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Brain Biology and Gendered Discourse

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Despite the greater presence of women in the workforce, their organisational experiences remain different from many men's. Most explanations for this difference are based on cultural socialisation or power and dominance. This paper offers the role of brain biology as a missing mediating link explaining the persistence of gendered communication in organisational discourse. The way men and women talk in interactions is mediated by differences in their brain structure, function, and chemistry. This produces gendered communication styles influenced by biology. A biopsychosocial model explains the simultaneous effects that biology, psychology, and socialisation have on each other for understanding gendered discourse style persistence. Following a characterisation of talk, a primer on brain biology is provided in three areas: (1) structure including hemisphere asymmetry, corpus callosum size, and defined brain areas; (2) function including organisation for language and information processing, attention, and emotion; and (3) chemistry, linking each area of brain biology to examples of gendered discourse differences characterising normatively masculine and feminine discourse styles, and a wide-verbal-repertoire style (WVR), used by some men and women. We conclude with implications of brain science for "doing leadership" through discourse in the workplace, in any role, at any organisational level, and the value of such differences.

INTRODUCTION

Organisational neuroscience, an emerging discipline, explores implications of brain science for workplace behavior linking brain research to thoughts, actions, and organisational theory (Becker & Cropanzano, 2010; Becker, Cropanzano, & Sanfey, 2011; Beugré, 2010). With brain-imaging techniques, examining the human brain is possible, helping us understand how it relates to workplace behaviors. Many neural processes are biologically programmed

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for specific, automatic, and relatively inflexible purposes (Lieberman, 2007). This article describes the role of brain biology in mediating communication behavior, a missing perspective in the literature for understanding persistence of gender-preferred styles of organisational discourse. By incorporating brain biology, we contribute to understanding why communication diversity in organisational discourse at all levels of informal and formal workplace leadership will continue.

Differences in gender communication are currently explained through two existing literatures, neither of which is able to account for its surprising persistence over time. One focuses on cultural differences, deficit, or dominance approaches in examining gendered behavior in organisations. The two-culture theory of differences attributes communication variation to socialisation: childrearing, schooling, peers, and social environment. Differences develop in the absence of innate ones transmitted through cultural beliefs and gender stereotypes (Case, 1988; Tannen, 1994). The second approach, power, privilege, and dominance, suggests societal discrimination based on gender, with preferences for male behavior and styles (Case, 1993a). We add a third perspective that has not been linked to gender differences in communication behavior in organisations: the role of brain biology in communication discourse. We draw on evidence supporting claims of sex differences in brain structure, function, and chemistry that not only influence cognitive skills (Ceci & Williams, 2010; Halpern, 2012; Maccoby & Jacklin, 1974) but also language through which leadership is done.

Nearly all studies on leadership and women can be understood as studies of women in relation to power and structures of authority (Heifetz, 2007). Extraordinary numbers of women exercise leadership behaviors without formal authority in organisations. As in Heifetz (2007, p. 318), we see leadership as "an activity that occurs in moments of time, sometimes rarely, but significantly . . . across sectors and eras of a life". In crucial leadership competencies, females outperform males on tests requiring recognition of emotion and relationships among people (Eliot, 2009). Sex differences in empathy emerge in infancy (Geary, 2002), persist throughout development, and are one of the more reliable findings in adults (Eliot, 2009). Other leadership traits are influenced by genetics, explaining 78 per cent of the covariance between leadership role occupancy and transformational leadership behaviors (Li, Arvey, Zhang, & Song, 2012). This work examines a new perspective, "How does brain biology illuminate understanding of persistent gendered discourse styles of leadership at any level of the workplace?" There is too much new biological evidence for sociological arguments of social conditioning and power and dominance to prevail.

New insights in this paper begin with a biopsychosocial model for understanding differences in gendered discourse recognising continuous, inseparable interactions between biology and environment and mutual influences that

biological, psychological, and social variables have on each other (Halpern, 2012). We link features of normatively masculine, normatively feminine, and a wide-verbal-repertoire discourse style (WVR), used by some men and women, to brain structure, function, and chemistry, which has not been done before. In the final section, workplace implications and the value of such differences are discussed.

A BIOPSYCHSOCIAL PERSPECTIVE

Early sex-related individual differences arise through mediating and moderating effects of socialisation on sex hormone-influenced differences or early gene expression in behavioral development. Even if minor, differences may link to persistence of gendered workplace discourse, further impacted by experiences. The stereotype of a leader is overwhelmingly male (Heilman & Eagly, 2008; Koenig, Eagly, Mitchell, & Ristikari, 2011). Gendered discourse, an interactional style with speech gendered as male and female, has a biological component. The psychosocial component regulates gendered behavior. Our explanation for differences in gendered workplace discourse relates to men's historical occupancy of leadership positions, with discourse strategies rooted in brain biology. A biopsychosocial perspective assumes a false nature vs. nurture dichotomy (Halpern, 2012, p. 366). They are inextricably entwined, making it impossible to ascertain independent contributions. The model depicts individuals seeking learning experiences from their environments, influencing interests, directing learning, and altering underlying neural structures in their brains.

If testosterone influences the brain, providing a slight advantage on spatial tasks such as block playing, males look for opportunities to engage in activities that further build these skills. An initially small difference between males and females is now a large one. From a biopsychosocial perspective the same variables are cause and effect. Brain alterations result from different life experiences and genetic propensities affecting future behavior, further influencing brain development. This circular pattern is depicted in a biopsychosocial model where nature and nurture are continuous and inseparable (Figure 1; Halpern, 2012). Similarly with normatively masculine and feminine discourse behaviors, biological and psychosocial variables influence each other enhancing initially small between-sex differences, or reducing initially large sex differences, as displayed in wide-verbal-repertoire speech. This model has not been applied to gendered discourse or workplace leadership behavior.

In Figure 1, thoughts and behaviors emanate from brain activity biologically mediating the environment that individuals experience, altering brain development and hormone secretions. Cultural variables, the social part of

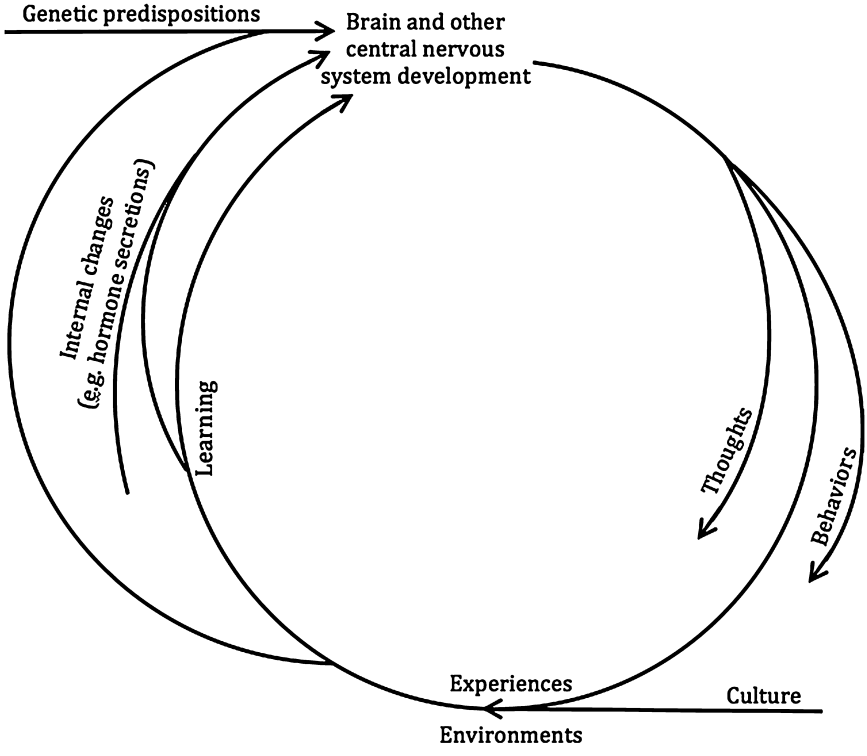

FIGURE 1. Biopsychosocial model from Halpern (2012).

the model, create, reduce, or magnify differences in the brain and other biological systems (Halpern, 2012, p. 16).

We do not believe any single factor explains gendered discourse. Biological factors enmesh with social forces throughout development. Differences begin in infancy (Leveroni & Berenbaum, 1998); are influenced by hormones (Halpern, 2012; Kimura, 2002); and are present across cultures (Geary & DeSoto, 2001). The degree of difference has not changed over four decades despite substantial changes in women's roles and access to higher education (Kimura, 2002). Women now earn the majority of all degrees granted, including 60 per cent of master's and 52 per cent of doctoral degrees (US Department of Education, 2012). Increased workforce participation is one of the most significant changes in Western industrialised nations over the past 50 years. Despite educational parity and equal opportunity laws and policies, management and executive work roles are asymmetric throughout post-industrial nations (Heilman & Eagly, 2008; Koenig et al., 2011). In 2011, 58.1

per cent of women participated in the labor force (US Bureau of Labor Statistics, 2013) with 51 per cent in professional and management-related occupations. Women-owned companies increased to 44 per cent in a single decade (US Department of Commerce, 2010) as did career orientation. Sixty-six per cent of US women rank career success as very important compared to 59 per cent for men (Patten & Parker, 2012).

Cognitive neuroscience research links some gender differences in behavior and cognitive functioning to brain structure and function (Kaiser, Haller, Schmitz, & Nitsch, 2009), suggesting that much happens outside conscious awareness (Becker et al., 2011). Conversely, theories of workplace behavior imply high levels of conscious control over thoughts and actions. Cultural neuroscience builds on the concept of brain neuroplasticity, asserting that human brains have capacity to adjust in response to sociocultural environments over time (Han, Northoff, Vogeley, Wexler, Kitayama, & Varnum, 2013). Neuroplasticity involves learning and experience that alter connections within the brain either reinforcing or weakening, but not eliminating, gender-specific predilections.

LINKING BIOLOGY AND GENDERED DISCOURSE

Although evidence suggests that sex differences in the human brain underlie cognition, we are far from understanding these differences (Halpern, 2012). This area of study has multiple problems and contradictory findings. As suggested, differences attributed to varying life experiences of males and females are always entwined with biology. There is concern that recognition of sex differences in the underlying hardware of human thought will justify discrimination by those wanting to keep women out of nontraditional occupations (Halpern, 2012, p. 247). Suggesting that men are different from women in a range of aptitudes, skills, and abilities appears to betray hard-fought victories for equality of status, opportunity, and respect. But sex differences are not synonymous with sexism; differences are not deficiencies. Average differences within any group of people tell us nothing about individual variability within groups or overlap between groups. The degree of difference in gendered discourse has remained unchanged over four decades. Behavioral and cognitive differences among people are still primarily ascribed to explanations of culture and environment. Genes, heritability, and biological bases are recent explanations for some variance in observed behavior.

Two recent studies examine heritability of leadership role occupancy. Using over 600 pairs of identical and fraternal twins across the studies, genetic factors explained 30–32 per cent of the variance (Arvey, Rotundo, Johnson, Zhang, & McGue, 2006; Arvey, Zhang, Avolio, & Krueger, 2007). The heritability of emergent leadership has also been examined, moderated

by age and gender. Using a sample of 24,994 participants, between 25 and 53 years of age, genetic contributions to leadership emergence were 44 per cent for women and 37 per cent for men with statistically significant differences across women by age, with no age differences for men (Chaturvedi, Zyphur, Arvey, Avolio, & Larsson, 2012). A third study on influence behavior finds subtle differences in male and female neuroendocrine systems, a biological explanation for the use of their different influence strategies (Colarelli, Spranger, & Hechanova, 2006).

In spite of similarity, male and female brains are constructed and work differently in how and what is remembered; information, emotions, and words processed; connections made; and the world experienced (Bremner, Soufer, McCarthy, DeLaney, Staib, Duncan, & Charney, 2001; Hofer, Siedentopf, Ischebeck, Rettenbacher, Verius, Felber, & Wolfgang Fleischhacker, 2007). It is unclear which differences in brain biology link to gendered discourse behavior. We suggest patterns likely to emerge from such differences with sex-differentiated workplace advantages embedded in biology. Empirical verification is needed to understand the respective roles innate predispositions and cultural learning have to discourse.

CHARACTERISATIONS OF TALK

Over the last 40 years a large body of psychological, sociolinguistic, and gender studies research has examined gender discourse with different approaches, frameworks, and methodologies (Ladegaard, 2011; Mullany, 2007). This research finds clear, stable, systematic differences in men's and women's workplace language, with different goals, rules, strategies, preferences, and ways of interpreting talk (Case, 1988, 1993a, 1993b, 1994, 1995; Holmes, 2006a; Ladegaard, 2011; Schnurr, 2009; Tannen, 1994; Wood, 2013). It describes female communication as more indirect, affiliative, and democratic, and male communication as more direct, assertive, and task-oriented. Deborah Tannen (1990) described women's relational language as "rapport talk", whereas male interactions within the hierarchy were called "report talk" (p. 76). This more competitive talk, done mostly by men, and more affiliative talk, done more often by women, exists in today's workplace, although some men use softened language with aspects of the indirect, normatively feminine style (Ladegaard, 2011).

Currently we find more similarities between men and women (Holmes, 2006a; Ladegaard, 2011; Mullany, 2007), with increased use of wide-verbal repertoire speech (Case, 1988, 1993b, 1995; Holmes, 2006a; Ladegaard, 2011; Mullany, 2007). There is more variation within each gender than between them (Holmes, 2006a; Ladegaard, 2011; Mullany, 2007). Nonetheless, there are still differences, even if fewer than in the past (Leaper & Ayres, 2007). Many of these differences appear cross-culturally. People regularly draw on

gendered speech styles displaying behaviors indexed for masculinity and femininity. Even in Denmark where the gender salience has been dramatically reduced in schools, Ladegaard (2011) found meaningful variation in gendered communication at work. When differences do occur, women are more likely than men to use language to connect with others (Leaper & Ayres, 2007).

The characteristics of a normatively feminine affiliative and empathetic speech style and a normatively assertive and competitive masculine speech style are briefly presented. Brain research suggests that the major empathy/aggression difference is wired into people through brain structure, biochemistry, and is impacted by socialisation. Each style persists today with variations across genders and expectations about gender-appropriate ways of talking (Brescoll, 2012; Case, 1993a, 1995; Ladegaard, 2011).

Affiliative Style: Normatively Feminine

Affiliative talk is relational, facilitative, person/process oriented, collaborative, and indirect, a style used by women more than men. Regardless of status, women use communication to foster connection, form bonds, and offer support, understanding, and affirmation. They seek to draw others into conversations, recognising contributions (Leaper & Ayres, 2007). Their discursive style of interaction is inclusive and reciprocal with leadership often shared, uniting the structures of formal and informal authority (Heifetz, 2007). Women are more linguistically polite than men, even when occupying positions of authority (Case, 1988; Mullany, 2007). Status equality is important with high power women adjusting talking time to be identical to low power women and men, equalising status and avoiding backlash (Brescoll, 2012). Emphasising status differences makes them appear arrogant or boastful, negatively impacting relationships.

When Case (1993a, 1995) first identified three styles of speech (feminine, masculine, and wide-verbal repertoire [WVR]), the feminine style used by most women had a 7:1 ratio of female to male speech characteristics. Attention to relational communication, cultivating involvement and accommodation, is often more significant than the content. Showing support and expressing understanding are required. This fits what we describe as normatively feminine and is likely linked to differences in the amygdala and oxytocin.

Assertive Style: Normatively Masculine

In a normatively masculine style, the goal of talk is control, autonomy, and status. Talk is used to prove oneself and negotiate prestige and status in the hierarchy through competition (Wood, 2013). Speech acts attempt to get

TABLE 1
Features of Normatively "Feminine" and "Masculine" Communication Styles

Feminine	*Masculine*
Indirectness	Directness
Facilitative	Competitive
Collaborative	Autonomous
Collegial	Confrontational
Collective sharing	One-upmanship
Talks less	Talks more
Supportive simultaneous talk	Topic changing
Supportive feedback	Disruptive interruptions
Person/process oriented	Task/outcome oriented
Relational practice	Referential practice
Status equalising	Status enhancing
Affiliative	Assertive

another to do something (Mullany, 2007) through influence tactics like pressure, ingratiation, legitimating, and assertiveness (van Knippenberg & Steensma, 2003). Relationships are instrumental to outcome-oriented contributions (Proudford, 2007). Men do not look for social connection through talk as women do. They exhibit knowledge, skills, and abilities with assertive confidence and little self-disclosure. Workplace norms emphasise objectivity, competition, and getting down to business (Holmes, 2006a). Speech is direct, emphasising confrontational or competitive action. Such displays of power and control are traditionally associated with masculinity and leadership (Kathlene, 1995). In the work of Case (1993a, 1995), the masculine style used by men had a 3:1 ratio of male characteristics to female characteristics, likely linked to the amygdala and testosterone.

Behaviorally dominant people, measured by speaking amounts, typically interrupt more and take more speaking time. Men talk more than women (Leaper & Ayres, 2007) with turns lasting one to four times longer (Edelsky, 1993). In all-male groups the man speaking first is usually more verbally assertive than the man speaking last. Few such differences exist in all-female groups, which are more participative with tension-reducing and affiliative language, less arguing, and fewer status distinctions (Colarelli et al., 2006). Exaggerated differences are found in mixed-gender groups. Men talk more than women of similar status in these settings.

Characteristics of frequently cited features of normatively feminine and normatively masculine communication styles are listed in Table 1. These discourse patterns of gendered speech styles provide expectations defining appropriate interactional norms for women's and men's speech in Western societies such as the USA, New Zealand, the UK, Denmark, and Australia.

Such a list simplifies a complex reality, not taking into account age, class, race, contextual factors, or social power that affect speech. It provides a summary of discursive strategies strongly associated with middle-class white men and women.

Wide-Verbal Repertoire: A Communication Shift

When Case (1988) developed the notion of WVR she found three of 20 managers who used this style. They maintained gender-appropriate patterns, while mixing elements of normatively feminine and normatively masculine styles in differing frequencies and proportions (Case, 1993b). Three variations of this style were identified: (a) balanced, the most gender-neutral with close to equal, but slightly more, male to female characteristics, used by a man; (b) extreme, combining selective high usage of previously identified male and female characteristics, used by a man; and (c) mixed, used by a woman, combining discourse structured like that of the more influential men showing confidence and semantic content reflecting empathy, a relational perspective, and personal-context bound orientation. Those using WVR speech were simultaneously assertive and supportive. They demonstrated language flexibility and adaptability to situational needs and tasks demands mixing a range of discourse strategies to assist with achievement of transactional and achievement goals (Case, 1988, 1993b, 1995), although the WVR men and women did this style of speech differently. Holmes, (2006a), Ladegaard (2011), and Mullany (2007) similarly identified a WVR style demonstrating flexibility and adaptability to situations and tasks, used by some men and women.

As WVR men increase collaborative discourse, biting or teasing humor mitigates more feminine discourse characteristics. This enables compliance with masculine discourse norms and practices (Schnurr, 2009), as well as preserving relationships that are important for future interactions (van Knippenberg & Steensma, 2003). Humor expresses male collegiality. Power and authority are maintained through other displays of normatively masculine talk. Far less mitigation is used to soften directives than WVR women use (Mullany, 2007). Nonetheless, both men and women express positive support for others at work, but in different ways.

In general, WVR women use a higher ratio of feminine speech characteristics to masculine ones. They are sophisticated communicators able to adapt to the circumstances of interactions. Power is displayed in subtle ways considering the needs of those with whom they are interacting (Case, 1994; Schnurr, 2009; Wodak, 1997). WVR women use humor to combine displays of authority with consideration of relationships (Holmes, 2006b; Schnurr, 2009).

The WVR speech style may indicate brain changes due to early hormonal influences in utero leading to different brains for men and women on average, and decreased male and female hormones with aging. The brain is most malleable in infants, with continued malleability during childhood (Eliot, 2009). Neuroplasticity from life experiences alters communication within the brain, reinforcing or weakening, but not eliminating, gender predilections, creating, reducing, or magnifying sex differences in the biology of males and females.

BRAIN FRAMING—A BIOLOGICAL APPROACH

All brains are organised similarly, with small, but recognised gender differences in structure, function, and neurochemistry (Baron-Cohen, 2007; Cosgrove, Mazure, & Staley, 2007; Eliot, 2009). These likely impact normal behavior including perception, attitudes, emotions, and communication (Cosgrove et al., 2007). Chromosomes and neurology determine "who you are". Both experiential and social learning impact the brain and behavioral functioning, making it difficult to separate the relative contributions of each.

Knowledge of sex differences in the brain is in its own perinatal period (Halpern, 2012, p. 231). Evidence exists for and against the influence of sex in the makeup of men's and women's brains (Baron-Cohen, 2003, 2007; Bishop & Wahlsten, 1997; Eliot, 2009). Much research on sex differences in adult brains has been replicated involving millions of test subjects in labs around the globe (Eliot, 2009). Important gender differences are subtle, linking power and influence to sex differences in brain structure, function, and chemistry (Colarelli et al., 2006). Experiences produce changes in connections between neurons in the cortex (Hales, 1999), impacting gender expression. The sex differences discussed come from studies examining genes and hormones, multiple activation studies, replicated fMRI studies, and traditional research. Studies of babies and children are used, but most cited differences have been demonstrated on adults. We do not use studies extrapolating results from animal research. Nor do we draw on popularised media commentators of sex differences, promoting larger chasms than likely exist. We believe females and males are mostly similar (Hyde, 2006), with salient brain differences, even if small, which affect normal behavior. What follows provides a primer on brain biology, linking each area (structure, function, chemistry) to examples of gendered discourse differences that characterise normatively masculine and feminine discourse styles.

BRAIN STRUCTURE

Beginning in the late 1970s, research on sex/gender differences in cognitive functions and relations to brain structures focused on three variables (Kaiser

et al., 2009): (1) asymmetries between the left and right hemisphere in anatomy and function (Halpern, 2012); (2) size of the corpus callosum (Steinmetz, Staiger, Schlaug, Huang, & Jäncke, 1995); and (3) extent of defined brain areas (Gur, Gunning-Dixon, Bilker, & Gur, 2002). The importance of sex differences in brain structure is far from being fully understood (Halpern, 2012). Although the male brain has the edge in dealing with things and theorems, the female brain communicates and responds more sensitively to sensory stimuli, connecting and relating information, placing primacy on personal relationships.

Asymmetries between Hemispheres

One subdivision of the ventral frontal cortex (VFC), the area involved in social cognition, interpersonal judgment, and decision-making, is proportionately larger in women. Size positively correlates with interpersonal awareness, including interpretation of nonverbal cues (Wood, Heitmiller, Andreasen, & Nopoulos, 2008), attribution of intentions (Brunet, Sarfarti, Hardy-Bayle, & Decety, 2000), and perceptions of anger (Wicker, Perrett, Baron-Cohen, & Decety, 2003). Blood flow patterns also differ in male and female brain centers. In male brains blood flows through spatial-mechanical centers in the right hemisphere, areas of kinesthetic intelligence and abstraction. In the female brain, blood flows through emotive centers in both sides, with more neural activity occurring in parts that think in and create words, and connect words to memories, emotions, sensory and context cues (Cosgrove et al., 2007). Blood flow patterns to different brain centers may link to differences in how men and women show appreciation: men high-fiving, women connecting feelings with words.

Women's blood flow to the cingulate gyrus inside the limbic system in the midbrain coordinates sensory input with emotions, enabling ongoing attention to voice tone, gestures, and facial expression. Context is considered for rapport building, facilitating a person/process style of engagement. Men process less experience through the gyrus with fewer contextual applications and less use of nonverbal cues, focusing more on data (Cosgrove et al., 2007) within a task/outcome orientation style.

Blood flow is consistently 20 per cent greater between the hemispheres in the female brain, a large difference in brain research, with more ongoing neural activity during cognition and rest (Cosgrove et al., 2007; Gur & Gur, 2007). Male brain scans show neurons in highly specific areas with activity decreasing at rest (Gur & Gur, 2007). Recent findings report similar, but smaller, differences in blood flow and neural activity (Liu, Stufflebeam, Sepulcre, Hedden, & Buckner, 2009). Blood flow differences enable the hemispheres of the female brain to work simultaneously in ways the male brain cannot. This supports the theory of a lateral male brain dividing tasks

between its two hemispheres allowing intense focus, whereas the female brain draws more equally on both sides for processing information, experiences, listening, and talk.

However, the greater male lateralisation (GML) hypothesis remains contested among neuroscientists. Fine (2010) urges caution interpreting results of purported sex differences in lateralisation, citing insufficient empirical evidence, whereas Halpern (2012) believes that research warrants conclusions of female brains more bilaterally organised and male brains lateralised.

Corpus Callosum Size

The corpus callosum, a dense band of neural fibers running down the center of the brain connecting right and left hemispheres, has been suggested as a site of sex differences in the brain. It provides physical and informational connections between the hemispheres forming the primary pathway for communication between them. Research shows sex differences in the shape and volume of a portion of the corpus callosum (Dubb, Gur, Avants, & Gee, 2003; Luders, Thompson, & Toga, 2010). Much research suggests that the posterior portion of the corpus callosum is larger and more bulbous in women, and more elongated in men (Liu, Vidarsson, Winter, Tran, & Krassner, 2010; Steinmetz et al., 1995), perhaps in response to prenatal hormones, experiences, or a combination of these (Halpern, 2012). The two sides of women's brain have a larger number of connections allowing more information exchange and communication between them.

Some research suggests that size differences occur in scale with the 8–11 per cent larger male brain (Bishop & Wahlsten, 1997), with women having a larger corpus callosum relative to cranial capacity than men (Johnson, Pinkston, Bigler, & Blatter, 1996). Eliot (personal communication, 28 April 2012) indicates that about equal numbers of studies find the corpus callosum larger in females, larger in males, or no differences, stating that these have been difficult to verify since sex differences in the brain vary as a function of age, leading to study inconsistency.

A slightly larger callosal splenium, in the back third of the corpus callosum, is thought to optimise communication between hemispheres allowing more "cross talk" in language processing (Dubb et al., 2003; Gur & Gur, 2007) and increased social sensitivity (Wood et al., 2008). A larger corpus callosum is important for stronger female connectivity between cerebral hemispheres (Innocenti, 1994), faster information transfer (Jäncke, & Steinmetz, 1994), and better organisation for using both hemispheres in cognition (Halpern, 2012) as well as relationship building and connecting. The physical capacity of women to connect and relate more pieces of information across hemispheres simultaneously enables attention to nonverbal cues (voice, gesture, facial expression), and other sensory input for nuances;

close listening to understand intent, focusing on what is meant; and a greater capacity than men to integrate verbal and visual information while staying engaged in conversation.

Women may be less able to separate emotions from reason because their brains are organised with emotional capacities on both sides and exchange between the sides. The emotional and verbal sides of the brain are integrated, enabling expression of emotions in words. The slightly smaller male callosal splenia assists one hemisphere, the left, with information processing that is primarily linear and logical. Since less cross talk occurs between the hemispheres, less attention is paid to nonverbal cues. Listening is more literal with attention to words said. Since men process emotions on the right side of their brains, expressing feelings in speech flows less easily to the verbal left side of their brains. Because the halves are connected by a smaller number of fibers than in women, information flow between the two sides of the brain is more restricted, with hemispheres used sequentially.

Extent of Defined Brain Areas

Gray matter is the information-processing center of the brain; white matter, the networks of connection among brain's processing centers. There are differences in the amount of gray and white matter in different brain regions, with women having relatively more gray matter than white matter and men having relatively more white matter than gray matter (Lenroot & Giedd, 2010). Although ratios are small when controlling for overall brain size, sex differences in ratios exist in specific brain areas (Halpern, 2012). Women have slightly larger gray to white matter ratios with more gray matter in the anterior cingulate region (Cosgrove et al., 2007; Haier, Jung, Yeo, Head, & Alkire, 2005). They have more white and gray matter in the frontal part of their brains, whereas men have more gray matter in the parietal area with no gray matter in their frontal lobes (Haier et al., 2005). Gray matter in the male brain is processed within one hemisphere, localising brain activity. This helps men focus on tasks without distraction, getting at facts. The female brain integrates and assimilates information from distributed gray matter regions enabling attention to many stimuli at once (Johnson & Bouchard, 2007), important for decision-making and problem solving, integrating talk with tasks, emotions and memories. Men and women use different brain regions to achieve similar results (Haier et al., 2005).

The hippocampus, the gateway and control center of the brain's memory system, is proportionately larger in women than men (Eliot, 2009) and more active (Frings, Wagner, Unterrainer, Spreer, Halsband, & Schulze-Bonhage, 2006). Women have more neural pathways between the hippocampus to emotive and sensory brain centers, enabling retrieval of interactive details from the past and greater understanding of situational subtleties. The

hippocampus links to discourse functions of memory and emotional expression. Integrating past emotional memories into decision-making slows down the process. Women benefit from talking through problems. They share more personal experiences using feeling words. The smaller, less active male hippocampus is less linked to memory and word centers of the brain. This leads to less sharing of emotional and relational experiences and reduced memory of interactive details unencumbering men to move forward more rapidly in decision-making contexts. Men prefer action words (Moir & Jessel, 1991).

In some regions of the female brain nerve cells are more densely packed per unit volume (Hales, 1999). Witelson, Glezer, and Kigar (1995) found 11–14 per cent more neurons in the planum temporale within the temporal lobe, a crucial area for understanding language and speech tone recognition. The female brain, with a higher proportion of gray matter and greater cortical volume, suggests greater functional activity compared with a male brain (Hines, 2007). The occipital and parietal lobes, more active in females with more neural connections, provide greater ability to hear words and translate this to action. The male temporal lobe is less active. Men and women use words for different purposes, completing the same tasks through different brain circuits.

Sex-based temporal lobe activation differences have been demonstrated during listening (Munro & Govier, 1993). Women nod, establish eye contact, smile, and ask more questions than men to understand, encouraging elaboration and exploration of details. Two ethnographic case studies in UK businesses conclude that female managers rely heavily on mutual listening, strategically using small talk about their personal lives mixed with business talk, to create collegiality amongst team members (Mullany, 2007; Holmes & Stubbe, 2003). In professional settings it fills a range of transactional and relational goals, building bridges to more task-oriented work. Men listen differently. They listen for facts to get straight to the point, with little eye contact, interrupt more frequently, and give advice when they hear a problem. They attend to voice tone, like sarcasm or anger, when it deviates in an extreme way from normal tone.

BRAIN FUNCTION

Anatomical differences are continuously being identified. Such differences lead to activation for task accomplishment in different male and female brain areas (Haier et al., 2005).

Organisation for Language and Information Processing

Specialisation of hemispheres for cognitive processing begins prior to birth, with brain bilateralisation evidenced as early as 4 weeks of age (Friederici,

Pannekamp, Partsch, Ulmen, Oehler, Schmutzler, & Hesse, 2008), and nearly complete by age 5 or 6 (Martin, 2006). Female brains have verbal abilities represented in both hemispheres; male brains devote the left hemisphere exclusively to verbal abilities (Bitan, Lifshitz, Breznitz, & Booth, 2010). Emergence of sex differences in verbal skills in early infancy suggests something innate (Eliot, 2009), with language processing one of the most pronounced sex/gender differentiations (Kaiser et al., 2009). Female dominance in language and verbal memory is well documented in adults (Kimura, 1999).

Empathy, the ability to understand and identify with the feelings or emotional states of others, has both affective and cognitive components (Cox, Uddin, Martino, Castellanos, Milham, & Kelly, 2011). It is involved in relational aspects of management linking to brain bilateralisation, an activated core neural network (Fan, Duncan, de Greck, & Northoff, 2011) and hormones, contributors to how the brain is differently organised for language and information processing in men and women. In communication, women use discourse to preserve harmonious relationships, valuing empathy in their work groups. In a meta-analysis of 45 studies of different management styles, women were more likely than men to use a transformational style supporting and empowering followers to reach their potential (Eagly, Johannesen-Schmidt, & van Engen, 2003). This style uses more normatively feminine talk. Respect is shown through support and encouragement, qualities associated with optimal effectiveness.

The corpus callosum is important in this process. Differences in how the two hemispheres process language in each sex are subtle and unresolved. Evidence suggests that sex differences in lateralisation pertain to specific types of language tasks (Eliot, 2011). Methodological differences in types of verbal tasks may account for some inconsistencies in detecting sex differences. Tasks requiring higher-order language processing show significant and consistent sex differences across studies. They suggest sexual dimorphism of structures associated with language: the female bilateral activation and the male use of the left hemisphere only (Baxter, Saykin, Flashman, Johnson, Guerin, Babcock, & Wishart, 2003). This provides broader input for cognitive strategising and language processing in women who have verbal abilities and emotional responses residing in both hemispheres. Such diffuse lateralisation allows women to access both sides of their brain in decision-making, enabling "and–but" framing rather than the male "either–or" viewpoint, drawing on experiences of the right brain and reasoning of the left brain. Men mainly use the left hemisphere for verbal abilities, drawing primarily on internal cues for input. Emotional functions are concentrated on the right side of the brain.

Because brain organisation is more holistic, women frequently rely on context, making more connections and formulating interpretations of information from interactions (Koles, Lind, & Flor-Henry, 2010). They use both

hemispheres for listening (Ceci & Williams, 2010; Munro & Govier, 1993). The more lateralised male brain leads to task-focused analytical thinking with language for information gathering. This compartmentalisation makes them less distracted by superfluous information. Since only the left hemisphere is used for listening, nuance is harder.

Organisation for Attention: Systemising and Empathising

There is evidence of pronounced sex differences in how the brain is organised for attention. Baron-Cohen maintains that male and female brains are "essentially" different (2003). He described a systemising style men use with strength in analyzing underlying rules that predict and govern system behavior. Neural markers, responsive to order, organise the environment, leading to a big picture application of information. In contrast, women's strength is empathy. Women, predisposed to learn about people's emotions, provide empathic responses. In a study of 102 1-day-old newborns, provided choices to look at a live human face or a colorful mobile with a hanging ball, statistically significant differences were found. Girl babies preferred faces, especially eyes; boy babies, inanimate objects, demonstrating, in part, differences of biological origin (Connellan, Baron-Cohen, Wheelwright, Batki, & Ahluwalia, 2000).

Sexual dimorphism in regions of the brain structure mediating these is expected. Based on questionnaires, small, statistically significant sex differences (Baron-Cohen, 2003) and brain activation differences (Derntl, Finkelmeyer, Eickoff, Kellerman, Falkenberg, Schneider, & Habel, 2010; Proverbio, Zani, & Adorni, 2008) replicated cross-culturally (Lippa, 2010) were found. On average, men systemise to a greater degree than women (Baron-Cohen, 2007). Females empathise more than males (Baron-Cohen, 2007; Eliot, 2009). There are gender differences in the regions of the brain forming the core empathy neural network with stronger lateralisation of a male cognitive network for emotion processing, and stronger bilateral activation in females drawing on emotion-related regions (Derntl et al., 2010; Fan et al., 2011), connecting emotion with verbal expression.

Women are more adept at social perception than men (Wood et al., 2008), having neural markers more responsive to social stimuli and a larger anterior cortex (Proverbio et al., 2008). They outperform men at making emotional inferences, deciphering displays of anger, interest, and other emotions (Eliot, 2009), a type of cognitive empathy (Cox et al., 2011). They show greater sensitivity to sound and tone of voice (Maccoby & Jacklin, 1974), demonstrating affective empathy (Cox et al., 2011) with enhanced abilities to perceive, relate, and communicate verbal and nonverbal information and

emotion. Their brains are designed to quickly assess thoughts and intentions of others based on the smallest of hints and intuitive feelings. Men are not as nuanced to voice tone or facial expression intensity.

Sex differences in the brain also reflect socialisation effects of neural wiring. Much learning during socialisation is unconsciously processed. Women smile more than men, even when not happy, and are nice, more often than men, to people they might not like (Moir & Jessel, 1991). Implicit attitudes arise without much cognitive processing, relying on long-term memory stored in the deep brain structure of the temporal lobe, processed in the limbic system, an area closely linked to emotion. Nonconscious predispositions play a role in many organisational phenomena (Becker et al., 2011) linking to gendered discourse.

Brain biases persist and strengthen as children age. Most children conform to sex stereotypes, listening to what their brains tell them is important. As they use skills repetitively, their natural, preferred ways reinforce inherent sex bias. Boys explore areas, spaces, and things because their brain bias predisposes them to those aspects of their environment. Girls like to talk and listen because that is what their brains are better designed to do (Moir & Jessel, 1991). In one study, boys showed 50 times greater competitive behavior compared with girls, whereas girls showed 20 times greater turn-taking (Charlesworth & Dzur, 1987).

Each sex practices, exercises, and strengthens sexually distinctive aptitudes. Even in Israeli Kibbutzim, with deliberate attempts made to play down differences between boys and girls, it was found across age groups that while girls cooperated, shared, and acted affectionately, boys challenged, tested, and engaged in more acts of conflict such as seizing toys from other children, and more acts of disobedience, violence, and verbal abuse (Tiger & Shepher, 1977).

Girls' and women's speech facilitates relationship building. It is a "double voiced discourse", cooperative and collaborative. A turn-taking, reciprocal style quickly draws others into the conversation, recognising contributions. Expressing emotion, sharing confidences, and self-disclosing soften speech. Women try to like people they work with, understand needs, and break down status barriers. Conversational softening devices make jumping into a conversation easier. This includes *perhaps* for consensus; using open questions, *What do you think?*; qualifying statements, *I'm probably not the best judge of this, but . . .* as a way to both avoid conflict and open the conversational floor for exploring other perspectives. Men use much less softening speech (Wood, 2013), preferring debate and action-oriented closed questions like, *What do you want?* Women score higher than men on self-report questionnaires designed to measure empathic responses (Baron-Cohen & Wheelwright, 2004), with slightly smaller differences demonstrated in empathy with observational measures (Eliot, 2009).

Boys and men use more "single voiced discourse" to present their own perspectives (Smith, 1985). They process emotional tones of discourse more slowly, using physical action to substitute for emotion. Capacity to feel is divorced from articulation to a greater degree than in women. In general, men show more direct aggression including playful roughhousing and anger (Baron-Cohen, 2007; Maccoby & Jacklin, 1974), often enjoying conflict and competition (Maccoby, 1998). Females show aggression more indirectly through gossip or exclusion.

The biggest behavioral difference between men and women is the more natural, innate aggression of men (Moir & Jessel, 1991), requiring lower empathy than indirect aggression (Maccoby, 1998). For men, discourse is used for tactical maneuvering of office politics with differentiated roles, explicit goals, and arbitrary rules. Work relationships are often relationships of function. The backslapping and banter of their work world has little to do with feelings.

Women are more sensitive to and affected by interpersonal conflicts than men (Wodak, 1997). Their brains react to relational conflict and rejection, leading to negative chemical reactions creating stress and fear (Zubieta, Ketter, Bueller, Xu, Kilbourn, Young, & Koeppe, 2003). A study by Shirao, Okamoto, Okada, Ueda, and Yamawaki (2005) demonstrated gender differences in brain activity when processing unpleasant linguistic stimuli related to conflict. The data suggest that key areas of the brain play roles in word perception in women's, but not in men's, conflicts. The bilateral caudate nuclei and left putamen appear to regulate sensitivity to unpleasant information about interpersonal difficulties.

Organisation for Emotion

Innate sex differences appear in how men and women do emotional processing, emotion recognition (Halpern, 2012), gather and use information (Campbell, Muncer, & Odber, 1997), and the speed with which they combine it with emotions (Eliot, 2009). The limbic system, including its hypothalamus, hippocampus, and amygdala, is highly specialised to process the entire spectrum of human emotion. The amygdala, in particular, processes raw input from the visual stream before it reaches the visual cortex and consciousness (Pegna, Khateb, Lazeyras, & Seghier, 2005) and is larger in men than women.

The circuit board of the female brain experiences others' distress (Eliot, 2009), with their amygdala more strongly activated in processing emotion than men's (Derntl et al., 2010). Women's more networked brains lead to their relationship focus. Relational discourse uses mitigation as a linguistic tactic to save face when issuing directives or criticism. Such directives include modal verbs like *can* and *could* indicating possibility rather than necessity,

and pragmatic particles like *sort of*. *Let's* signals a proposal rather than a command. Apologies are ritualised ways of maintaining relationship balance. Saying, "I'm sorry" may mean, "I'm sorry that happened" rather than "I was responsible and apologise." This type of talk involves eye contact with emotional expression and connection likely linked to the amygdala.

For men, emotion idles near the brain stem making processing of emotional experiences slower (Campbell et al., 1997; Eliot, 2009). Their more "doing brain" responds to another's distress searching rapidly for practical solutions, ignoring much information that women notice (Eliot, 2009). Their cerebral cortex links emotions to action, influencing them to communicate nonverbally and with physicality. Aggressive interruptions, sarcasm, and teasing humor challenge, undermine, or maintain dominance (Holmes, 2006b; Schnurr, 2009). Few hedges, disclaimers, or softening devices are used in discourse (Wood, 2013). For example, the language of one-upmanship respects the dominance hierarchy. In contrast, the cingulate gyrus, the most evolved part of the limbic system closer to the talking centers in the cerebral cortex, links emotional activity with language in women's brains (Cosgrove et al., 2007). In situations in which women perceive unfairness, they react to and express it with words. Gur and colleagues (2002) found that 35 per cent of men displayed limbic activity typical of women, whereas 17 per cent of women exhibited male-like patterns. Socialisation plays some role in this display.

With male aging, biological capacity to bring emotional valence into consciousness matures with more efficient brain myelination (Benes, Turtle, Kaha, & Farol, 1984). A 75-year longitudinal study of men's development shows more adeptness at recognising and expressing emotion as brains age (Vaillant, 2012) with desire for dominance. Brain changes integrate the impulsive male limbic system with reflective frontal lobes. These changes in brain physiology allow better integration of the "emotional" subcortical brain and the "planful" frontal cortex (Vaillant, 2012, p. 170). This could increase workplace discourse flexibility for men as they reach late middle age with increased emotional expressiveness and understanding of subtle emotional cues in interactions. In Ladegaard's (2011) sociolinguistic study of managerial communication in a large Danish corporation, a male-dominated environment of mostly engineers, he found male managers in their 50s had effectively adopted a WVR style.

BRAIN CHEMISTRY

Hormones influence the brain, with sex differences developing through genetic and hormonal action (Tobet, Knoll, Hartshorn, Aurand, Stratton, Kumar, Searcy, & McClellan, 2009). Pre- and postnatal hormone levels are influenced by sex-differentiated patterns of socialisation (Halpern, 2012).

While the brain develops in the womb, hormones control how neural networks are laid out. At puberty hormones revisit the brain to switch on the network they previously created, influencing the respective verbal skills and aptitudes of men and women. The neuroendocrine literature suggests links between the brain, hormones, and cognitive behavior (Van Strien & Bouma, 1995) particularly in dominance, competitive and coalitional behavior (Colarelli et al., 2006). What makes a difference is the interplay between hormones and the male or female brain, pre-wired to react with them. Boys channel hormonally inlaid aggression into games of action, competition, dominance, and leadership.

Assertive speech styles promote individual interests, allowing critical directive statements and disagreement (Leaper & Ayres, 2007). Male talk exhibits knowledge, skills, and abilities, avoiding personal disclosure suggesting weakness or vulnerability. Advice giving, instrumental for accomplishing objectives, expresses superiority or control, and involves give and take. Even with socialisation and learning from experience, brain structures and hormone levels are different in men and women. It is not surprising that they communicate differently.

Both men and women have aggressive brain circuits that they use differently. Brain chemistry affects reactions to stress and threats (McClure, Monk, Nelson, Zarahn, Leibenluft, Bilder, Charney, Ernst, & Pine, 2004). These circuits lead to anger, with women and men angry at different things. For men, anger erupts as a threat to autonomy. Women's anger comes from feeling ignored, having ideas discounted, feeling disrespected with too many interruptions, or being treated unfairly (Hales, 1999).

The brain continues to develop throughout its life span with susceptibility to hormonal effects (Halpern, 2012). Differences appearing after puberty may be influenced by alterations in sex hormone levels across menstrual cycles in women and across seasons and time of day in men. These differences are associated with variations in cognitive abilities such as enhanced spatial cognition in men and verbal memory in women. Because of dramatic age-dependent fluctuations in hormone levels, it is likely that the influence of hormones varies with age. Age-related hormonal changes feminise men and masculinise women, providing a more similar playing field. Women's estrogen levels are highest during childbearing years, beginning to drop around 45–50 years of age when their menstrual cycle ends, leading to increased energy and aggression. With age they become more assertive in their discourse.

As men's testosterone levels decline, from about age 50, they assume more feminine qualities (Dabbs, 2000; Vaillant, 2012). There is a need to understand the link between brain and behavior in human aging (Vaillant, 2012, p. 107). These changes likely impact gendered discourse. As testosterone declines with age, men's leadership and discourse styles shift to ones includ-

ing more expressiveness and emotional attention to others. As the influence of hormones decreases, men's and women's behavior increasingly resembles each other.

The literature, often based on small unrepresentative samples, provides insufficient evidence to claim hormones as the major cause of sex differences. At a minimum, they play a part, producing gender-related differences in interests, styles, and roles (Ceci & Williams, 2010), interacting in complex ways with a person's learning environment. Early in utero hormonal exposure, such as surging testosterone in boys that is ten times higher than in girls (Swaab, Zhou, Fodor, & Hoffman, 1997), interacting with expression of specific genes, likely facilitates development of elaborate social cognition and behavioral systems (Adolphs, 2001). The degree of male hormones present appears to affect the efficiency with which male skills are performed, and amounts of female hormones influence success of normal female aptitudes.

Hormone distribution leads to structural and functional sex differences in the brain. Men's larger amygdala and hypothalamus and women's larger caudate and hippocampus volume involve distribution of estrogen and androgen receptors (Cosgrove et al., 2007), with brain chemistry leading to chemical secretion differences. Because men have five to seven times more testosterone in their blood and brain than women, they secrete more testosterone and vasopressin (Nelson, 2000), altering behaviors, perceptions, emotions, and abilities. These aggression and territoriality chemicals relate to competition, making the brain less susceptible to fatigue and more able to concentrate. Testosterone links to aggression is one of the largest, most reliable, and likely innate male/female differences (Eliot, 2009). As testosterone increases so do confidence, competitiveness, assertiveness, and self-reliance. Testosterone levels are higher in competitive individuals regardless of sex. Men's testosterone responds more sensitively to winning and losing than does women's whose testosterone levels remain flat or decline during and after competition whether they win or lose (Bateup, Booth, Shirtcliff, & Granger, 2002). Among men, testosterone levels rise during competition, remaining high in winners but dropping in losers (Booth, Shelley, Mazur, Tharp, & Kittok, 1989). Higher testosterone levels help explain why many men exhibit less nurturing and more competitive workplace behavior, also playing a role in their drive, creativity, and intellect. We suggest that testosterone is partly responsible for men's discourse directness, desire to control a conversation, disruptive interruptions to make a point, and disregard for others' input.

In formal group meetings, testosterone impacts talk. Dominant men have higher testosterone levels than women (Nelson, 2000) and higher levels than submissive men (Colarelli et al., 2006). Women in positions of dominance (executives) have higher testosterone levels than women in more female

occupations (Purifoy & Koopmans, 1979). Nonetheless, men's brain chemistry, brain structure, and socialisation appear to create discourse styles devoted to displaying power and protecting competitive systems of relationships. Their masculine ways of communicating are perceived as default expressions of leadership (Case, 1993a).

Women have more estrogen, progesterone, and oxytocin. Estrogen appears throughout the brain including the hippocampus and cerebral cortex, maintaining verbal memory, increasing energy, and enhancing perception (Halpern, 2012). Oxytocin, a bonding chemical, increases trust, makes people more sociable, and lowers aggression, playing a central role in women's affiliative tendencies (Stallen, De Dreu, Shalvi, Smidts, & Sanfey, 2012). Oxytocin further contributes to a more empathic affiliative style of discourse, enhanced social memory (Taylor, Klein, Lewis, Gruenewald, Gurung, & Updegraff, 2000), and heightened attention to and accurate perception of social interactions (Fischer-Shofty, Levkovitz, & Shamay-Tsoory, 2013). High levels of female hormones in women enhance their innate skills while depressing skills men are better at. This enables coalition building. Men do this with competitive playfulness and attention to hierarchy; in contrast, women use a more collaborative, supportive, and facilitative style for social connection. Extremely small amounts of female hormones given to men increase their ability to read emotions (Domes, Heinrichs, Michel, Berger, & Herpertz, 2007). While both men and women produce oxytocin, women have more with stronger effects (Panksepp, 1998). It rises during relaxing conversations and falls when women feel ignored. As a result of hormonal differences, women may seek connection through communication with others at work taking the form of conversational co-creation, building on others' utterances, seeking input, frequent indirectness, and steering women toward win–win solutions to conflict.

Table 2 summarises identified sex differences and their function across the previously discussed three categories of brain structure, function, and chemistry.

SUMMARY OF BRAIN BIOLOGY AND WORKPLACE GENDERED DISCOURSE CONNECTIONS

Biological differences in brain structure, function, and chemistry are linked to communication and their enactment in normatively masculine, feminine, and WVR discourse styles in Table 3. This table suggests that differences are both biologically based and reinforced from early years by the social learning process. The suggested discourse characteristics are based on brain neuroscience and gendered discourse in the workplace.

TABLE 2
Functions of Brain Biology Sex Differences

Brain Biology	*Sex Differences Female*	*Function*	*Sex Differences Male*	*Function*
Brain Structure				
Hemispheric Asymmetries	Ventral frontal cortex proportionately larger (Wood et al., 2008)	Interpersonal judgment (Brunet et al., 2000; Wicker et al., 2003; Wood et al., 2008); social cognition (Brunet et al., 2000; Wicker et al., 2003)	Ventral frontal cortex proportionately smaller (Wood et al., 2008)	Less interpersonal awareness (Wood et al., 2008)
	Blood flows through both hemispheres, more through cingulate gyrus (Cosgrove et al., 2007)	Emotive center connecting memories, emotions, and cues to context (Cosgrove et al., 2007)	Blood flows through right hemisphere (Cosgrove et al., 2007)	Spatial-mechanical center linking kinesthetic intelligence and abstraction (Cosgrove et al., 2007)
	Blood flow 20% greater between hemispheres (Cosgrove et al., 2007; Gur & Gur, 2007; Liu et al., 2009)	Simultaneous activity in both hemispheres when processing information (Liu et al., 2009)	Blood flow to specific areas (Gur & Gur, 2007; Liu et al., 2009)	More task separation divided between the hemispheres (Liu et al., 2009)
	More neural activity during cognition and when resting (Cosgrove et al., 2007; Gur & Gur, 2007; Liu et al., 2009)	Continued simultaneous activity (Cosgrove et al., 2007; Gur & Gur, 2007; Liu et al., 2009)	Neural activity in specific regions decreases at rest (Gur & Gur, 2007; Liu et al., 2009)	Focus (Gur & Gur, 2007; Liu et al., 2009)
Corpus Callosum Size Difference	Sex difference in shape and volume of part of the corpus callosum (Bishop & Wahlsten, 1997; Dubb et al., 2003; Halpern, 2012; Liu et al., 2010; Luders et al., 2010; Steinmetz et al., 1995)	Communication between hemispheres (Dubb et al., 2003; Gur & Gur, 2007; Halpern, 2012; Innocenti, 1994; Jäncke & Steinmetz, 1994); social sensitivity (Wood et al., 2008)	Callosal splenia slightly smaller (Dubb et al., 2003; Gur & Gur, 2007)	More lateralised communication using one hemisphere (Dubb et al., 2003; Gur & Gur, 2007)
Defined Brain Areas	Larger gray-to-white ratio (Cosgrove et al., 2007; Haier et al., 2005; Halpern, 2012; Hines, 2007; Lenroot & Giedd, 2010)	Gray matter processes information; white matter connects information between brain processing centers across hemispheres (Gur & Gur, 2007)	Slightly smaller ratio of gray-to-white matter (Cosgrove et al., 2007; Haier et al., 2005; Hines, 2007; Lenroot & Giedd, 2010)	Gray matter processes information; white matter connects information within one hemisphere (Gur & Gur, 2007)
	More white and gray matter in frontal part of brain (Gur & Gur, 2007)	Gray matter distributes processing of information to both hemispheres (Gur & Gur, 2007); attention to multiple stimuli (Johnson & Bouchard, 2007)	More gray matter in parietal area (Gur & Gur, 2007; Haier et al., 2005)	Gray matter localises processing of information to one hemisphere (Gur & Gur, 2007)
	More densely packed neurons in temporal lobe (Witelson et al., 1995)	Understand language, speech tone recognition (Witelson et al., 1995)	Less dense temporal lobe (Witelson et al., 1995)	Use different brain circuits for understanding words (Hines, 2007)

TABLE 2
Continued

Brain Biology	*Sex Differences Female*	*Function*	*Sex Differences Male*	*Function*
Brain Function				
Organization for Language and Information Processing	Both hemispheres used (Baxter et al., 2003; Bitan et al., 2010; Friederici et al., 2008; Gur et al., 2002; Gur & Gur, 2007; Kaiser et al., 2009; Kimura, 1999; Martin, 2006)	Broader input for cognitive strategies and language processing (Frings et al., 2006; Gur & Gur, 2007)	Left hemisphere used (Baxter et al., 2003; Bitan et al., 2010; Gur et al., 2002; Gur & Gur, 2007; Kaiser et al., 2009; Kimura, 1999)	Focused input for cognitive strategies and language processing (Frings et al., 2006; Gur & Gur, 2007)
	More holistic organisation (Koles et al., 2010)	Nuanced approach to information considering context (Ceci & Williams, 2010; Koles et al., 2010; Munro & Govier, 1993)	More lateralisation (Bitan et al., 2010; Friederici et al., 2008; Koles et al., 2010; Martin, 2006)	Focused analytic approach to information (Koles et al., 2010)
Organization for Attention	Neural markers more responsive to social stimuli; brain activation differences (Baron-Cohen, 2003; Becker et al., 2011; Derntl et al., 2010; Lippa, 2010; Proverbio et al., 2008; Shirao et al., 2005; Wood et al., 2008)	Empathic responses to people (Baron-Cohen, 2003, 2007; Connellan et al., 2000; Derntl et al., 2010; Eliot, 2009; Fan et al., 2011; Geary, 2002; Hoffman, 1977; Lippa, 2010; Proverbio et al., 2008; Shirao et al., 2005; Wood et al., 2008)	Neural markers more responsive to order and organisation of external environment (Baron-Cohen, 2003, 2007; Proverbio et al., 2008)	Focus on system analysis (Baron-Cohen, 2003, 2007; Fan et al., 2011)
Organization for Emotion	Amygdala smaller in limbic system (Eliot, 2009; Pegna et al., 2005)	Processes input from visual stream before consciousness (Pegna et al., 2005)	Amygdala larger in limbic system (Eliot, 2009; Pegna et al., 2005)	Serves same function as in women (Pegna et al., 2005)
	Emotions processed through cingulate gyrus, close to cerebral cortex (Cosgrove et al., 2007)	Links language center to interpretation of emotional signals (Baron-Cohen & Wheelwright, 2004; Eliot, 2009; Pegna et al., 2005)	Emotions processed more slowly, close to brain stem (Campbell et al., 1997; Eliot, 2009)	Links action center to emotional signals (Campbell et al., 1997; Cox et al., 2011; Pegna et al., 2005); less empathy (Maccoby, 1998)
	Network bilateral characteristics (Bremner et al., 2001; Cox et al., 2011; Derntl et al., 2010)	Relationship focus (Bremner et al., 2001; Cox et al., 2011; Sasson et al., 2010; Wood et al., 2008)	Localised, lateralised characteristics (Cox et al., 2011; Derntl et al., 2010)	Internal cognitive focus (Cox et al., 2011)

TABLE 2
Continued

Brain Biology	*Sex Differences Female*	*Function*	*Sex Differences Male*	*Function*
Brain Chemistry				
Testosterone	Lower amount (Cosgrove et al., 2007; Purifoy & Koopmans, 1979)	Decreased aggressive and competitive behavior (Colarelli et al., 2006; Nelson, 2000)	5–7 times more (Nelson, 2000; Swaab et al., 1997)	Increased aggressive and competitive behavior (Colarelli et al., 2006; Eliot, 2009; Nelson, 2000); spatial ability (Geary, & Desoto, 2001)
	Higher in competitive women (Bateup et al., 2002)	Level flat or declines during and after competition regardless of win or loss (Bateup et al., 2002)	Heightened testosterone sensitivity in men (Bateup et al., 2002)	Level rises during competition (Bateup et al., 2002; Van Strien & Bouma, 1995), remains high in winners, drops in losers (Booth et al., 1989)
			Decreases with age (Benes et al., 1984; Dabbs, 2000;Vaillant, 2012)	Assumption of more feminine qualities (Dabbs, 2000;Vaillant, 2012)
Estrogen and Oxytocin	More estrogen throughout the brain (Halpern, 2012); levels drop in 40s (Dabbs, 2000)	Maintains verbal memory (Halpern, 2012), enhances perception (Fischer-Shofty, 2013); increases energy and aggression (Dabbs, 2000)	Less estrogen produced (Halpern, 2012)	Helps maintain well-being (Halpern, 2012)
	More oxytocin, with stronger effects (Panksepp, 1998)	Bonding chemical, enhances affiliation and social memory (Colarelli et al., 2006; Stallen et al., 2012; Taylor et al., 2000)	Weaker effects (Panksepp, 1998)	Fewer affiliative tendencies (Taylor et al., 2000)

TABLE 3
Brain Biology Differences—Implications for Gendered Discourse

Brain Biology	*Discourse Function*	*Normatively Masculine Discourse*	*Normatively Feminine Discourse*	*Wide-Verbal-Repertoire (WVR)*
Brain Structure				
Hemisphere asymmetry	Interpersonal awareness Interpretation of nonverbal cues Attribution of intentions	Appreciation with joking, high fives Less use of nonverbal cues Focus on information Task/outcome oriented	Appreciation with feeling words Attend to tone, gestures, expressions Focus on relationship Person/process oriented	Varying combinations incorporating elements of both styles in gender-appropriate ways
Corpus callosum size	Larger Facilitates "cross talk" in language processing Increased social sensitivity	Less contextual Less attention to nonverbal cues Literal listening Report talk	Context for rapport building Attention to nonverbal cues Listening for intent Rapport talk	
Gray and white matter	Integration of talk with tasks, emotions, and memories	Focus on facts and tasks	Focus on tasks with relationships	
Hippocampus	Memory and emotional expression Anger expression	Less sharing of emotional and relational experiences Rapid decision-making Sarcasm, anger, teasing words Debate solutions	Attention to details of interactive situations and events Greater ability to read faces, gestures, and situational subtleties Slower decision-making More emotional expression, feeling words Talk through problems	
Brain Function				
Information Processing	Use of one or both hemispheres for language processing	"Either–or" framing Analytic, specific Verbalise more literally Language for information gathering Listening for facts	"And–but" framing Contextual, flexible Verbalise more interpretively Language to motivate Listening for possibility	Context sensitive Discourse flexibility
Activation for Attention	Affinity for either objects or social relationships	Referential practice More systemising Eye contact unnecessary Present own perspective One-upmanship Not nuanced to facial expressions, tone Assertive influence tactics Direct aggression One problem at a time	Relational practice More empathising Eye contact important Incorporates others' views Collective sharing More adept in social perception Softening influence tactics Indirect aggression Switch topics	Situational adaptability

TABLE 3
Continued

Brain Biology	*Discourse Function*	*Normatively Masculine Discourse*	*Normatively Feminine Discourse*	*Wide-Verbal-Repertoire (WVR)*
Limbic System for Emotion	Emotional processing	Status enhancing	Status equalising	
		Self-promoting	Turn-taking	
		Slower processing of emotion	Quicker processing of emotion	
		Forcing directives	Mitigated directives	
		Intentional infrequent apologies	Ritual apologies	
	Information use	Specific application of information	Big picture application of information	Person/process oriented style
	Lateralisation in processing of cues	Reliance on internal cues	Reliance on context	Inspirational and consultative
		Express aggression	Express connection	
Brain Chemistry				
Neuroendocrine differences	Style of discourse	Assertive	Affiliative	Contextually assertive and supportive
		Talks more	Talks less	
		Knowledge exhibiting	Knowledge co-creation	
		Little disclosure	Self-disclosure	
	Reaction to stress/threats	Direct verbal aggression	Relational verbal aggression	
		Anger expression	Anger suppression	
		Confrontational	Gossip, backstab	
		Concern for winning	Concern for fairness	
Testosterone	Dominance	Control conversation	Co-create conversation	
		Disruptive interruptions	Build on others' utterances	
		Ignore input	Seek out input	
		Directness	Indirectness	
		Advice giving	Experience sharing	
		Competitive	Collaborative	
			With age: hold floor	
			Disallow interruptions	
			Self-confident sound	
			With age: expresses assertively	
Oxytocin	Coalition building	Competitively playful	Collaboratively supportive	
		Attention to hierarchy	Collegial	
		With age: emotional expressiveness	Facilitative	
		Emotional attention to others	Empathic	

IMPLICATIONS

Gendered discourse patterns remain complex. Women and men are increasingly communicating in many similar ways with situational factors and gendered ideologies exaggerating differences and perpetuating inequalities. Recognising that biology and culture interact, we contribute to the literature by integrating a brain biology perspective recognising mounting evidence of sexual dimorphism from the biological and neurosciences. Specifically, we incorporate an alternative theory, a biopsychosocial model, to explain observable and persistent communication differences between men and women. Understanding the implications of biology and culture interaction is essential for organisations' effectiveness. The question is not, "are there brain differences?" but rather, "how are we going to respond to brain differences?" Implications for organisations, valuing and leveraging diverse discourse styles for "doing leadership" (in any role or at any organisational level), and suggestions for further research follow.

For Organisations

Organisations leveraging and building on strengths of gendered discourse styles will be uniquely equipped for competitiveness in the global marketplace, increased workforce and customer diversity, and accelerated social change. Organisations are too complicated to have one set of rules, behaviors, and skills applied to women and men. A global shift to flattened management structures demands adaptability and approaches emphasising relational styles oriented to the needs of others, good working relations, and improving overall effectiveness and productivity (Lazar, 2007). Influence occurs through consensus, careful listening for cues through demeanor and voice tone, and nurturing people to take collective responsibility to solve problems, characteristics fitting women more naturally than men (Heifetz, 2007; Holmes & Marra, 2004; Holmes & Schnurr, 2005). This biologically influenced style is appropriate in response to change, for long-term perspectives, and including diverse viewpoints. It works in multicultural contexts such as Mexico or Taiwan, which value the collective over the individual, or Scandinavian countries or Thailand emphasising feminine values of nurturance or support.

Throughout the world of work, differences between the sexes echo differences in the bias of their brains. Women gravitate towards work and discourse with fulfilling and personal dimensions (Case & Richley, 2013). Men, for the same biologically determined reasons, are interested in things and power, using discourse for those ends. By rejecting evidence about sex differences in the brain, organisational strategies cannot change to accommodate differences.

Organisations should learn to value the different work of men and women equally. Male and female brain differences will always exist. Understanding the science of these differences allows organisations to better harness innate skills of all employees. Women are not advancing in the business world because they fail to lean in, but because businesses are still inherently male systems (Annis & Merron, 2014). A variety of gendered discourse styles across all levels of the organisation's formal and informal leadership enable incorporation of men's and women's different strengths and strategies in approaching work life.

Employers can exploit biological brain differences by integrating the workplace to respect women's and men's strengths, adding perspectives and values to the decision-making process. Diversity is a biological fact. Equality is a political, ethical, and social construct. Furthermore, by ensuring that a diverse range of gendered discourse styles are represented and valued in daily organisational processes, making supervisors accountable to diversity goals, conversations can be transformed, problems seen in new ways, and decision-making enhanced by perspective sharing. Leadership needs many discursive skills to meet the challenges of workplace cultures and interactional contexts. It currently remains a gendered concept with the normatively masculine style of discourse associated with the role.

Organisational culture and norms should not place employees in a double-bind, with consequences as they stray outside the frame for appropriate gendered behavior (Tannen, 1994). When people transcend traditional gender categorisation, they are penalised (Brescoll, 2012; Heilman & Okimoto, 2007; Ladegaard, 2011). Because men and women are expected to behave in particular gendered ways (Sunderland, 2004) that parallel natural brain biases, the prejudices of society reinforce biological advantages and disadvantages, leading women to encounter two language barriers in organisations: the words they say and the words spoken about them. Employees unconsciously assess co-workers' behaviors for appropriateness in relation to gender norms, carrying ideas about how leaders act and talk. Understanding the nature and importance of brain-based differences can overcome unconscious, biased behavior that adversely affects the ability of companies to realise the full potential of their employees and compete successfully.

In research by Ladegaard (2011), employee responses to the WVR styles of their managers followed expected gender norms. Men who claimed authority and accomplished transactional goals were never challenged. Alternatively, male employees challenged female managers' authority in normatively masculine ways with interruptions and ganging up. Similar communication emerged from male subordinates when female managers had open-ended meetings about issues and processes. The women's more innate person/process approach was counter to the desired outcome-oriented approach. Contextual sensitivity and stylistic flexibility in this organisation worked

better for the men in their 50s, possibly the result of decreased testosterone. Paradoxically, when women managers used a feminine style, male but not female staff challenged their authority and competence.

In Case's WVR study (1993b, 1995), both men and women had problems with gender speech incongruity of WVR speakers. Experimental research by Brescoll (2012) supports earlier findings of backlash effects resulting from incongruous behavior. A study of women managers in Turkey also supports this finding. Observations of gendered communication in their workplace indicated, ". . . when you communicate with them [men] in similar ways, they can readily reach faulty opinions about you" (Aycan, 2004, p. 468). Beliefs about expected gender hierarchies and behavior are shared among both women and men, reflecting the socialisation effects of neural wiring.

Organisations need to expand their current images of what competent leadership looks and sounds like. When an organisation's default discourse and leadership style is strongly masculine, the voices and contributions of those with different discourse styles are suppressed. As the women managers in Turkey experienced, "The communication and support network among men is strong and hard to penetrate" (Aycan, 2004, p. 468). They indicated, "When you cannot communicate with them the way they do among themselves, they ostracize you" (2004, p. 468). Brain physiology and existing gender-based brain differences make a homogenous leadership discourse culture a disadvantage to organisations, leading to lost talent. Drawing on sociolinguistic studies, it is clear that masculine workplace cultures do not welcome or enable full participation for many women and some men. Many male-oriented organisations judge women's contributions by male norms and discourse standards, with women asked to compete in male ways, suppressing female skills.

Brain science identifies natural strengths of men and women that organisations have come to expect. Men and women bring different, often complementary skills to the jobs they do. Men tend to be more transactional in interacting, giving something in order to receive something in return; women are more interactive, using talk to maintain alliances and relationships. Women are more participative in teamwork (collaborative, sharing information, and finding connectivity across ideas). Men are more competitive, testing and challenging ideas to efficiently find the best course of action. Men are also more deductive in problem solving. They use more risk-taking guesses relying on more linear data and proof. Men see a solution and act on it. Women use more inductive reasoning. They may see the solution, but more often than men, encourage expression of different viewpoints to arrive at a best decision before acting.

While some level of assertiveness is important for leaders of either sex to be deemed effective by others (Ames & Flynn, 2007), findings in three studies, of full-time MBA students, suggest that it is not a simple case of more asser-

tiveness being better. Instead, a curvilinear relationship exists between assertiveness and perceptions of an individual's current leadership effectiveness or future success in a sample of predominantly Caucasian, male, 28-year-olds (Ames & Flynn, 2007). Demonstrating too much or too little assertiveness yields perceptions of leadership weakness. A study of police officers' compliance to supervisor requests, drawn from a predominantly male sample in Spain, showed that an assertive influence style led to resistance and was ineffective. When coupled with a softer influence style (like WVR), involving inspirational appeals, rational persuasion, and consultation, employee compliance was enhanced (Emans, Munduate, Klaver, & Van de Vliert, 2003). It makes sense to put these talents to good use.

Organisation cultures need change, developing effective policies to enhance gender equality, acknowledging, understanding, and exploiting the complementary differences between men and women, supporting employees' natural discourse styles. They can educate employees about biology's role in diverse discourse styles and how each adds value to the workplace. The workplace culture for doing business was developed from a mindset, natural and comfortable for men. This makes it difficult to recognise the undervaluing of women who often struggle with male hierarchies and rules. It doesn't relate to how they think and act. For example, men are more naturally inclined to solve problems by narrowing down and implementing solutions quickly and decisively. Women collaborate instinctively, ensuring that all voices are heard and all options explored before making a decision.

We suggest that such biologically mediated styles are less malleable than changing leader norms. Policies that help people speak in their own voice take advantage of those differences and enable them to do their best, rather than women wasting energy in pursuit of surrogate masculinity. Because of brain differences, decision-making is more complex for women as they take in more factual and emotional information across their hemispheres than men, perceiving the human dimension of a business decision through discourse and context, with heightened sensitivity to personal and moral aspects of decision-making. Men rely more on calculated, formulaic, deductive processes from one hemisphere, divorced from many human and personal dimensions of choice. Their approach is more analytic, extracting essential information deemed relevant. Women consider a larger picture including context. Because of women's brain wiring, they bring additional emotional sensitivity into the equation. Rather than suppressing these uniquely female skills, they should be valued, exploited, and promoted.

Traditionally the effort to increase access for women in positions of influence in organisations has focused on educating women to adapt to the world of business, take charge of their careers as men do, and advance even if what is required feels inauthentic. This was not working, as talented women left organisations in proportions far greater than men. Organisations recognising

and benefiting from understanding differences and advantages emerging in brain-based science rethink gender, leadership, and daily life in organisations. They include IBM, Deloitte-Touche, Proctor & Gamble, Microsoft, American Express, and United Airlines. Instead of expecting women to become more like men, they learn to embrace the differences women bring to the workplace, that offset and complement strategies men have found useful for success. Brain science provides a competitive advantage in terms of talent development and retention.

Their gender awareness training includes application of brain-based differences to work relationships, developing competencies for understanding differences between women and men in decision-making, problem solving, and communicating. Employees view PET-scans and MRIs, learn some biochemistry, and talk openly about differences (and exceptions), thereby reshaping images of leadership competence. Senior leaders are expected to model the behavior taught and ensure that it cascades down the organisation. With increased awareness, training, coaching and mentoring, employees learn to be inclusive of men and women and fluent in understanding the different contributions women and men bring to the workplace (Annis & Merron, 2014). These cultures blend the strengths of men and women into how they manage people, work in teams, and deal with clients, creating an atmosphere of cultural inclusiveness.

For Individuals: Valuing and Leveraging Individual Discourse Styles

Women and men can be empowered to speak in their own discourse style to facilitate organisational objectives. With the existing demonstrated brain-based differences, most women have more female brain structures, functions, and chemistry. Biology steers them toward ways of interaction. They may struggle trying to become a more WVR speaker. Inability to comfortably use one's own discourse style and preferred cognitive strategy (Witelson, 1978) affects job performance. Women, in particular, can use humor strategically to navigate contexts of power and authority, particularly when there are marked power differences among individuals in an interaction. Self-denigrating humor coupled with irony is useful for resolving conflict between gender and professional identity (Schnurr, 2009). It is better for individuals to utilise their own natural and unique discourse styles. Men and women need to play to mental strengths. This also allows room for gender atypical leaders to contribute to organisations in meaningful ways without prejudice devaluing how they do their work.

When doing leadership both women and men should maintain flexibility to enhance effectiveness, learning from and incorporating discourse skills outside their natural styles. The WVR style allows discourse expansion in

comfortable ways building on biological predilections and learned strengths. Once familiar with their own patterns of gendered discourse, it is important for individuals to recognise contexts where discourse style strengths fit workplace needs. In a study by Emans et al. (2003), the most effective leaders were those able to incorporate a combination of both more forceful and softer influence behaviors, although we expect that men and women would do this differently. Both women and men should challenge perceptions of effectiveness of gendered discourse norms in their workplaces.

CONCLUSION

This paper began with a biopsychosocial model for understanding the continuous, inseparable interactions between biology and environment and mutual influences that biological, psychological, and social variables have on each other (Halpern, 2012). Our focus was on the role of brain biology mediating communication discourse, a missing explanation for the persistence of gendered discourse styles. As a theoretical paper, we generate a framework for why these differences between men and women continue to exist, reframing the literature with a primer on brain biology (structure, function, and chemistry), linking biology to normatively masculine and normatively feminine gendered workplace discourse styles, and a style used by some men and women (WVR) that may result from neuroplasticity of experience and/or alterations in hormone levels as people age. We then discuss implications of these two types of brains for the workplace.

It is clear that more research is needed to understand complexities of the discourse process and links to brain differences. We do not know how much of the identified differences may be hard-wired at birth and which are the consequence of biology interacting with life experiences. It is a leap from brain anatomy to cognition and behavior, but a leap needing empirical verification. There are no studies in neuroscience, management, communication, or organisational behavior that examine brain biology and gendered discourse at an empirical level. Sex differences in brain structure and function relating to discourse process are not easily captured with currently available research methods.

Although we have drawn on the literature that examines gender differences in human samples, too many studies control for gender rather than examining its implications. Sample differences, small sample size, single-study fMRI results, lack of control of spurious variables, and a lack of comparison of males and females in many brain-based science studies make studies difficult to compare, limiting conclusions that can be drawn. A further limitation involves not linking different dimensions of empathy to specific brain regions, a task left for future research. Rather we looked for gender patterns in the relative empathic ability and functional architecture of the brain.

Assuming that sexually dimorphic brains exist, future research needs to examine how, how much, and whether the size of identified brain differences have meaningful relationships to cognitive abilities and discourse behavior. This source of data will enable us to better understand the respective roles of innate predisposition and cultural learning to discourse. Further research should generate and test hypotheses concerning (1) empirical verification with advanced techniques of neuroimaging of proposed characteristics of discourse styles that we link to the brain and its functions, (2) congruence between brain activation, social abilities, and empathy on discourse, (3) when and how gender brain differences emerge in the leadership discourse process, and (4) how WVR styles advantage (or disadvantage) gendered leadership discourse. Biologically rooted differences in men's and women's discourse styles, likely to persist, have unique and positive attributes contributing to inclusive and productive organisations. By welcoming these natural differences and transcending perceptions of deficiencies, discourse flexibility improves how men and women work together.

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