Transsexualism and sex-related differences in hemispheric asymmetry

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Abstract. Sex differences in human brain lateralization are documented by studies on normal subjects, patients with the unilateral brain damage, and individuals with atypical level of hormones. However, there is no agreement as to the specific role of gender in the development of hemispheric asymmetry. This experiment was designed to examine whether gender identity plays an important role in the formation of brain lateralization, as some recent data seem to suggest. A group of subjects showing gender dysphoria (transsexuals) and two groups of control male and female subjects were presented with verbal and visual-spatial tasks. Results show that neither biological sex nor gender identity are sufficient factors to determine the pattern of hemispheric asymmetry.

Key words: hemispheric asymmetry, sex differences, transsexualism
INTRODUCTION

A great deal of data regarding possible of sex influence on human brain lateralization have accumulated over the last decades (for reviews see McGlone 1980, Bryden 1982, Beaton 1985). Some of these findings do not support the idea of sex differences in the pattern of the human cerebral asymmetry (Fairweather 1982). Others favour the notion that the brain is more lateralized in females than in males (Buffrey and Gray 1972, Moore and Haynes 1980). However, the most popular and well documented finding is that male subjects have a greater functional asymmetry than female subjects (McGlone 1980, Harshman 1983, Wood et al. 1991).

Sex differences in hemispheric asymmetry and in some cognitive abilities (Buffery and Gray 1972, Maccoby and Jacklin 1974, Kimura 1992), have been associated with the level of gonadal steroids (Geschwind and Galaburda 1985, Williams 1991, Witelson 1991). Many investigations performed predominately on animals (Dorner 1980, Dimond 1990) but also on human subjects (Waber 1976, Kally 1990, Swaab and Hoffman 1984), have shown that sex hormones have an organizational effect on the prenatal/perinatal brain during the critical period and might irreversibly alter its functions. Clinical studies demonstrate that patients with atypical early level of sex hormones e.g., women with congenital adrenal hyperplasia (CAH) (Slijper 1984, Nass 1987), women exposed during their fetal life to high level of maternally ingested diethylstilbestrol (DES) (Hines and Shipley 1984), or men with Klinefelter syndrome (Netley and Rovet 1984) showed atypical patterns of cognitive skills and functional asymmetry. Moreover, there are data which indicate that level of sex hormones might influence the pattern of the hemispheric asymmetry and cognitive functions also in postnatal life (Goy and McEwen 1980). Puberty seems to be the particular time when this effect may be distinct. As Weber (1976) has reported, early-maturating adolescents (regardless of sex) perform better on tests of verbal than spatial abilities, whereas the late-maturating ones show the opposite pattern. Furthermore, subjects maturating late, as boys usually do (Money and Ehrhard 1982), are more lateralized for speech than those maturating earlier (Waber 1976). And since the most conspicuous effect of prenatal androgen treatment has proved to be a delay in the onset of maturation, it might be suggested that it is timing of puberty which correlates with cognitive functioning and degree of brain asymmetry, but not sex per se (Money and Ehrhard 1982). Additionally, a growing body of evidence indicates that both the pattern of hemispheric asymmetry and cognitive performance are sensitive to the level of sex hormones in adulthood (Gouchie 1991) as well as to their fluctuations in women over the menstrual phases (Chiarello et al. 1989, Heister et al. 1989) or in men during the annual cycle (Kimura 1992).

Recent data have shown that sexual differentiation in the brain function is a very complicated process of several stages (Goy and McEwen 1980) and is influenced by various psychosocial components such as social learning and conditioning (Maccoby and Jacklin 1974). Research on the possible effects of sex on brain lateralization includes, therefore, not only comparison of male and female populations, but also homosexuals and heterosexuals (Gladue 1988, Sanders 1992) and endocrinological patients. The purpose of the present research was to study the cerebral lateralization in another group of subjects showing a clinical sex-related problems, namely transsexual patients. This gender dysphoria manifests as an incongruence between the biological sex and the self-declared gender identity (Gooren 1984, 1990). Transsexuals, in terms of their chromosomes, hormones and anatomy, correspond to their phenotypic sexual characteristics, but they feel that they are members of the opposite sex. Some authors, however, suggest that transsexualism is caused, by atypical level of hormones in prenatal life, during the critical.

To our knowledge there is only one study concerning cognitive functioning of transsexuals. This study by Buchanowski and Andreew (personal communication) revealed that gender identity was a pivotal factor for cognitive performance. Both fe-
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male-to-male transsexuals (those individuals with a
female body but a feeling of being male) and control
males performed better than females on spatial
tasks. Male-to-female transsexuals as well as fe-
males exceeded males on verbal tasks.

The present experiment is an attempt to study the
problem of brain asymmetry in transsexual sub-
jects. Specifically, we tested whether the pattern of
hemispheric asymmetry in transsexual subjects de-
pends on phenotypic sexual characteristic or on the
self-declared gender.

METHODS

Subjects

Twelve female to male transsexuals, aged 17 to
30, were selected to participate in this study. Trans-
sexualism had been diagnosed in each patient by Dr
S. Dulko’s team in the Department of Sexuology
and Pathology of Human Relation, Medical Centre
of Postgraduate Education, Warsaw. All of the pa-
tients were studied prior to any medical treatment
and to surgical sex reassignment. A control group
of 72 students (36 females, 36 males), aged 18 to 27,
was recruited from different departments of both
Warsaw University and Warsaw Polytechnic
School. All subjects were right-handed as assessed
by the Brigges and Nebes questionnaire (Brigges
and Nebes 1975), with no left-handed relatives in
their immediate family. They had normal or cor-
rected to normal vision and did not report head trau-
ma in their postnatal life. All subjects were naive
about the purpose of experiment and were paid for
their participation.

Material and procedure

The experiment consisted of two sessions, each
with a different kind of stimulus material: verbal (12
Polish 3-letter nouns) and spatial (12 square-wave
gratings with different spatial frequencies ranging
from 1.00 to 6.70 c/deg). In our earlier studies
words and gratings were found to be processed bet-
ter by the left and right hemispheres, respectively
(Czachowska-Sieszynska et al. 1985, Grabowska et
al. 1989, Sobóta and Grodzicka 1989, Grabowska
et al. 1992). The stimuli were prepared in the form
of slides and displayed on a screen using a Kodak
Carousel projector with an electronic shutter. Each trial began with a brief acoustic signal. A
subject, sitting at 1.5 m. in front of the screen,
pressed a button in order to display the stimulus.
Every word or grating was presented randomly to
the left or the right side of a fixation point (a black
dot of 0.35 deg. located in the centre of the
screen) for 20 ms. After each exposure the sub-
ject was shown a response slide with 3 different
words or gratings. The response slide followed
the stimulus slide with a 400 ms delay. The re-
sponse (yes/no) indicating whether the exposed
stimulus was on the response slide or not, was
given verbally. The importance of maintaining
fixation on the fixation point was stressed and the
subject was informed that this was necessary to
be able to perceive the stimulus. The distance be-
tween the dot and the inner border of the exposed
stimulus was 3.15 deg. The order of the two ses-
sions was counterbalanced across every group.
Each session consisted of 144 trials, 72 in each
visual field, divided into four 36-trial blocks. Rest periods were given at the end of each block
and one longer break (5 min) separated the two
sessions.

The error data were collected and a laterality
index (LI) was calculated for each person and for
each kind of stimulus (Marshall et al. 1975) accord-
ing to the following equation:

\[
LI = \frac{E_{RVF} - E_{LVF}}{E_{RVF} + E_{LVF}} \times 100\%
\]

where \(E_{RVF}\) is the number of errors committed in
the right visual field and \(E_{LVF}\) is the number of er-
rors committed in the left visual field. Positive
values of LI denote lateralization to the left side of
the brain, whereas negative values denote lateraliz-
ation to the right side. The absolute value of LI
shows the degree of lateralization.
RESULTS

The number of errors committed in the left and in the right visual field is graphed in Fig. 1 and Fig. 2 for words and gratings, respectively.

These data were submitted to two separate analyses of variance for words and one for gratings. In both analyses Field (right/left) was a within-subject variable and Group (males/females/transsexuals) was a between-subject variable. For the verbal task only the main effect of Field was significant ($F=158.01, df=1/81, P<0.0001$). Post-hoc analysis revealed the right visual field advantage in each of the three groups ($P<0.0001$, 2-tail-Student $t$-test).

For the grating task no visual field differences were observed. However, the main effect of Sex was significant ($F=3.28, df=2/81, P<0.05$) with males making more errors than females ($F=6.28, df=1/70, P<0.02$) and slightly more than transsexuals ($F=1.15, df=1/46, N.S.$). The interaction did not reach statistical significance.

To assess the possible differences between the three groups in the degree of lateralization (Fig. 3 and Fig. 4) a two-way MANOVA on the laterality
index data with Material and Group as factors was performed. The analysis showed a significant effect of Material ($F=151.2$, $df=1/81$, $P<0.0001$). This effect resulted from high values of the laterality index for words and much smaller index values for gratings. Neither the GROUP factor nor the interaction reached statistical significance.

The results confirmed previous findings of greater left hemisphere involvement in verbal tasks (positive values of the laterality index) and no clear hemispheric asymmetry in grating processing, the laterality index being close to zero. Although the three groups of subjects did not differ significantly either in general pattern or in the degree of lateralization, it is noteworthy that transsexuals showed the highest degree of lateralization for processing of both words (RVF advantage) and gratings (LVF advantage).

**DISCUSSION**

The results of this study show that the three groups of subjects do not differ in the pattern of hemispheric organization pattern in either a verbal task or a spatial task. As in many other studies (Beaton 1985, Sobótka and Grodzicka 1989), subjects demonstrated a distinct advantage of the right visual field in a word recognition task, but there were no statistically significant sex differences. In the grating recognition task no superiority for either visual field was observed. The failure to obtain the expected right hemisphere superiority for this kind of task might be related to the fact that this effect is usually not very strong and depends on the specific nature of the task as well as on the interaction of task variables with characteristics of the visual stimulus and mode of presentation (Kitterle et. al. 1991). The results of the present study as well as the lability of previous findings may illustrate the complexity of sexual differentiation of the human brain (Dorner 1988). The trend toward slightly stronger hemispheric asymmetry in transsexuals than in two control groups might suggest that gender identity may also play a role in the development of brain lateralization. Our observation were limited to only one group of transsexuals (female-to-male) as most patients in the Sexuology Clinic were of that type. Studying brain lateralization in male-to-female transsexuals would be of great interest.

To summarize, our results show that neither biological sex nor gender identity are significant factors in determining the pattern of hemispheric asymmetry for either the verbal or nonverbal task used in this study. Further investigations with the larger samples of both female to male and male to female transsexuals may shed more light on this field.

**ACKNOWLEDGEMENT**

This research was supported by a statutable grant from the State Committee for Scientific Research to the Nencki Institute.

**REFERENCES**


