

# The General Psychologist

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## Diverse Brains

*Morton Ann Gernsbacher, PhD*

2014 Ernest R. Hilgard's Award Lecture



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What a great era it is to be involved in brain research, because the public loves brains. From just the books that are sold on Amazon.com, you can learn how to Use Your Brain (Amen, 2013), Use Both Sides Of Your Brain (Buzan, 1991), and Challenge Your Brain (Tuller & Rios, 2005). You can also find out how to Boost Your Brain's Power (Pasinski, & Neporent, 2012), Feed Your Brain (McCleary, 2011), Power Up Your Brain (Perimutter, 2012), even Beef Up Your Brain (Noir, 2009). But just remember: You Are Not Your Brain (Schwartz, & Gladding, 2012).

However, if you want to, you can Change Your Brain, indeed, Change Your Brain To Change Your Body (Amen, 2010). You can Save Your Brain (Nussbaum, 2010), Rewire Your Brain (Arden, 2010), and more specifically, Rewire Your Brain For Love (Lucas, 2013). You can Educate Your Brain (Brown, 2012), Entertain Your Brain (Stickels, Harris, & Christin, 2007), Stress Proof Your Brain (Hanson, 2010), Evolve Your Brain (Dispenza, 2008), Unchain Your Brain (Amen & Smith, 2010), even Outsmart Your Brain (Reynolds, 2004).

But Don't Check Your Brains At The Door! (McDowell & Hostetler, 2011), because you need to Train Your Brain about food (Hughes, 2012), Train Your Brain For Success (Seip, 2012), Train Your Brain For Wealth, Prosperity, and

Financial Security (Aubele, 2011), Train Your Brain the Green Beret Way (Martel, 2012), and Train Your Brain More (Kawashima, 2008). If all of this is confusing, you are in luck because Amazon also sells a Training Your Brain for Dummies manual (Alloway, 2011).

These book titles illustrate just how much the public wants to read about anything to do with the brain. Journalists are also aware of our passion for reading about the brain. Riffing off the 1980s Public Service Announcement, "This is your brain. This is your brain on drugs" (Suddath, 2009), we now have a whole slew of articles, proclaiming "This is your brain. This is your brain on love" (Popular Science, n.d.).

A few years ago, the New York Times offered us "Your Brain on Computers" (2010) and followed that offering with "Your Brain on E-Books and Smartphone Apps" (Bilton, 2012). TIME Magazine offered us "Your Brain on Laughter" (Szalavitz, 2013); NPR offered us "Your Brain on God" (2009) and Psychology Today, "Your Brain on Food" (Wenk, 2010). Even TED conferences got into the act, with "Your Brain on Improv" (Limb, 2010).

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Websites are also honed into our love of the brain, and they seem to be mining the 'your-brain-on' meme for click bait. For example, Mashable.com, which covers social media, lured readers with the headline, "My Brain on YouTube" (Erickson, 2012). For the Scholastic Corporation, it was "Your Brain on Reading" (Cunningham & Rose, n.d.). For a website called The Credits, "Your Brain on the Movies" (Nuwer, 2013), and from Coupons.com, "Your Brains on Coupons" (Pavini, 2012).

During the 2012 election cycle, there was great interest in your brain on politics. A Science Daily press release claimed that, "Neuroscience reveals brain differences between Democrats and Republicans" (University of South Carolina, 2012). A research study described in USA Today claimed that brain differences can be found based on faith (Shimron, 2011). A study reported in PositScience claimed brain differences between morning people and night owls (Fitzgerald, 2012).

In my presentation, I outlined when, we as scientists, should accentuate brain differences, and when we probably should resist doing so; why we, as individuals, should accept the brain differences that truly exist; and, how, we as a society, can accommodate those brain differences.

### Scientists Should Resist Over-Hyping Brain Differences

I began my presentation by focusing on an area of putative diversity that has held popular mystique for centuries: the potential differences between male versus female brains. A 2007 issue of Scientific American (Halpern et al., 2007b), to which I contributed, was based on a juried review of scientific evidence that we had previously published in the APS journal, Psychological Science in the Public Interest (Halpern et al., 2007a). The starting point for our scholarly review was the stereotypic assumption that men's brains are best suited for analytical careers, such as being math and science professors at Harvard (Summers, 2005).

In another APS journal, Current Directions, author Cordelia Fine (2010), had reminded the public that centuries before our

current stable of high-tech brain imaging tools, such as MRI scanners, other tools were used to identify brain differences, such as scales. In the Victorian era, the 'missing five ounces,' the difference in weight between the average male and female brain, was considered the source of women's intellectual inferiority.

On average, female brains still weigh less (Ruigrok et al., 2014), and, on average, a female brain has a thicker cortex, which is the outermost sheet of neural tissue (Im et al., 2008; Luders et al., 2006; Preul et al., 2006; Sowell et al., 2007). But, these days, most neuroscientists no longer interpret the fact that women have thicker cortices than men – or conversely, that men have thinner cortices than women – as a deficit. It is simply a difference. However, such a progressive interpretation of difference as diversity rather than different as always deficient does not extend to all other groups.

As I reviewed in one of my APS Presidential columns (Gernsbacher, 2007b), when one research study reported that autistic persons have thicker cortices than non-autistic persons, the finding was interpreted as an autistic deficit (Hardan et al., 2006). When other research studies reported the opposite finding, autistic persons have thinner cortices, that finding was also interpreted as an autistic deficit (Chung et al., 2005; Hadjikhani et al., 2006). In neither case, was the effect size larger than what is observed between average males and females, but such heads you lose, and tails you also lose interpretations that pervade the neuroimaging-of-autism literature (Gernsbacher, 2006; 2007a; 2010).

Indeed, a few years ago, one of my PhD students, Jennifer Stevenson examined all of the autism-related neuroimaging studies in the literature at that time. The list included 36 studies with data on the cerebellum; 32 studies with data on the Superior Temporal Gyrus and Sulcus; 30 studies with data on the inferior frontal gyrus; 29 studies with data on the amygdala; 27 studies with data on the fusiform gyrus; 24 on the striatum; another 24 on the cingulate gyrus; and another 24 on the hippocampus.

To make a long story of meta-analyses short, for none of these brain regions was there a consistent pattern of results across

studies. There were inconsistent findings among the functional imaging studies; there were inconsistent findings among the structural, volumetric, imaging studies. Not one brain region showed a consistent pattern across studies. But, whenever a difference between autistic and non-autistic participants was reported, even if the direction of the difference conflicted with the finding of another study, the difference was always interpreted as an autistic deficit.

For example, among studies examining the volume of the hippocampus, six studies reported that autistic participants had larger hippocampi than non-autistic participants. In each of those six studies, the autistic participants' larger hippocampi were interpreted as an autistic deficit. Another three studies reported just the opposite: that autistic participants had smaller hippocampi than non-autistic participants. In each of these studies, the autistic participants' smaller hippocampi were also interpreted as a deficit. Another study reported no difference between autistic and non-autistic participants' hippocampi. This study suggested that it must be other brain regions that are to blame for autistic participants' deficits.

As another example, among studies examining task-related functional activation in the superior temporal sulcus or gyrus, nine studies reported that autistic participants produced greater task-related activation, and that greater activation was interpreted as an autistic deficit. Another seven studies reported just the opposite – that autistic participants produced less task-related activation, and that was considered a deficit. And two other studies split the difference.

As a third example, among studies examining task-related functional activation in the amygdala. Five studies reported that autistic participants produced greater task-related activation, and that was a deficit. Three studies reported less activation, and that was a deficit. And seven studies found no difference between autistic and non-autistic participants, with some of these studies suggesting that the autistic participants must have been 'compensating for there to be no differences.

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Inconsistency characterized all the brain regions that Jennifer Stevenson reviewed. Such inconsistencies might be due to methodological pitfalls that can befall cognitive and affective neuroscience, for example, small sample sizes and what's known as p-hacking. Indeed, in research made possible by the Simons Foundation, Haar et al. (2014) drew similar conclusions.

Examining a collection of neuroimaging data from nearly a thousand autistic and non-autistic participants, made possible by Autism Brain Imaging Data Exchange, and motivated by the fact that previous findings "have not been replicated consistently in the literature" most likely due to "small samples of participants," Haar et al. (2014, p. 1, 9) found "no evidence for between-group differences in any measures of gross anatomy or in specific brain regions including the amygdala, hippocampus, most segments of the cerebral cortex, and the cerebellum".

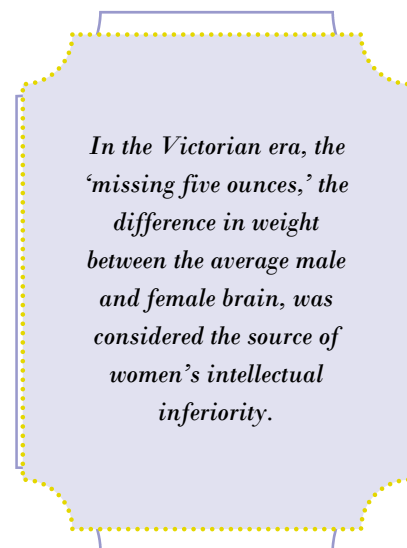
However, in all the previous, less-powered studies, whenever a difference was observed, regardless of whether it was consistent with the previous literature or not, the difference was always attributed to an autistic deficit. Similarly, a few years ago in the APS journal *Perspectives on Psychological Science*, I reviewed the evidence for whether mirror neuron dysfunction underlies autism (Gallese, Gernsbacher, Heyes, Hickok, & Iacoboni, 2011). This body of data was also riddled with inconsistencies.

For example, one study measured autistic and non-autistic participants' brain activity during imitation and reported that autistic participants demonstrated greater task-related activity in the inferior parietal region. That greater task-related activity was interpreted as evidence that autistic persons have broken mirror neurons (Williams et al., 2006). But another study, also using an imitation task, reported that autistic participants demonstrated less task-related activity in the inferior parietal region, and that finding was also interpreted as evidence that autistic persons have broken mirror neurons (Dapretto et al., 2006).

I think we as neuroscientists can do better; I think we can be more sophisticated when we conceptualize diverse brains. Attributing every difference, regardless of the direction of the effect, to a minority group's deficit is cheap – and boring. A considerably more fruitful, approach has been demonstrated by an exciting series of neuroimaging studies of blind individuals (Bedny, Pascual-Leone, Dravida, & Saxe, 2012; Bedny, Pascual-Leone,

Dodell-Feder, Fedorenko, & Saxe, 2011; Burton, Snyder, Diamond, & Raichle, 2002; Ofan & Zohary, 2007; Röeder, Stock, Bien, Neville, & Rösler, 2002; Watkins et al., 2012).

Although the brain is not nearly as regionally functional as our color-coded schematics lead us to believe, some of the most explicit functional specificity is found in the lobe farthest to the back, the occipital lobe. In sighted people, the occipital lobe shows strong specificity for processing visual infor-



mation. But what about blind people, particularly people like Stevie Wonder, who have been blind since birth? If the occipital lobe's usual job is to handle visual processing, what do the occipital lobes of blind people do?

It would be boring and rather foolish to give blind people a bunch of visual stimuli, and when the blind participants' occipital lobes showed less task-related activity than that of sighted participants, pop the champagne, write up the study, and conclude that one has found a blind deficit. A more interesting approach is to investigate what type stimuli the occipital lobes of congenitally blind persons do respond to, and several recent neuroimaging studies have done just that.

These studies show that the brains of blind people are amazingly flexible organs. They take that prime brain real estate known as the occipital lobe, and they use it for other functions, like higher-order reasoning, judgment and decision-making, and spoken language comprehension. From my vantage point, that discovery provides a stellar model for how we as neuroscientists can more fruitfully go about studying brain differences. Similarly fruitful models have also been demonstrated recently by developmental psychologists who study children with disabilities other than autism.

For example, Susan Goldin-Meadow has demonstrated a masterful approach to studying deaf children (2003). Most compelling to Susan Goldin-Meadow are deaf children who neither are exposed to a spoken language, because they are deaf and cannot hear a spoken language, nor are these children exposed to a signed language, because their hearing parents resist using it. These deaf children develop what is known as home sign, a unique gesture system, which does not resemble their hearing parents' gestures. Rather, deaf children's home signs resemble other deaf children's home signs – even deaf children halfway around the world.

Thus, instead of describing deaf children as having a deficit in learning their parents' spoken language, and instead of describing deaf children as having a deficit in learning their speaking parents' gestures, Susan Goldin-Meadow describes deaf children's home signing as a masterful demonstration of their cleverness. Susan Goldin-Meadow appreciates that deaf children's home signing can provide an informative window into the resilience of human communication.

Another example of a more fruitful model for how to study differences without calling everything a deficit is represented by Miguel Perez-Perera and Gina Conti-Ramsden's book analyzing *Language Development and Social Interaction in Blind Children* (1999). As one of this book's reviewers notes: "This book summarizes and discusses the existing and very often conflicting literature and concludes that blind children's language development is not just a slower version of 'normal' development. Rather, blind children's language acquisition follows a different route" (Schleef, 2002, p. 589). A different route, not a deficit route.

Members of another minority have also witnessed a progression from their neuroanatomy and behavior being defined as a deficit to simply a difference. I am referring to left-handers. In the 19th-century, left-handedness was considered extremely pathologic (Kushner, 2011; 2013); it was assumed to be an indicator of primitivism, savagery, possession by the devil, and criminality, hence the term, sinister (Goodman, 2014).

By the middle of the 20th century, some of the cruelest of those assumptions had attenuated, at least in Western societies. As developmental psychologist Gertrude Hildreth reported in 1949, parents had become a bit more willing to accept that their left-handed children must have been, presaging the words of Lady Gaga, "born that way" (Hildreth, 1949, p. 213).

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Nonetheless, when over 100 upper-middle class parents were asked whether they would prefer that their child be right-handed, all but 2% of the parents indicated a preference for right-handed children. Similarly, when parents were asked if their child showed a left-handed tendency would they make the child shift to the right hand, nearly three fourths of parents said yes. And when parents were asked if their child showed a left-handed tendency would they help him become a better left-hander, only a minority of parents said that they would (Hildreth, 1949).

Times have changed, and in Western societies, attitudes toward left-handedness now epitomize the United Nations Convention on the Rights of Persons with Disabilities, which prescribes "respect for difference and acceptance of persons with disabilities as part of human diversity and humanity," which led me to the second part of my presentation.

#### Individuals Should Accept Their Brain Differences

I described a bountiful literature of behavioral studies, because these studies empirically document the robust, positive effects of accepting disability as diversity. The statement "It is important for me to accept myself as I am" is one of the key items on the Acceptance of Disability Scale, which was constructed over 40 years ago, and has been used in numerous research studies around the world (Linkowski, 1971). The Acceptance of Disability scale also includes other items, such as "I feel ok talking about my disability with others," "There are more important things in life than those my disability prevents me from doing," and "Because of my disability, I have a lot to offer other people."

As with most psychological scales, the Acceptance of Disability Scale comprises both positively scored items, like these items, for which acceptance of disability is indicated by a person's agreement with the item, and negatively scored items, such as "My disability affects aspects of my life that I care the most about," "My disability prevents me from doing the things I want to do," and "My disability has disrupted my life greatly." For these items, agreeing with the statement indicates a lack of acceptance of disability.

Using the Acceptance of Disability Scale, and other measures like it, a wealth of scientific data has been collected from persons of all ages, with various disabilities, in numerous countries. Unlike the morass of inconsistent brain imaging data, the body of data on acceptance of disability is remarkably consistent. Each study demonstrates a positive association between acceptance of disability and positive psychological states.

For example, one large-scale study of nearly 1300 individuals in the U.S, with a wide range of various disabilities, demonstrates that disabled persons' acceptance of their disability is highly and positively correlated with their self-esteem (Li & Moore, 1998). The more the individuals accept their disability, the more positive their self-esteem. This strong positive relation between acceptance of disability and self-esteem, for persons with disabilities, is independent of the person's gender, race, level of education, or marital status, and it is only weakly a function of whether the person has multiple disabilities or just one (see also Belgrave, 1991; Heineemann & Shontz, 1982; Linkowski & Dunn, 1974; Starr & Heiserman, 1977).

Other studies measuring acceptance of disability demonstrate a related, positive effect. Persons who accept their disabilities have better psychological well-being, as demonstrated in a U.S. study of nearly 120 Polio Survivors (Tate et al., 1994) and a Belgian study of nearly 100 individuals with Chronic Fatigue Syndrome (Van Damme, Crombez, Van Houdenhove, Mariman, & Michielsen, 2006). A Dutch study of nearly 600 persons with Spinal Cord Injury also demonstrates a strong, positive correlation between acceptance of disability and psychological well-being (Wollaars, Post, van Asbeck, & Brand, 2007).

This Dutch study, as well as a Thai study (Attawong & Kovindha, 2005), and an Australian study (Snead & Davis, 2002) with persons with Acquired Brain Injury, also illustrate another important principle: Acceptance of disability is frequently independent of severity of disability. There are individuals with severe spinal cord or brain injury who fully accept their disability and reap those positive benefits of acceptance. And there are individuals with much milder injury who resist accepting their disability and therefore, they miss out on the benefits of acceptance.

Independence between acceptance of disability and severity of disability has also been shown in a Polish study of 115 persons with chronic lower back pain (Janowski, Steuden, & Kurylowicz, 2010) and a U.S. study of 50 persons with pain from a spinal cord injury (Summers, Rapoff, Varghese, Porter, & Palmer, 1991).

Multiple studies also demonstrate that quality of life for persons with disabilities is also independent of the severity of the person's disability. For example, a British study of nearly 50 adults who were disabled by prenatal exposure to thalidomide demonstrates that their quality of life is independent of the severity of their disability (Bent, Tenant, Neumann, & Chamberlain, 2007).

In this British study, severity of disability was precisely determined because of the long-term financial compensation provided by the UK Thalidomide Trust. There were individuals with severe levels of impairment due to their exposure to thalidomide as well as individuals with only minor levels of impairment. A U.S. study of nearly 100 adults with Parkinson's also demonstrates that quality of life is independent of degree of or severity of disability (Gruber-Baldini, Ye, Anderson, & Shulman, 2009). Rather, the primary predictor of quality of life was the person's optimism.

All the studies that I reviewed pertain to individuals themselves accepting their own disability and reaping positive effects on their own self-esteem and their own quality of life. But frequently I am asked to speak to parents of children with disabilities, perhaps because in addition to being a researcher in this field, I too am a parent of an offspring with a disability.

An area in which parents are deeply interested, particularly parents of children with disabilities, is stress. And the data could not be clearer that for parents of children with a wide range of disabilities and medical conditions, parents' stress is not related to objective measures of their children's impairments. That is, parents' stress is not a function of, it is independent of, the severity of their children's disabilities.

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For example, in a US study of nearly 100 parents of children with congenital heart disease, parents' subjectively reported stress was unrelated to objective measures of their child's illness, including the number of hospitalizations, operations, catheterizations, outpatient visits, or a cardiologist's independent rating of the severity of the child's illness (DeMaso et al., 1991). In a Canadian study of 53 mothers of children with intractable epilepsy, parents' subjectively reported stress was unrelated to seizure type, seizure frequency, number of failed treatments and surgeries (Wirrell, Wood, Hamiwka, & Sherman, 2008).

In a US study of 63 parents of children with intellectual disability, parents' subjectively reported stress was unrelated to objective measures of their children's functioning levels, for instance, whether their children were so-called high functioning or low functioning (Guralnick, Hammond, Neville, & Connor, 2008). For 70 Taiwanese parents of children with Duchenne muscular dystrophy (Chen & Clark, 2007), and for 270 US parents of children with cerebral palsy (Manuel, Naughton, Balkrishnan, Smith, & Koman, 2003), parents' subjectively reported stress was unrelated to objective measures of their children's disability.

The same, highly consistent pattern has been shown for the disability of autism. Although parents of autistic children sometimes report experiencing even more stress than parents of children with other disabilities, parents' stress is unrelated to every objective measure of autism. Parents' stress is unrelated to their autistic children's level of social interaction (Davis & Carter, 2008), receptive and expressive language (Davis & Carter, 2008; Kasari & Sigman, 1997), IQ and cognitive abilities (Baker-Ericzen et al., 2005; Bishop, Richler, Cain, & Lord, 2007; Kasari & Sigman, 1997), and even the degree of or severity of their children's objectively measured autistic traits (Baker-Ericzen et al., 2005; Davis & Carter, 2008; Epstein et al., 2008).

In contrast to objective measures of impairment, for children with autism, and for children with other disabilities, their parents' stress is related to parents' subjective judgments of their children's impairments. The more stress the parents feel, the more impaired they judge their children to be (Arnaud et al., 2008; Beck et al., 2004; Benson et al., 2006; Benson & Karlof, 2009; Ekas & Whitman, 2011; Georgiades et al., 2011; Kasari & Sigman, 1997).

Given the powerful role of affect on per-

ception, the strong relation between parents' subjectively reported stress and their subjective evaluations of their children's abilities and disabilities is not surprising. But the strong relation between parents' subjectively reported stress and their subjective evaluations of their children's abilities should throw caution to any researcher who relies on parent report for any aspect of assessment in their studies.

*The United Nations prescribes "respect for difference and acceptance of persons with disabilities as part of human diversity and humanity."*

If parents' stress is not a function of how disabled their children are, at least not as objectively measured, then what can attenuate parents' stress? In collaboration with fellow University of Wisconsin Psychology professor, Hill Goldsmith, and former graduate student Emily Schweigert, we investigated whether parents' acceptance of their children's disabilities attenuated those parents' subjective levels of stress. The disability we worked with was autism, and we modified items from the Acceptance of Disability Scale (Linkowski, 1971).

For example, rather than parents responding to the item, "It is important for me to accept myself as I am," we asked them to respond to the item, "It is important for me to accept my child with autism as they are." Rather than "My disability prevents me from doing the things I want to do," the item was stated as, "My child's autism prevents me from doing the things I want to do." Rather than "My disability affects aspects of my life that I care the most about," the item was "My child's autism affects aspects of my life that I care the most about." And rather than "Because of my disability, I have a lot to offer other people," "Because my child has autism, they have a lot to offer other people."

Our participants were parents of twins, one or both of whom were objectively diagnosed as autistic. In this way, we could investigate whether parents' stress was compounded by having two children with autism. It was not. In fact, as countless other studies have shown,

parents' subjectively reported stress was not related to any objective measure of their children's disabilities – even, as our study demonstrated, when those disabilities were doubled. Rather, parents' subjectively reported stress was solely a function of their acceptance of their children's disabilities.

By acceptance, I surely do not mean doing nothing. Indeed, the parents, in our study, who scored high on acceptance of their children's disability reported enrolling their children in just as many conventional therapies as the parents who scored low on acceptance.

But the parents in our study who scored high on acceptance of disability, as well as persons with disabilities who score high on acceptance of disability, are adept at reframing their situation (Gerber, Reiff, & Ginsberg, 1996; Hastings, Allen, McDermott, & Still, 2002; King et al., 2006). Reframing is the art of stepping back from the current frame or lens through which one is viewing a situation, reconsidering that frame, and reconstructing a new frame, as the adage recommends: "Life may not be the party we hoped for. But while we're here we should dance."

Reframing is illustrated by a flyer from the Canadian Association for Community Living: Superimposed over a full-page photo of a school-age boy with Down syndrome, the caption reads, "Chances are he'll never cure cancer, walk on the moon, or be Prime Minister. Then again, neither will you."

Reframing is also illustrated by a case study of a pair of identical twins who were raised apart (Neubauer & Neubauer, 1996). That is, through adoption, each twin was raised in a different family. When one of the adoptive mothers was asked if her adopted child was a picky eater, the mother responded with frustration, consternation, and exasperation, saying something akin to, "Oh! My goodness, yes!" She is such a picky eater! She won't eat anything unless – unless – I put cinnamon on it. She wants to have cinnamon on everything she eats. It's bizarre, and it tries my patience on a daily basis."

When the adoptive mother of this child's identical co-twin was asked the same question about her adopted daughter's eating habits, she responded calmly and evenly, with a response such as, "No, she's not a very picky eater at all. In fact, she's a great little eater, with a very healthy appetite. I bet she'd eat just about anything — well, just as long as I put some cinnamon on it." This cinnamon anecdote illustrates the heart and soul of the concept of accommodation, which is the last topic I spoke about.

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#### Society Should Accommodate Brain Differences

Accommodation is key to supporting disability and enabling the diversity that disability affords. We can classify accommodations into two broad categories. There are accommodations such as curb cuts, which were initially established to level the playing ground – literally level the playing ground – for one minority group, namely persons with mobility disabilities. But in reality, although curb cuts have been incredibly important for improving the mobility of wheelchair users and scooter users, look at any street corner, and you'll see that the overwhelmingly vast majority of persons who benefit from curb cuts are not persons with disabilities, but rather bicyclists, people pushing strollers, and people pushing dollies.

Similarly, closed captions have been incredibly important for improving access to entertainment and education for deaf and hard of hearing people. But the majority of people who benefit from captions are not deaf or hard of hearing. Rather, the majority of people who benefit from captions are hearing people – and not just hearing people at bars, airports, or work cubicles who want to watch YouTube without getting caught by their boss.

Numerous studies show that captions increase literacy skills for hearing children learning to read (Linebarger, 2001; Linebarger, Piotrowski, & Greenwood, 2010). Other studies show that captions increase language comprehension skills for hearing persons learning a second language (Garza, 1991; Neuman, & Koskinen, 1992). And still other studies show that captions increase language comprehension and memory for hearing people of all ages (Bean & Wilson, 1989; Griffin & Dumesire, 1993; Kruger & Steyn, 2013).

Indeed, every study ever conducted demonstrates that captions are beneficial to a wide range of hearing people because bimodal redundancy almost always trumps unimodal presentation (Bird & Williams, 2002; Hinkin, Harris, & Miranda, 2014).

In contrast to accommodations like captions and curb cuts, which although implemented initially to aid only disabled people are now used predominantly by non-disabled

people, are accommodations that remain specific to a disability, such as Braille for blind people and sign language for deaf and hard of

*Accommodation is the key to supporting diversity; without accommodation we cannot level the playing field for our diverse society.*

hearing people. Accommodations, like Braille and sign language that remain specific to disability groups are often, still shrouded, in stigma.

A prime example of the stigma that still surrounds disability-specific accommodations is provided by hearing aids. A 2014 article on the Mayo Clinic's website provides potential hearing aid consumers with the following advice: "Perhaps you've thought about getting a hearing aid, but you're worried about how it will look." The article explains: "All hearing aids contain the same parts to carry sound from the environment into your ear. However, hearing aids ... differ in size ... Some are small enough to fit inside your ear canal, making them almost invisible."

The Mayo Clinic article further explains that in general, the smaller a hearing aid is, the less powerful it is, the shorter its battery life, the harder it is to use, and the more it will cost. Yet, that is what the Mayo Clinic, as well as every other hearing aid website I have perused, assumes that consumers prioritize: the least visible hearing aid. Can't we, as a society, agree to not be prejudiced about the visibility of a person's hearing aid? I think we can, given the strides, all puns intended, that we as a society have made in overcoming prejudice

about the form of prosthetic limbs.

For centuries, the overarching goal was to create a prosthetic that most closely resembled a flesh limb. But prosthetics that prioritized the superficial aspects of a flesh limb, were bulky, often quite uncomfortable, and not very functional (Oatman-Stanford, 2012). We now prize function over form.

Indeed, some prosthetic wearers like Dan Horkey, who runs a business creating "prosthetic tattoo art" want their prosthetics to be noticed. After avoiding showing his prosthetic for two decades, decorating it was a way to be proud of it, Horkey said. "It was instant – it just made me feel good. When I walked around in public, people wouldn't look away and avoid eye contact. Instead it would provoke compliments. I was proud of my leg for the first time" (Perez, 2013). Kiera Roche wears a floral prosthetic leg, sculpted by hand, because "it's personal, it's a fashion statement" (Schweitzer, 2012).

Speaking of fashion brought me to clothing tags. For years, persons like me, persons with enhanced tactile sensitivity, what diagnosticians call "sensory defensiveness," told garment producers that clothing tags were annoying (Goldsmith, van Hulle, Arneson, Schreiber, & Gernsbacher, 2006). For such persons, our only recourse was to perform meticulous apparel surgery, being careful to remove each offending tag without creating a hole in its garment. But a few years ago, clothing manufacturers finally listened to this neural minority of consumers, and guess what they learned? Like curb cuts and captions, it is not only a minority of people who benefit from the accommodation, it is a lot of people (Murphy, 2011).

Lastly, I turned to discuss one more accommodation, quite familiar to those of us on university campuses. As chair of my University's Committee on Access and Accommodation in Instruction, I have received a lot of boots on the ground experience with regard to accommodating diverse brains. The most frequently requested accommodation made by students at my university is not Braille or sign language, which is not surprising, because the most frequent disability among students at my university, and most other universities, is not visual or hearing disabilities.

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Indeed, at my university, students with vision disabilities comprise less than 2% of the population of students with disabilities. And students with hearing disabilities comprise less than 3%, as do students with the disability of autism. Students with mobility disabilities comprise 7% and students with chronic health disabilities comprise 13%. The highest frequency disabilities on my university campus and other campuses are learning disabilities, such as dyslexia and ADHD, and the most frequent disabilities are psychological disabilities, such as anxiety and depression.

Therefore, it is not surprising that the most frequently requested accommodation is not Braille, not sign language, and not curb cuts. It is extended time on in-class exams and tests, what is often called 'time and a half.' But the terms, extended time and time and a half, are misnomers. When students request extended time or time and a half, what they really want is to take the quiz or exam without the pressure of being timed. From everything we know about the psychometrics of testing, these students are barking up the right tree.

Psychometrically, tests can be classified into speeded tests, which as the name implies, test how rapidly the examinee can complete all of the items, and power tests, which are designed to measure the examinees' power – their skill or knowledge, regardless of speed of performance (Gulliksen, 1950).

Because speeded tests are timed, speeded tests typically contain more items than every examinee can complete during the testing time. Therefore, the number of items completed during a fixed period of time is expected to vary among examinees. In contrast, power tests have no time limit whatsoever. All examinees are allowed as much time as they need. All examinees are not expected to answer correctly all items on a power test, but that is not because they run out of time. Rather it is because they do not know the information.

Most of us who teach on college campuses assume when we administer an in-class test, we are administering a power test, not a speeded test. We assume we are measuring how well the students have learned the material and how skillfully they can apply what they have learned. But if an in-class exam has a stop time, it is by definition a speeded test.

When students request extended time or time and a half, what they are really requesting is not to feel the pressure of time ticking off; not to experience anxiety about running out of time; not to have a power test administered as a speeded test. And just like curb cuts, captions,

and tagless clothes, power tests, that is, tests without time limits, aid everyone.

Numerous studies across all age ranges, indicate that removing time limits not only decreases students' anxiety, but also increases the tests' validity and reliability (Attali, 2005; Elliott & Marquart, 2004; Lovett, 2010; Lu & Sireci, 2007; Scrams, & Schnipke, 1999). A decade ago, the tenth version of the Stanford Achievement Test removed all time limits for all of its subtests. This decision was based on data from 360,000 students (Brooks, Case, & Young, 2004).

Therefore, if you use in-class exams, and you too want to measure power, I have two suggestions: Either allow all students to remain as long as they want to finish every exam, or if that is infeasible, design exams that last no longer than two thirds of a class period, and tell students that. Announce to all students that everyone is welcome to remain for the entire class period, if they so desire. You will be accommodating all students, those with and without disabilities, and you will be increasing the validity and reliability of your exams (Attali, 2005).

Students, use that extra time, to review your answers and change them if you are not sure. Every research study in the literature shows that the majority of changes on tests are from wrong to right, rather than right to wrong (Fischer, Herrmann, & Kopp, 2005; Higham & Gerrard, 2005; Lynch & Smith, 1975; McMorris, DeMers, & Schwarz, 1987; Schwarz, McMorris, & DeMers, 1991; Vispoel, 1998).

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## Diverse Brains

By Morton Ann Gernsbacher, PhD

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