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Chapter 6

Gender differences in language are small but matter for disorders

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Abstract

Gender differences in language can be signs of cognitive differences, but can also by themselves be the cause for such differences. Females have a slight linguistic advantage over males, but effect sizes are small, and gender explains very little of the variance seen in the normal population (1%–2%). However, males outnumber females in the lowest 10th percentile in language tests (2:1), causing males to more often be diagnosed with developmental disorders, which rely on tests of language development.

Thus, gender differences in language are negligible, if you focus on the whole population, but if you focus on language deficits, gender differences are outspoken. Differences in voice and word use can be observed among the genders, making it possible to predict gender from these measures with a high degree of certainty. A subtle finding is that women use more first person pronouns. This is also observed in depression, which is more prevalent in females, opening up a potential link. Sex chromosome trisomies are often accompanied by language deficits, but the causes for this are not known. No gender differences are observed in the linguistic symptoms of neurodegenerative disorders. Poststroke aphasia is more prevalent among women than among men, but this seems to be an age-effect. A link between the brain and gender differences in language is thus missing.

WHY SHOULD NEUROSCIENTISTS CARE ABOUT LANGUAGE?

Humans speak around 16,000 words per day (Mehl et al., 2007). This amounts to around 1000 words every waking hour or 16 per minute (at a 500 ms/word rate), and this is just speaking. If we add listening to conversation, reading, writing, texting, social media, television and inner dialogue, we realize that language is omnipresent in our lives, from before we learn to speak until we die.

Language modulates and potentiates brain plasticity. The main evolutionary driver for neural systems is to allow an organism to respond flexibly to the environment and learn from its experiences in an adaptive manner. Language provides leverage for this learning system, in the process taking over large parts of the attentional space. Language is thus an important tool for interacting minds (Tylén et al., 2010), and linguistic exchange gives humans their unique abilities to collaborate and to acquire knowledge without firsthand experience.

Language is a part of everything we do and modulates all aspects of behavior and cognition, including eye movements (Tanenhaus et al., 1995; Wallentin et al., 2011), perception of color (Roberson et al., 2005; Regier et al., 2007; Winawer et al., 2007; Maier and Abdel Rahman, 2018), perception of space (Levinson, 2003; Wallentin et al., 2008), respiration (MacLarnon and Hewitt, 1999), posture (Yardley et al., 1999), conditioning (Phelps et al., 2001), imagery (Stroustrup and Wallentin, 2018; Wallentin et al., 2019), sleep (Petit et al., 2007), and even anatomy exam performance

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(Stephens and Moxham, 2018). Following from this, there is a language component to almost all neurologic and psychiatric deficits. A loss of language due to brain disease is, furthermore, one of the worst imaginable handicaps (Lam and Wodchis, 2010). It distances the patient from other people and changes her/his identity and personality.

Early language deficits are also cause for and/or indications of psychopathology. Fifty percent of children seen in mental health clinics and in special classrooms for children who have social–emotional problems have some language impairment, and the same proportion of children referred to speech-language pathologists or to special education classes for learning disabilities have a social–emotional problem (Im-Bolter and Cohen, 2007). Longitudinal studies have documented the association between developmental language impairment, psychiatric disorder, poor social competence, and well-being (Beitchman et al., 2001; Conti-Ramsden and Botting, 2008; Whitehouse et al., 2009; Chow et al., 2018).

GENDER, EVOLUTION AND LANGUAGE

Theories about interactions between cognition and gender have a long and controversial history. Darwin wrote that "Man is more courageous, pugnacious and energetic than woman, and has a more inventive genius" (Darwin, 1889, p. 557). Galton "found as a rule that men have more delicate powers of discrimination than women" (Galton, 1892, p. 20). However, already with Darwin and Galton, it was hard to disentangle science from personal prejudice and political ideology (Buss, 1976; Denmark et al., 2008), something that has riddled the study of gender differences in cognition ever since, exemplified by statistically significant effects of author gender on outcome measures in gender difference research (Hyde and Linn, 1988).

Views similar to those of Darwin and Galton are still shared by many people today. Gender researchers (Kite et al., 2008; Haines et al., 2016) have identified two principal dimensions in gender stereotypes: beliefs that women are primarily occupied with the welfare of other people (labeled expressive or communal) and beliefs that men are assertive and controlling (labeled instrumental or agentic). Part of the female expressive stereotype includes that women are supposedly more verbally skilled than men (Cejka and Eagly, 1999).

Essentialist "sex" model

Essentialists regard cognitive differences between women and men as natural, fixed, deep-seated, discrete, and related to biological sex (Haslam et al., 2000; Skewes et al., 2018).

Seen through an evolutionary lens, two possibilities arise if a cognitive trait is heritable; the trait can either be transmitted equally to both sexes or unequally. This gives rise to two hypotheses; the gender similarity hypothesis (Hyde, 2005, 2014) or a sexual difference hypothesis (e.g. Buss and Schmitt, 1993; Miller, 2000; Kimura, 2004; Baron-Cohen et al., 2005; Cahill, 2006).

The basis for an evolutionary pressure leading to sexually divergent traits could be a long-term division of labor between the sexes, hypothesized to be present in prehistoric groups of hunter/gatherer foragers (Marlowe, 2007). Another possibility is that divergent traits arise through within-sex competition or as sexual fitness display, usually in males (Miller, 2000; Locke and Bogin, 2006; Lange et al., 2014). These two theories predict opposite outcomes for sex differences in language skills. The hunter/gatherer theory posits that women have better developed social (and hence verbal) skills due to spending more time in groups and with offspring, while the sexual display hypothesis posits that language is a runaway trait selected for its aesthetic features like the tail-feather of the peacock. The consequence of the latter process, where language is used to signal a healthy cognitive system during sexual selection, would be that males compete to become better speakers while females would benefit from being better listeners (Rosenberg and Tunney, 2008).

Regardless of theory, however, an essentialist sexual difference hypothesis based on natural selection would, in the long run, lead to clearly separable distributions of the particular cognitive traits.

The gender similarity hypothesis, on the other hand, as formulated by Hyde (2005, 2014), states that males and females are similar on most, but not all, cognitive variables (Hyde, 2005). Hyde presented evidence for the hypothesis using meta-analyses on 124 cognitive and psychologic gender difference measures and found that 30% of the effect sizes were effectively 0 (Cohen's *d*: 0–0.10), and an additional 48% were in the range of a small difference, between 0.11 and 0.35. Thus, Hyde found that almost 80% of the gender difference measures evaluated were either small or zero, arguing against any categorical gender divide in psychological traits.

Experientialist "gender" model

Gender differences may also arise without being hardwired. Given the plasticity of the human brain, especially under the influence of language, any difference in behavior or practice could hypothetically lead to differences at the neural level. The longer and more vigorously such differences are maintained during the lifespan of an individual, the deeper the differences will become entrenched. The origin of such differences in behavior could be historical, cultural, or otherwise contextual. Observed gender differences in language and brain, seen in this perspective, may be reflections of differences in gender roles in a society.

Importantly, however, experientialist linguistic differences can also be thought to arise as a side effect of innate sex differences in nonlinguistic domains, modulated and/or expressed with the help of language and with gender differences in linguistic behavior as a result. Language may both be the cause and the effect.

These three perspectives give rise to three different hypotheses: (1) If innate sex differences exist in language, we should expect to see strong behavioral effects and similar sexually dimorphic brain functions and structures subserving these differences; (2) If gender differences in language are only due to cultural factors, we should expect to see no universal differences and furthermore, any difference observed should in principle be reversible, depending on the constraints on brain plasticity; (3) If language interacts with nonlinguistic sex differences, we may see universal linguistic effects, but these may be much less categorical than "proper" sex differences and may not necessarily be underpinned by a clearly dimorphic brain.

Lastly, it is possible that we may find traces of all of the above functions across different measures of language function.

LANGUAGE AND GENDER IN THE NORMAL POPULATION

Primary language acquisition

Children usually start speaking their first words when they are around 12 months old (Tomasello, 2003). First language acquisition is most commonly studied using parental reports such as the MacArthur–Bates Communicative Development Inventories (Fenson et al., 1994), where parents go through a list of 600–800 words (depending on language) and report whether their child has produced/understands each individual word. Across multiple languages, it has been found that girls begin to speak slightly earlier and understand and produce significantly more words than boys (Fenson et al., 1994; Berglund et al., 2005; Bleses et al., 2008; Simonsen et al., 2013; Frota et al., 2016). The effect size is relatively small, accounting for 1%–2% of the variance. A synthesis of data from studies in 10 different languages (Austrian German, Basque, Croatian, Danish, Estonian, French, Galician, Slovene, Spanish, and Swedish), including >13,000 children replicated that girls are slightly ahead of boys in early communicative gestures, in productive vocabulary, and in combining words (Eriksson et al., 2011). Boys were not found to be more variable than girls. Data from the *CDI: Words and Sentences* is available from more than 28,000 children at http://wordbank.stanford.edu. This database covers a large number of languages, including Cantonese (Tardif et al., 2009), Croatian (Kovacevic et al., 1996), Czech (Markova and Smolík, 2013), Danish (Bleses et al., 2008), English (US) (Fenson et al., 2007; Thal et al., 2013), English (AU) (Kalashnikova et al., 2016), German (Szagun et al., 2009), Hebrew (Hila Gendler Shalev, Tel-Aviv University), Italian (Caselli et al., 1995), Korean (Pae and Kwak, 2011), Latvian (Urek et al., 2019), Mandarin (Tardif et al., 2009; 劉惠美 and 陳昱君, 2015), Norwegian (Simonsen et al., 2013), Portuguese (European) (Irene Cadime, University of Minho), Russian (Елисеева and Вершинина, 2009), Slovak (Svetlana Kapalková, Comenius University), Spanish (European) (López Ornat et al., 2005), Spanish (Mexican) (Jackson-Maldonado et al., 2003), Swedish (Eriksson and Berglund, 2002), and Turkish (Acarlar et al., 2009). Focusing on the number of produced words at the 16–30 months age range where the inventory has best coverage (see Fig. 6.1A), it can be seen that gender differences vary slightly with age, such that at 26 months of age, the median boy produces 330 different words, while the median girl produces 414 words. Across languages, gender explains approximately 1% of the variance. Variability for younger children is influenced by floor effects and for older children by ceiling effects as many children will have begun to produce all the words in the wordlists. While the amount of explained variance is small (Cohen's $d \approx 0.2$–0.4, see Fig. 6.1B), the pattern is near universal: Girls outperform boys in 19 out of the 21 sampled language areas. Furthermore, the difference is more outspoken among the lowest scoring children. In the low 10th percentile boys outnumber girls at a 2:1 ratio at 26 months of age (Fig. 6.1C).

Language development (4–12 years)

Studies on preschool development have found that the growth in vocabulary shows comparable slopes for boys and girls, suggesting that boys on average acquire language with a slight delay, rather than being on a different trajectory (Bornstein, 2004; Jiang et al., 2018). Longitudinal data from the Twins Early Development Study (TEDS) on British children (Hayiou-Thomas et al., 2012) measured vocabulary at 7 years ($n = 3329$), 9 years ($n = 2177$), 10 years ($n = 1686$) and 12 years ($n = 2900$) of age using the vocabulary subtest of the WISC-III (Wechsler, 1992). While gender differences in language had also been consistently found using the CDI method in early childhood in this sample, no significant gender differences were observed at 7–12 years, except for 10 years, where a surprising slight advantage for boys

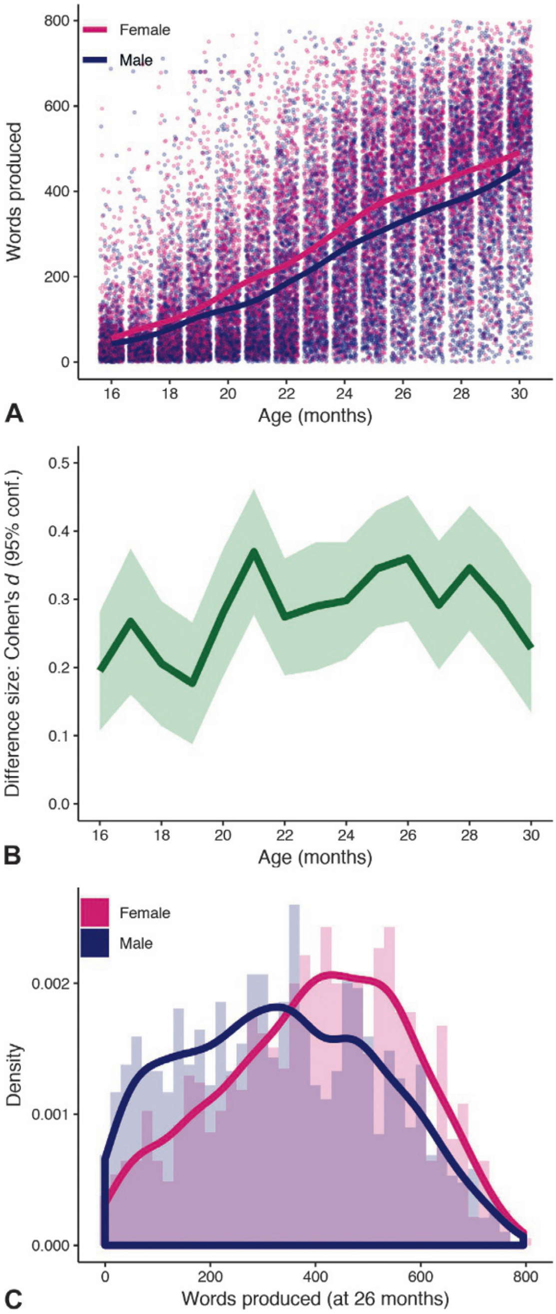

Fig. 6.1. Girls acquire words slightly earlier than boys. (A): Across multiple languages (Cantonese, Croatian, Czech, Danish, English (AU, US), German, Hebrew, Italian, Korean, Latvian, Mandarin, Norwegian, Portuguese (European), Russian, Slovak, Spanish (European, Mexican), Swedish, Turkish) with a total of 28,098 children, parental reports find that girls produce a slightly higher number of different words. (B): Effect sizes in word production differences are in the small range (Cohen's $d \approx 0.2$–0.4). Differences decrease slightly in the older children, but this may be due to ceiling effects. (C): At 26 months, girls produce a median of 414 words, while boys produce 330 words. In the low 10th percentile, boys outnumber girls 2:1, but note also the large overlap in distributions. NB. Cross-linguistic comparisons are challenging with CDIs, because the inventories are not identical (consist of lists of 600–800 words, depending on language). Data extracted from http://wordbank.stanford.edu (October 15, 2018).

was observed. This effect, however, straddled the boundary of significance and, given the other null-results, is probably a false positive. Interestingly, however, the same children were also evaluated by their teachers on their overall oral language skills, using the UK National Curriculum's *Speaking & Listening* criteria. Here, a small, but consistent advantage for girls was found with effect sizes around Cohen's $d \approx 0.2$ for all age groups. There are two possible explanations for this inconsistency. Either the "Speaking and Listening" evaluation picks up on language skills that the vocabulary test does not, or the teachers are biased towards evaluating the girls' language competences as better than the boys. Tests of figurative language, inferences, and syntax at 12 years did not yield significant gender differences.

Another study (Dale et al., 2010) on the (TEDS) data found a small difference in the *Listening/Grammar* subtest of the *Test of Adolescent Language–3* (Hammill et al., 1994) and in reading fluency (Tosto et al., 2017), but also found that there were no quantitative differences in etiology for the sexes, that is, no differences in the balance of genetic or environmental factors on language comprehension skills were observed.

A nationally representative UK sample (Strand et al., 2006) of over 320,000 school pupils aged 11–12 years from 2001 to 2003, on the other hand, found that girls scored higher than boys on verbal reasoning tests (word classification, sentence completion, and verbal analogies). The effect size was again small ($d = 0.15$), but below the 10th percentile, boys outnumbered girls at 1.42:1. Taken together, this suggests that girls' small early linguistic advantage is also present at age 12, but that it may be so small that it is not meaningful. The observed overrepresentation of boys in the lowest percentiles, however, indicates that 60% of all 12-year old children with serious language issues are boys.

Adolescent and adult language

Voice

Adult males have deeper voices than adult females. The mean fundamental frequency (F0) of a voice is associated with the perceptual notion of pitch. Pitch constitutes a major difference between the sexes. Mean F0 is around 125 Hz (SD: 20 Hz) for adult men and 230 Hz (SD: 23 Hz) for women (Fig. 6.2B) (Bachorowski and Owren, 1999). The primary difference is due to the size of the vocal organs related to overall body size

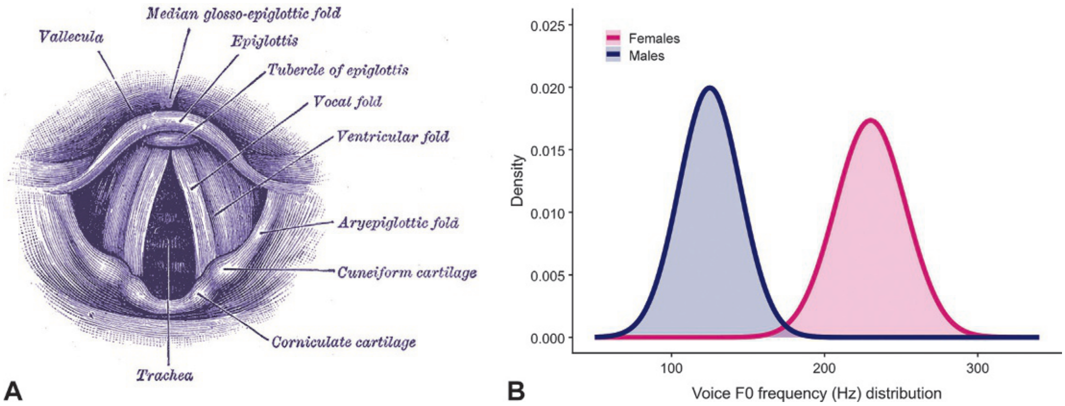

Fig. 6.2. (A). The vocal folds, enabling speech, differ in length between men and women with a ratio of 1.6:1. (B). Young adult men and women differ in voice fundamental frequency (F0) with very little overlap in distributions (assuming normal distributions). Women's mean F0: 230 Hz (std. 23 Hz). Men's mean F0: 125 Hz (std. 20 Hz). Plot based on Bachorowski and Owren (1999). Panel (A): Drawing reproduced from Gray H (1918). Anatomy of the human body, Philidelphia, Lea & Febiger.

(Fig. 6.2A). The male and female membranous vocal fold lengths are in the ratio 1.6:1 (Titze, 1989). This accounts for the difference in produced F0, airflow, and aerodynamic power. Gender classification can be conducted with almost 100% accuracy on the basis of extracted sound features, even from a short vowel segment alone (Childers and Wu, 1991; Bachorowski and Owren, 1999). Vowel formant frequencies have been found to differentiate gender for children as young as 4 years of age (Perry et al., 2001). Voice breaking in boys is clearly related to biological sex, and F0 in adolescents is strongly correlated with testicular size (Harries et al., 1997) and bioavailable testosterone (Markova et al., 2016). It has been found that heterosexual women find a low-pitched voice more attractive (Feinberg et al., 2006) while men prefer higher pitched female voices (Feinberg et al., 2008), but it has also been suggested that male intrasexual competition for dominance was a salient selection pressure for voice frequency (Puts et al., 2006). For both sexes, rated voice attractiveness have been found to predict reported age of first sexual intercourse and number of sexual partners (Hughes et al., 2004), indicating sexual selection pressure.

Speaking and talkativeness

A study of 396 US and Mexican university students (Mehl et al., 2007) wearing automatic recording devices found that women on average speak 16,215 words per day while men speak on average 15,669 words per day. This difference (Cohen's $d=0.07$) was not statistically significant. A meta-analysis (Leaper and Ayres, 2007) based on 70 studies and 4385 participants, on the other hand, found men to be significantly more talkative than women, although the effect was small ($d=-0.14$). Men ($d=0.09$) were found to use more assertive speech (i.e., verbal acts that seek to influence the listener), while women ($d=0.12$) used more affiliative speech (such as agreement and support that affirm the speaker's connection to the listener). Another meta-analysis (Leaper and Robnett, 2011) based on 3502 participants found that women were more likely to use tentative speech (such as hedges, qualifiers/disclaimers, tag questions). Again, the effect size was small ($d=0.23$). A study of 500,000 Mexican phone users' phone calls over a duration of 3 months revealed that women were on the phone for a total of 167 min on average, while men were on the phone for 177 min (Sarraute et al., 2014). Together, these results make it difficult to find support for the hypothesis that females are more "expressive" than males and effect sizes are generally so small that they do not have much real-world relevance.

Word use

Word use has been found to be predictive of gender both in natural conversations (Mehl and Pennebaker, 2003), in written texts (Newman et al., 2008), and on social media (Schwartz et al., 2013; Sap et al., 2014). Not so surprisingly, words like "boyfriend," "earrings," "heels" and "makeup" are highly correlated with the female gender, while words like "girlfriend," "boxers," and "beard" are predictive of male gender (see Fig. 6.3) (Sap et al., 2014). Using multivariate classification based on word use on Facebook, gender can be predicted with 80%–90% accuracy across different languages (Cheng et al., 2011; Sap et al., 2014; Basile et al., 2018). Revealing your gender through grammar is actually obligatory in some languages, such as French. Here, high gender classification rates can be achieved simply by investigating constructions such as "I am.../Je suis..." where the following adjective in French will most often take on

Fig. 6.3. Words used in a multivariate classification to predict gender extracted from English-speaking Facebook users ($N = 72{,}874$). Combinations of words used allow prediction with 92% accuracy. Plot contains the 300 most predictive words for each gender. Larger words have higher weight. Word data from Sap M, Park G, Eichstaedt JC, et al. (2014). Developing age and gender predictive lexica over social media. Proceedings of the 2014 conference on empirical methods in natural language processing (EMNLP), October 25–29 2014 Doha, Qatar: 1146–1151, reproduced with permission from the authors.

the gender of the speaker (e.g., Je suis heureux vs Je suis heureuse) (Ciot et al., 2013). Emotions are also expressed differently by the two genders on social media; females use more words related to positive emotions, but also anxiety and sadness, while males use more words related to negative emotions (e.g., swear words), especially anger (Newman et al., 2008; Schwartz et al., 2013). Focusing on high-frequency function words (articles, prepositions, conjunctions, and pronouns), females have consistently been found to use more first-person singular pronouns ("I," "me," "my") while males use more articles ("a," "an," "the"), which serves as a proxy for males using more nouns (Mehl and Pennebaker, 2003; Newman et al., 2008; Schwartz et al., 2013; Beach et al., 2016). Again, effect sizes are small (Cohen's $d \approx 0.2$).

Verbal comprehension and vocabulary

A very famous meta-analysis (Hyde and Linn, 1988) investigated 165 studies that reported data on gender differences in verbal ability and found a small female superiority in performance ($d = 0.11$). The authors concluded that the difference was so small that "gender differences in verbal ability no longer exist." The question is if this conclusion still holds and if the presence of even small differences could somehow still matter, e.g., if it leads to bigger differences in the parts of the distribution where language problems are experienced.

One large study, conducted around the same time as the Hyde and Linn data, points to a slightly higher, but still small effect size among young adults. From 1971 to 1984, the Israeli Defense Forces each year administered IQ tests to almost all 17 year old citizens (Flynn, 1998). A total of 328,597 participated (169,661 males, 158,936 females). On the verbal instructions test with items such as "write the last letter of the word which is the opposite of black," females scored higher every year on average ($d = 0.19$). No effect was found for nonverbal IQ.

A more recent meta-analysis (Voyer and Voyer, 2014) on gender differences in scholastic achievement for language courses in elementary, junior/middle, or high school and university levels found a consistent female advantage with a somewhat larger effect size ($d = 0.37$) than the one reported by Hyde and Linn.

Reading

Reading habits and print exposure are known to be correlated with other elements of language proficiency (Cunningham and Stanovich, 1991; Acheson et al., 2008). While language adds gears to learning, reading adds a gear to language. Reading proficiency thus has a "Matthew effect" (every one that hath shall be given) on language (Stanovich, 1986). It has been suggested that children (aged 4–15) who read a lot learn 4 words per day on average while children who do not read much only learn 1.5 words per day (http://testyourvocab.com/blog/2013-05-09-Reading-habits). Chiu and McBride-Chang (2006) reviewed reading comprehension tests from 43 countries, with a total of 199,097 15-year-old children. In every country, girls outscored boys. Differences in reading enjoyment accounted for approximately 40% of the gender effect. *The Program for International Student Assessment* (PISA—http://www.oecd.org/pisa/) has found similar effects. Girls on average outperform boys on the overall reading scale in all OECD and partner countries (see Fig. 6.4 for 2015 data from 73 countries at age 15). This finding documents a clear and seemingly universal gender difference. Data from 2000, 2003, and 2006 estimated the girls' advantage to be a Cohen's d of 0.49, 0.36, and 0.41, respectively ($d = 0.42$ on average) (Lynn and Mikk, 2009). Effect sizes are thus small–medium, and path models from a Finish PISA sample found that gender accounts for 2%–6% of the variance (Torppa et al., 2017). A larger number of boys are found in the lowest tail of the reading skill distributions. The risk of being among the lowest-scoring 10% on PISA is 2.4:1 for boys (see Fig. 6.4). The risk of being among the lowest-scoring 10% in reading fluency is 4.4:1 (Torppa et al., 2017).

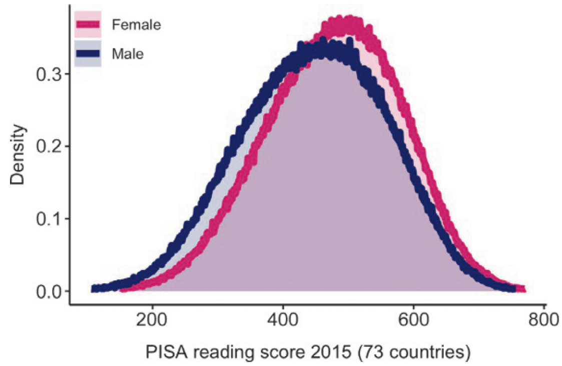

Fig. 6.4. Overall reading score at age 15 from all OECD and partner countries (73 countries, $n \approx 519{,}000$). Girls outperform boys on the PISA reading test in all participating countries. Reading habits are known to be correlated with vocabulary size. Effect size is found to be small to medium ($d \approx 0.4$). In the lowest 10th percentile, however, boys outnumber girls 2.4:1. Analyzed using Caro and Biecek (2017). Data from: http://www.oecd.org/pisa/data/2015database/.

If we argue that the initial small gender difference in language is due to a delay rather than an actual difference, then variability in reading habits, on the other hand, have the potential of transforming the delay into a permanent difference. Further, if boys who have language learning problems are also struggling with reading (see later), they may become permanently trapped in the lowest percentiles of the language proficiency distribution.

Verbal fluency

Verbal fluency (also known as *The Controlled Oral Word Association Test*) is often mentioned as a task that displays gender differences. The test involves naming as many words as possible in a minute, starting with either a specific letter (the phonemic task) or belonging to a specific category (e.g., animals). A meta-analysis (Barry et al., 2008) including 134 studies found no gender difference on the verbal fluency task, only clear effects of education and age.

Language and brain lateralization

The idea that men are more lateralized than women gained popularity in the 1970s (Harris, 1978; Levy and Reid, 1978; McGlone, 1980), but dates back more than 100 years (Crichton-Browne, 1879). The idea captured popular imagination, although it was controversial from the beginning (e.g., Fairweather, 1982). During the early years of functional imaging, a number of influential studies supported the early claims by reporting a more bilateral pattern of activity during language processing in women compared to men (Shaywitz et al., 1995; Kansaku et al., 2000; Phillips et al., 2001). However, a meta-analysis on 26 studies (including more than 2100 participants) found no significant effect of sex on language lateralization in functional imaging studies, neither in children nor in adults (Sommer, 2004; Sommer et al., 2008). Several methodological issues in studies on sex differences in language lateralization have been raised (Kaiser et al., 2009; Wallentin, 2009; Rippon et al., 2014), one of these being publication bias favoring positive effects. However, since the publication of Sommer and coworkers' meta-analyses, a number of studies have been published that replicate the null-finding in lateralization difference (Hirnstein et al., 2013; Wallentin et al., 2014; Somers et al., 2015; Nenert et al., 2017).

Historically, the idea that males are more lateralized has been linked to prenatal testosterone exposure (Geschwind and Galaburda, 1985). However, a meta-analysis on the effect of prenatal testosterone exposure on the direction of lateralization did not find an effect in humans (Pfannkuche et al., 2009). It thus seems that the gender differences observed in verbal behavior are uncoupled from brain lateralization (Hirnstein et al., 2018).

LANGUAGE AND GENDER IN DISORDERS AND IN THE DISEASED BRAIN

Language in sex chromosome aneuploidies

Sex chromosome syndromes represent an obvious test-case for whether parts of language function are tied to genetic sex. A number of different sex chromosome aneuploidies exists. Here, only the trisomies are discussed: 47, XXY (Klinefelter syndrome), 47, XYY (XYY syndrome) and 47, XXX (Triple X syndrome).

Klinefelter syndrome (KS), 47, XXY, is the most frequent sex chromosome syndrome (1 per 660 live born males) (Gravholt et al., 2018). People with KS are phenotypically male, but have an extra X chromosome. They typically have small testes, hypergonadotropic hypogonadism, and testosterone deficiency along with a number of more or less outspoken neural, cognitive, and psychological traits (see Gravholt et al., 2018 for an extensive review). Given that people with KS have an extra X-chromosome and lack testosterone, one could expect their linguistic profile to lean towards the stereotypical female profile. This, however, does not turn out to be the case. KS people score significantly below education matched controls on a range of cognitive tests with verbal skills displaying the largest effects (Skakkebæk et al., 2015). KS males exhibit deficits in different language domains, including verbal fluency (Boone et al., 2001) and general expressive skills (Rovet et al., 1996). Reading, writing, and literacy are also heavily affected in KS persons (Rovet et al., 1996). A study found that speech and language therapy was needed for 47% of boys with KS, compared to 18% among their male siblings (Bishop et al., 2009). Approximately 50% of both children and adults with KS show some level of dyslexia (Bender et al., 1986). Different genetic functions (Vawter et al., 2007; Bishop and Scerif, 2011) have been suggested to explain the language problems, but none have been replicable so far.

The XYY (47, XYY) syndrome affects one in 1000 phenotypical males (Ross et al., 2009). Contrary to KS, people with XYY syndrome usually have normal testosterone levels (Bardsley et al., 2013). Persons with XYY syndrome display similar linguistic effects to those seen in KS, although they can be more severe (Ross et al., 2009). More than 70% of 47 XYY boys were found to receive speech and language therapy, compared to 18% among their nonaffected male siblings (Bishop et al., 2009). Verbal impairments include difficulty in naming, receptive vocabulary, and oral fluency (Hong and Reiss, 2014). Reading and spelling have also been found to be affected to a similar or worse degree than what is seen in KS (Ross et al., 2009).

Trisomy X (TX), 47, XXX, is the most common female chromosomal abnormality, occurring in approximately 1 in 1000 female births (Tartaglia et al., 2010). TX females also display language problems in the form of speech delays in conjunction with other cognitive deficits and learning disabilities (Tartaglia et al., 2010). 40% of 47, XXX girls received speech and language therapy, compared to 4% among their female siblings (Bishop et al., 2009).

Viewing these effects together, one finds that the different sex chromosome trisomies share a tendency to give rise to problems with language and communication (Bishop and Scerif, 2011). Supporting this, the sex chromosome trisomies have been found to be overrepresented in random samples of children with language and reading disorders (Simpson et al., 2013). The finding that a large proportion (40%–70%) of trisomy persons have a history of speech and language therapy

(Bishop et al., 2009) suggests that a link exists between language development and the burden of an extra sex chromosome, and the fact that 47, XYY boys have the highest rates suggests that adding a Y chromosome may be more detrimental than adding an extra X chromosome. Another study found that the addition of a Y chromosome had a greater impact on pragmatic language, while the addition of an X chromosome had a disproportionately greater impact on structural language (Lee et al., 2012). Further studies are needed to replicate these findings.

All groups also have higher prevalence of autism spectrum disorder symptoms, although TX women may again be less affected (Bishop et al., 2009; Bruining et al., 2009; Tartaglia et al., 2010; Skakkebæk et al., 2014).

Further, it is worth noting that in Turner syndrome, 45, X0, where a woman/girl only has one X-chromosome, language and literacy is usually found to be in the normal range (Murphy, 2009), despite other cognitive deficits. With respect to speech/language deficits, it thus seems that duplication of a sex chromosome is more detrimental than haploinsufficiency.

Language lateralization in sex chromosome trisomies has also been investigated using functional imaging. One study found that KS men were less lateralized than a control group (van Rijn et al., 2008), but this finding has not been replicated (Wallentin et al., 2016), and a recent study failed to find atypical lateralization for any of the sex chromosome trisomies (Wilson and Bishop, 2018b). We thus find a somewhat specific language deficit related to sex chromosome functioning, but without any concrete neural correlate for it. Given the small number of studied cases as well as the large within-group variability, research is still needed to fully understand the significance of these observations.

Developmental disorders

Developmental language disorder

Developmental Language Disorder (DLD), a condition in which there are unexplained and persistent difficulties with language acquisition including vocabulary, sentence structure, and discourse (American Psychiatric Association, 2013), affects 7%–8% of children (Norbury et al., 2016b). Twin studies have suggested very strong heritability for DLD (Lewis and Thompson, 1992; Bishop et al., 1995), and language deficits have been found to be strongly comorbid with other cognitive function deficits (Trouton et al., 2002). No differences in measures of brain lateralization have been found between persons with DLD and typically developing groups (Wilson and Bishop, 2018a).

It has been known for many years that developmental language deficits are more prevalent in boys (Bendel et al., 1989). In accordance with this, a large study of children and adolescents (3–17 years) from Taiwan (Tseng et al., 2015) recently found an increasing gender discrepancy in DLD, going from 1.53:1 in 2004 to 1.83:1 in 2010. No explanation for this change is offered in the paper. In another recent large study, Norbury and coworkers identified children at risk for DLD and found a 2:1 male/female ratio (Norbury et al., 2016a). This is in line with the observations from CDI reports analyzed earlier, where boys outnumber girls 2:1 in the lower 10th percentile of language production scores at 26 months of age (Fig. 6.1C). DLD may thus represent the tail of the normal language acquisition distribution.

Autism spectrum disorder

Autism Spectrum Disorder (ASD) involves persistent deficits in social communication and social interaction across multiple contexts, i.e., not restricted to language (American Psychiatric Association, 2013). A delay in the production of the first words, however, has always been one of the earliest red flags for ASD (Jones et al., 2014), and many ASD individuals have language deficits, ranging from complete lack of speech through language delays, poor comprehension of speech, echoed speech, to stilted and overly literal language. Even when formal language skills (e.g., vocabulary, grammar) are age-appropriate, the use of language for reciprocal social communication is impaired in ASD (American Psychiatric Association, 2013). Prospective studies have confirmed that delays in communication and language development are apparent early in life in children who are later diagnosed with ASD (Mitchell et al., 2006; Jones et al., 2014). ASD and DLD cooccur above chance level, suggesting some degree of shared etiology (Bishop, 2010), and suggesting that the difference between diagnoses is not categorical, but related to differences in how overlapping symptoms are weighted. ASD has also been associated with peculiar tones of voice and disturbances of prosody. Most ASD individuals (70%–80%) develop functional spoken language, but a large proportion display early atypical acoustic patterns, and a meta-analysis has identified significant differences in mean pitch and pitch range (Fusaroli et al., 2016).

ASD is under a high degree of genetic control (Bailey et al., 1995; Sandin et al., 2014; Clarke et al., 2015) and shows a large sex difference. At 8 years of age, 1:42 boys will be diagnosed while 1:189 girls will receive the diagnosis (Autism and Developmental Disabilities Monitoring Network Surveillance Year 2010 Principal Investigators, 2014). With changing diagnostic criteria and increased awareness, these numbers have been changing which has also affected the male/female ratio to some extent (e.g., the same surveillance team found an ASD prevalence of 1:54 (boys) vs 1:252 (girls) in 2008). Within the group of children with an ASD diagnosis, no significant effects of sex have been found, suggesting a similar phenotype in males and females early in development (Reinhardt et al., 2015), although the genetic burden seems to be different (Vorstman et al., 2017).

Childhood-onset fluency disorder (stuttering)

The DSM-V criteria for stuttering (American Psychiatric Association, 2013) are early-onset disturbances in the fluency and time patterning of speech (inappropriate for the person's age) that interferes with communication and academic or occupational achievement.

Twin studies have revealed higher concordance for stuttering in monozygotic (63%) than dizygotic twins (19%), suggesting a genetic factor in stuttering (Howie, 1981). Stuttering most often reveals itself around the second to third year of age. A meta-analysis on studies of language competences in children with stuttering found that stuttering is accompanied by lower measures on overall language, receptive as well as expressive vocabulary and mean length of utterance (Ntourou et al., 2011). The meta-analysis looked at studies with age and gender-matched control groups and did not report gender differences. Further, it did not say whether the lower language competences reflect delayed acquisition or remain into adulthood. Another review, however, found that a large proportion (50%–94%) of early stutterers show spontaneous recovery (Yairi and Ambrose, 2013).

Stuttering actually has a well-known gender skew in prevalence. A survey of the literature for this article revealed 19 studies, where observed stuttering rates for males and females could be established along with measures of uncertainty (McCulloch and Fawcett, 1964; Porfert and Rosenfield, 1978; Ardila et al., 1994; Craig et al., 2002; Månson, 2005; van Borsel et al., 2006; Dworzynski et al., 2007; McKinnon et al., 2007; Mohamadi et al., 2008; Proctor et al., 2008; Akhavan Karbasi et al., 2011; McAllister et al., 2012; Rautakoski et al., 2012; Kefalianos et al., 2014; Abou Ella et al., 2015; Obeid et al., 2015; Mohamadi et al., 2016; Thapa et al., 2016; Gerlach et al., 2018). All studies uniformly reported boys/men to be more prone to stuttering than girls/women (see Fig. 6.5A). The average gender ratio was found to be 2:1 across these studies.

The studies, however, included participants in diverse age groups, both children and adults. Some studies were divided into several age groups (Craig et al., 2002; van Borsel et al., 2006; Dworzynski et al., 2007; Mohamadi et al., 2008). An interaction between gender and age has been observed for recovery, showing a longer recovery time in boys (Månson, 2005). The survey looked at differences in gender prevalence as a function of age (see Fig. 6.5B). As can be seen from Fig. 6.5B, the gender difference never disappears, but diminishes to some extent from middle childhood into adulthood.

Specific learning disorder with reading impairment (dyslexia)

Specific Learning Disorder (SLD) is defined as persistent difficulties in learning and using academic skills (American Psychiatric Association, 2013), which can

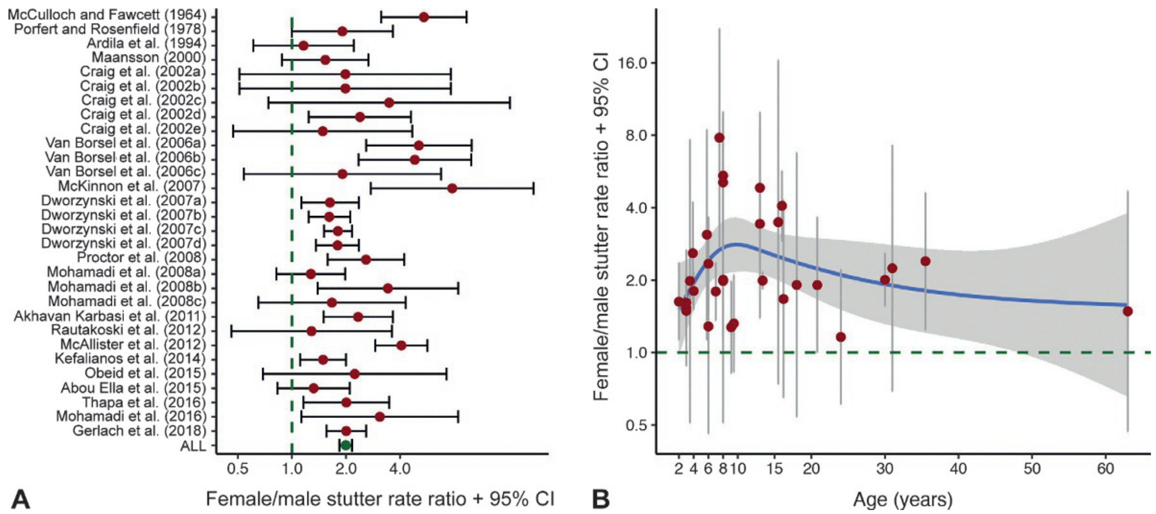

Fig. 6.5. (A) Males have a higher prevalence of stuttering than females (1:1.99) across different studies and age ranges. (B). Most children (50%–94%) show spontaneous recovery. Recovery, however, is delayed for boys, causing a bump in the gender difference in middle childhood.

be more or less selective for skills related to reading, writing, or math. To become literate, the child needs to take a step from implicit to explicit control of the phonemic segments of language. The productive use of an alphabetic script requires an explicit awareness of the elusive phonemes and a conscious control of these units, so that they can be manipulated, substituted, and recombined. This skill is called phonological awareness and its absence is the most important predictor of reading impairment (Lundberg et al., 1980, 2012). As indicated above, boys outnumber girls in the normal distribution of reading competences, and the lowest percentiles are likely to be diagnosed with SLD or *Dyslexia*. Depending on the diagnostic procedures, the gender ratio is found to range from 1.69:1 to 4.51:1 (Miles et al., 1998). These numbers correspond well with the gender ratio found in the lowest 10th percentile of the PISA reading test (see Fig. 6.4) and suggest that reading impairment is not a categorical deficit but a distribution, and that gender differences will vary according to how the cutoff between normal and abnormal is defined with respect to this distribution. A meta-analysis recently documented this effect and estimated the gender odds-ratio to be 1.83 (Quinn, 2018).

NEURODEGENERATIVE DISORDERS

Huntington's disease

Huntington's Disease (HD) is a neurodegenerative autosomal dominant disorder, caused by a CAG repeat expansion mutation in the HTT gene on the short arm of chromosome 4 (Walker, 2007) and usually appears between 30 and 50 years of age at equal rate in both genders. With respect to language, patients in late stages have been found to exhibit a loss of conversational initiative along with dysarthria (Podoll et al., 1988). HD patients exhibit no evidence of word-finding difficulty or other semantic deficits in spontaneous speech, and a study of 1267 HD patients (Zielonka et al., 2013) found no gender difference in HD-specific, language-related measures (verbal fluency, Stroop word task) at baseline and no language-related differences as a function of disease progression.

Parkinson's disease

Parkinson's Disease (PD) is a progressive neurodegenerative disease characterized primarily by motor symptoms, but also a variety of nonmotor symptoms including cognitive decline (Taylor et al., 1986; Elgh et al., 2009). PD is more prevalent in men than in women with a 1.5:1 ratio (Wooten et al., 2004). Core language function is not directly affected by PD, but a worsening of verbal fluency is often observed (Taylor et al., 1986), both as an independent symptom of the disease and as a side effect of treatment. Later stages of PD are often treated with deep brain stimulation of the subthalamic nucleus (Deuschl et al., 2006). Worsening of verbal fluency after treatment with deep brain stimulation in PD patients is one of the most often reported cognitive adverse effect (Højlund et al., 2017). None of the meta-analyses on the verbal fluency effects in PD target gender differences (Parsons et al., 2006; Combs et al., 2015), but one study (Obeso et al., 2012) that included 300 PD patients tested effects of gender in verbal fluency and found none.

Dementia

Dementia is a general term for a decline in mental ability caused by brain disease. Language is affected differently in different types of dementias (Klimova and Kuca, 2016).

Alzheimer's dementia

In Alzheimer's dementia (AD), language and communication are only severely affected in late stages of disease progression. Earlier signs are probably primarily linked to noncore linguistic processes, such as inability to concentrate. Verbal fluency tests, however, are significantly affected. Two meta-analyses (Henry et al., 2004; Laws et al., 2010) compared the magnitude of deficits in tests of phonemic and semantic fluency for AD patients relative to healthy controls. It was found that AD patients were significantly more impaired on tests of semantic fluency relative to phonemic fluency. This may imply a larger relative degradation of the semantic store. However, it may also simply be an exaggeration of a normal tendency for participants to score higher on the phonemic test (Laws et al., 2010) and as such reflect changes in executive functioning rather than linguistic abilities. Laws et al. (2010) found in their meta-analysis that studies with a greater proportion of female AD patients observed less severe degradation of both semantic and phonemic fluency, suggesting that females' verbal reserves are less vulnerable to AD or that those women were simply less affected by the disease at the time of testing.

Primary progressive aphasia

Primary progressive aphasia (PPA) is a disorder of declining language originating in neurodegenerative diseases such as frontotemporal lobar degeneration. Three variants of PPA are recognized (Grossman, 2010): Progressive Nonfluent Aphasia, Semantic Dementia, and Logopenic Progressive Aphasia. No gender bias has been observed, neither in the frequency of PPA

(Hodges and Patterson, 2007; Grossman, 2010) nor in frontotemporal dementia in general (Onyike and Diehl-Schmid, 2013).

The take-home message from this review of degenerative diseases is that language is affected, but not in a gender-specific manner. This argues against the existence of any largescale gender-specific neural systems for language.

ACQUIRED NEUROLOGIC DEFICITS

Stroke and aphasia

Aphasia severity and prevalence

On the surface, large-scale studies of poststroke aphasia have been inconsistent in their reports of gender differences in aphasia incidence rate or severity (Kertesz and Sheppard, 1981; Pizzamiglio et al., 1985; Hier et al., 1994; Pedersen et al., 1995; Engelter et al., 2006; Bersano et al., 2009; Kadojić et al., 2012; Flowers et al., 2013). One reason for this could be that unselected stroke patient groups often have a different age distribution for the two genders, due to the longer lifespan of females (Di Carlo et al., 2003; Kelly-Hayes et al., 2003). A recent meta-analysis (Wallentin, 2018), including 25 studies and a total of 48,362 stroke patients found a consistently higher prevalence of aphasia in female stroke patients than in male, uncorrected for age. Further, in the same paper Wallentin conducted an analysis of data from a large US patient database with 1,900,000 stroke patients and found the same overrepresentation of women among aphasia patients. However, when including a correction for age differences, the gender difference was no longer significant (see Fig. 6.6). This finding speaks against the notion that women have less lateralized language function. If that were true, women would be less vulnerable to poststroke aphasia, under the assumptions that bilaterality would be a protective factor against poststroke aphasia, due to the fact that stroke is usually unilateral.

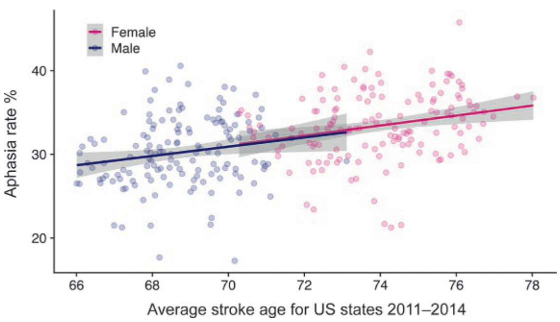

Fig. 6.6. Using data from a US health database, it was found that an observed sex difference in poststroke aphasia could be explained by age differences at the time of stroke. Note that there is no offset between the regression lines for males and females, suggestive of no main effect of sex. Figure reproduced from Wallentin M (2018). Sex differences in post-stroke aphasia rates are caused by age. A meta-analysis and database query. PLoS One 13: e0209571.

Types of aphasia

Studies investigating the relationship between gender and type of aphasia have also failed to find any consistent effects (Kertesz and Sheppard, 1981; Godefroy et al., 2002). Pedersen et al. (1995) studied 880 stroke patients and found no significant relationship between aphasia score and gender, nor any difference between men and women in the distribution of aphasia and anterior–posterior lesion localization.

Aphasia recovery

Most studies (Lendrem and Lincoln, 1985; Pedersen et al., 1995; Pedersen et al., 2004; Inatomi et al., 2008) fail to find gender differences in aphasia recovery (see Watila and Balarabe, 2015 for a review), but a few find larger improvements in women (Basso et al., 1982; Pizzamiglio et al., 1985).

Category-specific deficits

The functional organization of conceptual knowledge has been a central topic in cognitive neuroscience since Warrington described the first cases of selective impairments for particular semantic categories in patients with brain injury (Warrington, 1975; Warrington and Shallice, 1984; Warrington and McCarthy, 1987). It was initially found that comprehension of artifacts could be relatively preserved compared with comprehension of biological entities and vice versa. Other subdivisions of category specific impairments have also been suggested, e.g., within the category of biological entities, it has been found that brain injury can disproportionately disrupt the processing of fruit and vegetable concepts relative to animals (Capitani et al., 2009).

In the past decades there have also been reports of gender differences in these category specific deficits. In a review of single case studies (Gainotti, 2010) it was found that 70% of patients with category specific impairments were male, while only 30% were female. Furthermore, it was observed that 20 out of 21 (95%) patients with a greater impairment for fruit and vegetables were males, whereas 9 out of 11 (80%) patients with a predominant impairment for animals were females.

However, if these gender differences were to have an evolutionary origin, one would expect them to be present in a healthy population of young individuals raised in a society with a large degree of gender equality. Contrary to this, no evidence of gender differences in category-specificity was found in a relatively large sample ($N > 350$) drawn from such a population (Gerlach and Gainotti, 2016). Gender differences in semantic processing and deficits may thus reflect differences in familiarity with particular semantic categories, originating in gender roles or gendered interests, as we saw play out with word use (see earlier).

PSYCHIATRIC DISORDERS

Depression

The prevalence, incidence, and morbidity risk of depressive disorders are higher in females than in males, beginning at mid-puberty and persisting through adult life (Piccinelli and Wilkinson, 2000; Parker and Brotchie, 2010). The diagnosis of depression (American Psychiatric Association, 2013) crucially depends on subjective report, i.e. language. The symptoms that can be observed without a verbal report, such as weight change or sleep disturbances, are not sufficient to diagnose a depressive episode (Bech et al., 1975; Bagby et al., 2004).

Language use on social media has been found to be predictive of depression (Eichstaedt et al., 2018). Language-derived estimates of personality and demography can be used to differentiate users of the social media platform Twitter who disclose a diagnosis of depression from random controls users of the platform (Preotiuc-Pietro et al., 2015). Adding gender (estimated from language use) to the model was found to significantly improve prediction of depression. One aspect of depression is an increased self-focus and perseveration of self-relevant information (Pyszczynski and Greenberg, 1987). In line with this, a meta-analysis found that across different types of language production tasks, depression was linked to an increased use of first-person pronouns (Edwards and Holtzman, 2017; Eichstaedt et al., 2018). The effect size was small ($r = 0.13$), but higher than other linguistic correlates of personality traits (Edwards and Holtzman, 2017). Prior to a suicide attempt, Twitter users also present more self-focused language (Coppersmith et al., 2016). It is impossible not to speculate on the connection between these findings and the fact that women have both more frequent use of first person pronouns (see earlier) and greater depression rates. Edward and Holtzman, however, did not find any moderation of the correlation between pronoun use and depression by gender, although it was nominally higher in females. A possible link, though, is neuroticism, a personality trait known to increase the risk for depression and be more frequent in females (Fanous et al., 2002; Goodwin and Gotlib, 2004) and also linked to increased use of first person pronouns (Schwartz et al., 2013). Again, it seems that on a population basis, the gender difference in mood-related self-centering and the accompanying use of first person pronouns is negligible (small effect size); however, when looking at the tail of the distribution, where mood and word use may turn into a vicious cycle, females outnumber males. Again, we have no brain correlates of depression as a categorical diagnosis, perhaps because it is simply the tail of a normal distribution.

Schizophrenia

The origin of schizophrenia has speculatively been linked to both sex and language. It has been suggested to be "the price that *Homo sapiens* pays for language" (Crow, 1997), the idea being that schizophrenia is a side-product of language evolution, tied to brain lateralization that, again supposedly, relies on the sex chromosomes. There is some evidence that schizophrenia is linked to smaller degrees of lateralization (Sommer et al., 2001; Bleich-Cohen et al., 2009; Somers et al., 2009), but this has not convincingly been tied to gender differences (Sommer et al., 2003). There are, however, multiple other observed gender differences in the symptomatology of schizophrenia (e.g., Falkenburg and Tracy, 2014; Mendrek and Mancini-Marïe, 2016). Here, I focus on symptoms linked to language.

Hallucinations are among the defining characteristics of schizophrenia. Auditory hallucinations, most often in the shape of voices, are the most common form of hallucinations in schizophrenia and related disorders (American Psychiatric Association, 2013). Auditory hallucinations are experienced by around 60% of all patients diagnosed with a schizophrenia spectrum disorder (Waters et al., 2014). While auditory verbal hallucinations (AVHs) are in themselves linguistic phenomena, the science of AVH is further complicated by the fact that it can only be studied by verbal reports. The tendency in the population to hear voices is probably distributed along a continuum (Strauss, 1969; van Os et al., 2000; Johns et al., 2014), and depending on how the question is asked, studies find that between 0.6% and 84% of the population (median: 13.2%) has experienced AVHs (Beavan et al., 2011). One theory is that AVHs are from our own inner voice, which is misinterpreted as belonging to somebody else (Frith, 1992; Moseley et al., 2013).

It has been reported that women in the normal population hear voices more often than men, with reports estimating a 50% higher prevalence in women (Tien, 1991; Murphy et al., 2010; Dolphin et al., 2015) with some cultural differences (Johns et al., 2002). A similar difference has been found in schizophrenia patient samples (Marneros, 1984; Rector and Seeman, 1992). However, representative population samples of normal 7–8-year-old children (Bartels-Velthuis et al., 2010), as well as 11–12-year-old (Yoshizumi et al., 2004), found no gender difference in AVHs. Studies of overall prevalence of hallucinations (both auditory and others) have also failed to find gender differences (Scott et al., 2009). A recent population study on adults also failed to find a significant gender difference in the frequency of hearing voices (Kråkvik et al., 2015). Overall, these findings make it difficult to affirm or disconfirm the presence of gender differences in AVHs; but if they exist, their effect size may not be as large as previously believed.

Interestingly, the most dominant voice heard by psychotic patients with AVHs is usually male (70%), both for women and men (Nayani and David, 1996).

Gender differences in overall language function in schizophrenia patients have also been found with men reported to perform worse than women (DeLisi, 2001; Walder et al., 2006; Bozikas et al., 2010). Other studies, however, have found other and/or more general cognitive deficits in men, not linked to language in particular (Goldstein et al., 1998; Han et al., 2012). Yet others find no effect (Goldberg et al., 1995). Thus, although language plays a central role in schizophrenia, no clear picture has emerged on gender differences in language-related symptoms.

SUMMARY AND SYNTHESIS

Language plays a huge role in human life and, as a consequence, also in development and brain function. Gender and sex differences in language can be signs of deeper cognitive differences, but may also be the primary cause for them.

Three models for gender differences were presented: strongly innate differences linked to genetic sex, cultural gender difference linked to environmental asymmetries, and interaction accounts in which nonlinguistic differences influence language function.

The only example of a clearly innate language effect linked to sex is the difference in voice quality. The development of differences in the fundamental frequency of male and female voices is under strong genetic and hormonal control, and the result is two more or less completely separate distributions, allowing precise classification of sex on the basis of very small speech segments.

The remaining observations of gender differences in language all belong to the other two models.

There is very little evidence for the hypothesis that females are inherently more “expressive” than males, given that both genders use a similar amount of words, although they often use them to talk about different things and in a slightly different manner. The general picture from development is that girls and women have a slight linguistic advantage over boys and men, but gender as a categorical variable explains very little of the variance in linguistic proficiency seen across the population, with effect sizes usually in the small range. Males, however, outnumber females among the lowest scoring percentiles in language tests (approximately 2:1), and since certain developmental deficits arise from a poorly functioning language (including developmental language disorder, dyslexia, stuttering, and autism), males also clearly outnumber females in these diagnoses.

This leads to a situation where your perspective on gender differences in language determines the conclusion. If you focus on the population as a whole, gender differences in language are negligible, but if you focus on the parts of the population with developmental language deficits, gender differences are real and tangible. As of yet, no neural correlates have been found for these disorders, even though they are highly heritable; perhaps because developmental language deficits are simply the tails of the normal spectrum rather than categorical deficits.

There is no support in the literature for the hypothesis that males and females differ on large-scale functional brain systems for language. No difference in lateralization is found in meta-analyses of neuroimaging studies of language processing, and while poststroke aphasia is more prevalent among females than males, this effect seems to be an age confound rather than a gender effect because on average, women are older at age of stroke. Language related symptoms in neurodegenerative disorders, such as Huntington’s disease, Parkinson’s disease, and dementias, also show no consistent gender differences.

Differences in word use can be observed among the genders, making it possible to decode gender on this basis with a high degree of certainty. The two genders apparently have diverging interests, and this is reflected in language use. It is an open question if this is due to innate and/or cultural differences. One of the interesting findings is that women use more first person pronouns. The same phenomenon is observed in depression and given that women more often get diagnosed with depression, there might be a link. This needs to be investigated further. Again, it seems that the overall effect size is small, but there may be reasons that cause females to outnumber males in the tail of the distribution.

Across sex chromosome trisomies, language is affected to a larger degree than other cognitive functions. Thus, it is not the underlying phenotypical gender, but rather the presence of an added chromosome that seems to be dispositive for the primary effect, although some evidence points to a larger impact of an additional Y chromosome than of an X. It thus seems that adding an extra chromosome is one way in which people are pushed towards the lowest percentiles of the language proficiency distribution. However, many other unfortunate combinations of genes may trigger vulnerability to language deficits, with each gene only contributing with a very small effect. Only a minority of these will be related to sex.

The same logic applies to environmental effects. Most likely, there are a multitude of reasons for boys enjoying reading less than girls on average, and this can lead to diverse effects on language skills in general, depending on whether boys chose to replace reading with other language-supporting activities.

Future work should aim at studying the dynamic processes during development where language plays a role and where early gender differences might send a subset of boys and girls out on divergent linguistic trajectories. Likewise, it is worth considering if the role language plays in psychiatric disorders can somehow be altered by linguistic interventions. Psychotherapy is often a type of linguistic intervention, but other interventions specifically countering maladaptive linguistic behavior, such as self-centered inner and outer voices and speech, could be considered as well. The impact of such an intervention may turn out to show a gender difference.

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