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Sex Differences in Emotional Processing in Language

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Abstract: Many studies report sex differences in language processing, but there is still no consensus about differences between men and women in language processing. However, the sex differences in emotional processing are more evident and consistent. In this paper, some studies on sex differences in specific emotional area: emotional processing in language, empathy and pragmatic aspect of language, and humor processing are reviewed. These results demonstrate that women engage more emotion-related brain areas than men and the results are in consistent with sex-related cognitive style strategy hypothesis, that is, men and women favor different cognitive strategies during emotional processing. Based on the findings, sex-related cognitive strategies hypothesis and extreme male brain hypothesis are discussed. Men and women favor different cognitive strategies during emotional processing, and women show more sensitivity to emotion processing in language. Although biology may play a role to affect sex differences, the most important factor might be the different cognitive strategies employed by men and women influenced by sex hormones. The favor of different cognitive styles encourages women to have stronger drive to empathize and play the key role in sex-related differences in emotional processing in language, empathy and pragmatic reasoning, and humor processing. It is concluded that women are more efficient than men in emotional processing.

Keywords: Sex Differences, Emotional Processing, Empathy, Humor

1. Introduction

There are a lot of biological differences between men and women, and of particular interest are sex differences in brain which receive the extensive concern for decades. Language processing is a considered a highly valued variable reflecting sex differences in brain which has been widely investigated.

Many studies report sex differences in language processing. Women advantage in language learning and production than men [15]. Furthermore, it is reported women advantage in verbal memory, language ability, grammatical usage, and phonological processing compared to men [16, 21]. But some other results appear inconsistent and no or only marginal sex differences was observed [32, 33]. Although there is no agreement between sex differences in language processing, some studies demonstrated subtle but consistent temporal differences in the phonetic processing of speech [37, 19, 25]. Methodological and statistical issues and publication bias might explain the mixed results in part.

It seems that there is still no consensus about differences between men and women in language processing because of the divergent results. However, the sex differences in emotional processing are more evident and consistent. In this paper, some studies on sex differences in specific emotional area: emotional processing in language, empathy and pragmatic aspect of language, and humor processing are reviewed. And based on the findings, it is proposed that beyond the stereotypes of sex differences, findings about emotional sex differences in language support sex-related cognitive style strategy hypothesis and extreme male brain hypothesis and may help to understand the nature of sex differences between men and women better.

2. Emotional Processing in Language

In spite of some inconsistent findings, meta-analyses have found that women have an advantage in decoding non-verbal emotional cues than men, and women not only process sensory emotional information more efficiently but also combine vocal with sensory emotional information better than men [31]. It is evidenced that women use the prosodic cues more automatically than men, while men rely more on emotion content of lexicon [26, 14, 9]. Moreover, the prosodic

cues and content might influence semantic processing with an additionally enhancement activity in the left inferior frontal gyrus for women [27].

Although men and women engaged very similar neural resource to process speech, a sex-dependent modulation was discovered in the processing of emotional content in language. There are a wealth of findings of the differences between men and women of brain activations in emotional processing. During the emotional speech processing, the activation of brain area engaged in semantic processing is affected by sex, but brain areas involved in emotional prosodic processing were not [27]. It is reported that although the common neural resource is recruited for emotional processing, women automatically engage emotion in paralinguistic decoding, while men is task performed [27].

According to Beaucousin et al., (2011) [3], a larger engagement of orbital inferior frontal gyrus (IFGorb) was observed in men compared with women during emotional processing. Due to the area is also engaged in semantic processing [4, 35], they suggest that men recruit lexico-semantic areas during emotional processing more than women. Therefore, men rely on left inferior frontal areas more than women to process emotional speech, which suggesting they rely more on lexical contents and cues in emotional semantic processing.

The results are in consistent with sex-related cognitive style strategy hypothesis [6, 17], that is, men and women favor different cognitive strategies during emotional processing. When processing emotional speech, women engage more areas involved in emotional prosodic processing, but men engage more brain areas involved in semantic areas. I will turn back to this hypothesis in the last section.

3. Empathy and Pragmatic Aspect of Language

Increasing studies suggest women are more efficient than men in empathy, that is, women show more sensitivity to emotion processing and sympathetic attitudes to others [2]. Grounded on these findings, Baron-Cohen (2003) has proposed that the brain of men has weaker drive to empathize compared with women.

Theory of Mind (ToM), the ability of mindreading, has been suggested to be a cognitive component of empathy and the other is affective component [2]. According to Singer (2006) [30], the brain neural resource underlying affective empathy are similar but distinct from cognitive empathy. It has been found that women are advanced in affective empathy than men [10]. While divergent results are reported in cognitive empathy between men and women compared to affective empathy [8, 5], some studies report significant greater action of ToM areas of women than men [5, 12]. These results might give evidence of the possible sex difference in cognitive empathy processing.

Moreover, ToM is deeply interwoven with pragmatic reasoning due to pragmatic aspect of language involves integrating world knowledge with context and making inference [11]. The close relevance between ToM and pragmatic aspects of language is evidenced by many brain imaging studies [11, 23]. According to Eriksson et al., (2012), girls are observed to be more advanced than boys in ToM and pragmatic reasoning. And Frank et al. (2015) reports that, women engage more brain areas underlying cognitive empathy and affective empathy than men, which might explain women advance in pragmatic aspect of language than men.

In a nutshell, women engage more networks underlying cognitive empathy and affective empathy than men and it might partly explain why women advance in pragmatic reasoning of language.

4. Humor Processing

It is pervasive that men have higher verbal humor production abilities to produce funny remarks than women [18, 29]. Related with social functions of humor, men are more willing to produce humor, while women are more willing to appreciate humor. This sex difference may be partly relevant to the divergent styles in humor processing between men and women.

A number of studies report sex differences in humor processing, such as: Women recruit the bilateral inferior Frontal Gyrus (IFG) area more than men in humor processing [1]. Kohn et al. (2011) [22] has reported that women engage the ventral emotion processing system and process humor through limbic reactivity involving more emotional processing more than men.

Humor processing includes a set of cognitive processes. Sex differences in humor processing include the integration of cognitive and emotional components in the processes. According to the review of Vrticka et al. (2013) [36], the temporo-paretal junction (TPJ) area is associated with the cognitive component, and mesocorticolimbic areas are correlated with the emotional component in humor processing. It is found that men and women are very different in the incorporation of cognitive and emotional components in humor processing. It indicates the more recruitment of emotion-related brain regions in women than men. Therefore, women employ more neural resources to incorporate cognitive and emotional components, while men employ more automated processes [7].

In brief, these results demonstrate that women engage more emotion-related brain areas than men in humor processing.

5. Discussion

Overall, findings about emotional sex differences above are helpful to better understand the nature of sex differences between men and women. The results of studies in specific emotional areas: emotional processing in language, empathy and pragmatic reasoning, and humor processing, support sex-related cognitive strategies hypothesis and extreme male brain hypothesis.

Cognitive style strategy hypothesis, as mentioned before, asserts that individual men and women can modulate neural resources differently to reach similar performances. The results of emotional processing in language reviewed above are in line with sex-related differences in cognitive style strategy hypothesis. That is to say, men and women favor different cognitive strategies during emotional processing, and women show more sensitivity to emotion processing in language. To be specific, women engage more neural correlates involved in sensory and prosodic processing, while men engage more areas involved in semantic areas in emotional processing in language. And women engage more networks underlying cognitive empathy and affective empathy than men and advance in pragmatic reasoning in language. In addition, women engage more emotion-related brain areas than men in humor processing and at the same time the interplay between cognitive and emotional components is more influential in women.

Furthermore, I propose that sex-related cognitive strategies hypothesis is consistent with E-S theory of sex difference [2]. That is, the male brain is Type S (systemizing) brain, which might have a weaker drive to empathize. On the contrary, female brain is Type E (Empathizing) brain, which has a stronger drive to empathize. I may attribute the distinct drive to empathize to the favor of different cognitive strategies. Grounded on the E-S brain theory, Baron-Cohen (2003) [2] has postulated the extreme male brain hypothesis which proposes that women have greater hemispheric connectivity than men. According to Baron-Cohen (2003) [2], autism and Asperger's syndrome represent the exacerbation of the male's brain. Autism spectrum conditions (ASC) affect men far more than women with the important deficits in emotion expressions [28]. And ASC might be an extreme form of male brain, because ASC have decreased neural connectivity between ToM areas and left hemispheric language brain areas [24].

It is alleged that the origin of sex difference is partly associated with levels of sex hormones, such as the function of testosterone. It is evidenced that testosterone can influence cognitive style [34] even the neural structure and function of the brain [13]. It is supposed that due to the different cognitive strategies favored by men and women which are affected by biological sex hormones, female brain is more efficient than male brain in emotional and empathy processing in language.

Additionally, it should be noted that sex differences are also interwoven with social and cultural constructions from social-cultural perspectives. It is postulated that biological differences in neural networks and function are deeply shaped by social environments and experience. Since Lakoff (1975) claiming women's language are more hesitant, indirect, emotional than men's, a plethora of studies attempt to explore the relationship between sex and social factors. From this prospective, sex differences are affected by biological factors and social factors simultaneously, and are context-dependent [20]. However, social factors alone cannot explain all sex differences, due to some differences are present very early before socialization and experience. Biology may play a role to affect sex differences, and the most important factor might be the different cognitive strategies employed by men and women which are affected by sex hormones. The favor of different cognitive styles encourages women to have stronger drive to empathize and play the key role in sex-related differences in emotional processing in language, empathy and pragmatic reasoning, and humor processing.

6. Conclusion

Results of sex differences studies in specific emotional areas: emotional processing in language, empathy and pragmatic aspect of language, and humor processing, support sex-related cognitive style strategy hypothesis and extreme male brain hypothesis. Biology may play a role to affect sex differences, but the most important factor might be the different cognitive strategies employed by men and women affected by sex hormones. Due to the different cognitive strategies favored by men and women which are influenced by sex hormones, women are more efficient than men in emotional processing.

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