying a "character" happens when humans see a photo of a person or a photo of a fire hydrant with plastic googly eyes stuck on it. The degree of empathy one feels to these photos may favor the photo of the human, but, if instead they were moving pictures of a human and an animated fire hydrant with the same googly eyes, pantomiming the same actions and expressing the same emotions, the audience's ingrained recognition of higher-order thinking would recognize both characters as having human-like consciousness. Even anthropomorphized characters with no face or limbs, such as the Pixar logo lamp at the start of each of their films, successfully acts in pantomime communicating that they are a living, thinking being. The lamp projects play, curiosity, and perhaps a bit of mischievousness as it bounces onto the logo, squashing one of the letters and "looking" back at the viewer through its light bulb, by "facing" us. Even through describing the action, the lamp is humanized with words such as looking and facing.

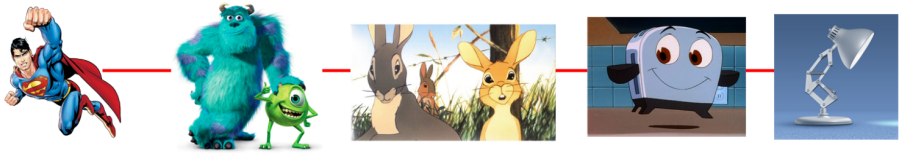
"People tend to personify their technical servants, including giving them human names as well as attributing personality traits and intentions to them." [Hahn et al., 2018] Researchers and designers have studied the relationship between anthropomorphism and the amount of trust a person gives to that object or avatar, finding that adding human qualities (name, gender, voice) to

the interface of a semi-autonomous car, for example, increases trust. [Waytz et al., 2014] The anthropomorphism of a character is an important measure of whether it will induce familiarity and empathy of an audience.

It is worth noting how people view psychological anthropomorphism, which can be thought of as egomorphism, or perceiving similarities in others because they are "like me" instead of because they are "human-like" in general. [Lulka 2008] The first-person viewpoint of the mind is naturally the lens of personal experience that comparison to the external world is made through. It is why anthropomorphizing non-humans by thinking that they are "like me" makes it so easy to engage with non-human characters. This explains why pets are seen as members of the family, or videos of animals doing cute and funny things are universally loved. The human mind has the potential to see these non-humans as "like me," and therefore relatable and lovable.



On the axis of mental anthropomorphism from the amount of humanness to non-humanness, characters can be graphed depending on their relative higher order consciousness. Typical range for characters would be from human consciousness to animal consciousness, to complete non-humanness.



The axis of anthropomorphism of form extends from human-like form to non-humanlike form, wherein the human-like form includes androids, and bipedal beings with similar human proportions, and non-human like forms, or low levels of anthropomorphism of form includes characters formed like other animals or objects.

The first conclusive evidence of anthropomorphic thinking comes with the appearance of art in Europe 30,000 years ago in the form of a statue of a man with a lion head. [Mithen et al.,

1996] Since then, there is abundant evidence that humans have been anthropomorphizing non-human creatures and objects worldwide, across all cultures. Non-anthropomorphic formed characters tend to have at least some human-like qualities for inducing human empathy, such as the aforementioned Pixar logo lamp. For objects to become characters, they almost always need some level of anthropomorphism of form to create that empathy in humans. Though it has no face, no limbs, and no voice, the way the Pixar lamp moves and through what it does, it appears to play, and think, like a playful child or human, indicating mental anthropomorphism of a higher level. The characters in Pixar's *Cars*, for example, are non-human like forms, but are vehicles with eyes for windshields and mouths where front bumpers should be. If a stapler had no anthropomorphizing characteristics, such as a face or limbs, and did not move in a fluid and natural way, but instead slid mechanically across the table, and did no bits of performance that indicate any thinking or emoting, then it would be difficult to find empathy and engagement for this moving object via anthropomorphization, as there would be essentially none. Fantastic creatures like aliens, monsters, dragons, etc. can still be graphed on this axis by their level of similarity to the human form.

Robots interestingly do not need to be humanized for them to complete most functions that robots are useful for, except in the consideration of how humans will react and interact with them. Robots of many shapes build cars, explore the lunar surface, go on search and rescue missions in dangerous terrain, or wage war in the form of flying drones. The android is the humanized robot, designed in that form for human benefit. Once the form of a robot "character" approaches humanness, the anthropomorphization engages and potential empathy follows. Humans appear to consistently project their sense of self-experience onto other things that are "like me" and are unable to untether their associated preconceptions. Studies have found that people even project gender stereotypes onto robots perceived as either masculine or feminine. [Wosk 2019]

Cuteness to grotesqueness, mundanity to fantasticness

Cuteness is a popularly-understood concept on its surface. Considering what is often considered cute in general reveals the primary clue and connection to human psychology. Babies, infants, and juvenile animals of all sorts have features and proportions that are considered cute, which in humans specifically include a large head-to-body proportion, large

eyes-to-head proportions, and a rounder, softer appearance than the slender or muscled healthy adult body in comparison. [Dale 2016] Humans, and other animals, appear to have evolved to recognize cuteness as a sign to protect, nourish, and fawn over the young being; an evolutionarily positive instinct to encourage keeping a baby alive and well. Cuteness can also be denoted by behaviors that convey a sense of simplicity, weakness and clumsiness, further enhancing the observer's urge to protect and cherish the cute object. [GN 2006]

It is notable that cuteness in itself as an aesthetic can include cute graphics, typography, or color combinations that complement other cute images, including those of characters. [GN 2006] Dale suggests that cuteness promotes the desire to engage and interact with the cute object, and thus is more than just infantile and passive, but can be used with agency as "soft power" both to disarm and control. [Dale 2016] Cuteness can be used to conceal intention and manipulate emotion.

Grotesqueness is defined as of, relating to, or having the characteristics of the grotesque: such as being fanciful, bizarre, absurdly incongruous, or departing markedly from the natural, the expected, or the typical. [Merriam-Webster] Additional words to describe the grotesque may include the strange, mysterious, magnificent, fantastic, hideous, ugly, unpleasant, or disgusting. The grotesque also recalls some elements of decorative, fanciful distortion of natural forms into the fantastic, so it has overlapping qualities with the below scale of mundanity to the fantastic. However on a scale of cute to grotesque, the focus is on the intended effect of pleasant familiarity and empathy with a cute object in contrast to the discomfort and suspicion of a grotesque object.

A moving character design's relative cute or grotesqueness does not define its success as a character that is ideal for its role in context of the story, world or experience. Both cute and grotesque objects tend to be deformed caricatures of nature, with each being on polar opposites of invoking positive and negative feelings. Cuteness may also invoke revulsion, and grotesqueness empathy, as additional factors are considered, and allowing for the possibility that both may exist simultaneously. Consider the designs of the young women of the hit *Frozen* films

from Disney. Their eyes enlarged to maximum engorgement, their noses reduced to a bizarre, bridgeless button (with the distorted proportions most clear in profile), their heads shaped like babies', their necks pencil thin, and yet this cartoon abstraction (which looks much more appealing in their 2D concept art) is rendered in 3D with realistically detailed hair and texture. These designs truly walk the line between cute and grotesque.

Why are the "memoji" (personalized emoji heads that express different attitudes for text messaging) designs available to the user on the Apple iOS platform relegated to cute, child-like head shapes with big, expressive eyes in a similar design style popularized in the aforementioned Disney film? Do adults really want to portray themselves as these childlike avatars? Why is the range so limited, from cute, to cuter, instead of any more flexible choices that may seem to mature the emoji head? The designs are intentionally using the manipulative power of cuteness to disarm and promote engagement, as well as the transformative power of masks to transform the users into a more abstract mental state of emotions. No one wants to see their own, photoreal face portraying emotions as stickers in a messaging app because the detailed realism has too much specificity, baggage, and potential for subtext to each facial expression. A cute cartoon does a better job sending a purer distillation of emotional messages.

Transformation of the body is deeply rooted in the human psyche as we all transform from birth to death: the human has core relationships to the transformational journey of life and has explained the origins and natural phenomena of our physical forms by creating stories of gods and afterlife.

The use of masks in ritual is an ancient human practice and scholars have studied the transformative power of masks, as they literally transform the self. "The head and face, whether human or animal, are powerful symbols of identity and persona because they figure so prominently in the differentiation of self." [Merrill 2004] Relating with a character or playing with an avatar are the modern extensions of this universal human practice. These related human experiences feed a universal curiosity and desire to become someone else in order to experience as well as escape, and the mask, whether it be an animated character, virtual avatar or emoji sent in a message to represent the self, becomes an extension of the self. Masks are iconic as they draw upon dimensions or extensions of their objects to signal their representation. [Pollock 1995]

For millennia humans mainly had the power of storytelling, mostly through oral traditions, to use their imagination to have transformative experiences. (Art, religious ceremony,

and psychoactive substances also had their roles.) Now people have the power to play and watch stories on screens, and immerse themselves in worlds where they may act in the first person as a different character, a form of transformation and escape from the physical body that otherwise offers no escape other than death. Thus the appeal of transference of mind into a character, becoming another, has a core appeal to the human brain that has used stories as the main way of understanding the world. Measuring the appeal of a character for suitability of transformational personification along a graph is difficult, as people are capable of becoming attached to and imagining being a variety of human and nonhuman characters. People also wish to see themselves in characters that are meaningful to them, as do creators, so many of the ways that people will find meaningful connection to characters will be highly individual.

It is the fantasy of experiencing life through another, perhaps more fantastic being, that drives engagement in many stories, movies, and interactive experiences. Participants in the Furry Fandom are individuals who center their imaginative play around the concept of characters that are suitable for identifying and empathizing with on a transformational level. These are fans of anthropomorphic characters, generally animals, who may create a personal character that represents them, or for a subset, may wear a full body costume of the same. The transformational power of masking drives this behavior, as many of these individuals feel that "they had something that made them different and ill-fitting in mainstream society, such as Asperger's syndrome or a facial tic. They found some aspect of childhood, such as cartoon characters or stuffed animals, to be comforting, and this appreciation continued on into their adult lives. The fandom gave them a safe venue in which to express themselves and to feel accepted by others who feel similarly." [Soh et al., 2014] This group is interesting to study, as it is less of a fandom of a particular book series or film, and instead a fandom of a concept, and so it is largely centered around original characters generated by the fan/artists themselves, which reveal a tendency towards the fantastic.

Moving character creators might consider this universal human interest in transformation through "masking" (or stories, or costuming, or use of avatars) when designing. One way to chart existing characters' suitability for empathy and transformation might be by charting a scale of their relative mundanity to the fantastic, as one of the typical ways that people engage with characters is a desire for the idealized, or fantastic. This is informally observable by counting the amount of mundane versus fantastic creations that users themselves generate when designing

their own avatar in online worlds such as *Second Life*, or in *VR Chat*, where the majority by far are idealized and model-like in appearance at least, and beyond, presenting in a variety of fantastic forms including animals, objects, and monsters.

Mundanity then, could be defined by its relation to the real, observable, everyday world that we exist in day to day. The mundane character might be a realistic looking man or woman, dressed in typical clothes, doing typical things, acting in contextually expected ways. It should be stated that the mundanity of a character does not mean that the character is good or bad, well or poorly designed, or will tend to inspire empathy or boredom. There is much more to a moving character's effect on an audience, or user, than simply whether they are a mailman or a magical wizard. In fact the everyman, sort of boring, average guy is exactly the type so often designed as the hero, then thrust into a fantastic scenario or world as the core ingredients of major films (see the mundane human hero of Pixar's *Ratatouille*, for example.)

Fantasticness then, would be the character's relation to the extraordinary. Through the above discussion of the universal human trauma of our body's constant transformation, the transformative psychological power of masks, and the desire to escape the reality of this world (i.e. mortality), it follows that people desire to escape through fantasy, and the fantastic nature of stories and narratives, as humankind has for millenia. Further the discussion noted that we are only a century into experiencing the modern marvel of moving pictures, and just decades into the ability to interactively play with animated characters in games, and with avatars, and other people also "masked" as avatars, with the technology multiplying in complexity and immersive believability constantly, and so, the public at large has only had this immense power to realize fantasy at their fingertips in any believable form for just several years at the time of this writing in 2022. At the dawn of such an intensely imaginative and transformative technology with the power to immerse a user, it is useful to consider this very question of why people might enjoy escaping into these fantastic worlds.

The recent example of Meta's billion-dollar Metaverse rollout being met with derision in general may have been avoided if they considered these psychological factors of why humans

may want to go to the trouble of putting on a headset and running a specific program for virtual reality: the answer is not for business meetings with bland, legless icons of your coworkers.

In conclusion, the context of the character usage and the intention of its purpose should drive the design process, and while there is a wide variety of effective choices to be made along the spectrums described above, there are clusters of typical choices made among the majority of relatively successful character usages which can inform new designs that either intend to follow or attempt to buck the trend. Through this literature review, and small experiments in categorizing existing characters along the proposed scales of measurement, new connections have been made in thinking about character design holistically. Beyond merely exploring the concept of cuteness or the popularized theory of the uncanny valley, for example, this broader thinking about moving character design practice attempts to connect the psychology behind our empathy with characters and how their forms and details may affect the degree of this empathy. There is no formula to record here that will create the ultimate character design for every purpose, indeed, the subjectiveness of the process defies establishing absolutes. Instead the questions asked here will serve to inform the process of design by reminding creators to ask themselves not just who and what their characters are but additionally how and why their intended audience may engage with their creations.

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