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Mirror Imaging in Twins: Biological Polarization – an Evolving Hypothesis

A. Golbin[1], Y. Golbin[1], L. Keith[2,3], D. Keith[2]

[1]Department of Psychiatry, University of Illinois at Chicago, and the Department of Psychiatry, Cook County Hospital, Chicago, IL; [2]Center for Study of Multiple Births, Chicago IL; [3]Department of Obstetrics and Gynecology, Northwestern University Medical School and the Prentice Women's Hospital and Maternity Center of Northwestern Memorial Hospital, Chicago, IL

Abstract. This study examined sleep patterns in twins, paying special attention to the mirroring phenomenon. Concordance and discordance of sleep related patterns (parasomnias) in a group of 27 monozygotic (MZ) mirror image twins were compared to sleep patterns in a group of 53 MZ non-mirror image twins and a group of 24 dizygotic (DZ) twin pairs. Sleep patterns had the lowest concordance among MZ mirror twins. "Mirroring" was observed not only in facial features but also in some physiological patterns such as sleep and sleep deviations. These facts suggest that mirroring in MZ twins is not merely a superficial epiphenomenon, but a reflection of a biological polarization. Biological polarization in this context is a descriptive term emphasizing the role of biological (physiological, biochemical or even genetic) versus psychological or environmental factors causing not only mirror body image but opposite tendencies in the development of personality, professional and sex orientation and, most importantly, the opposite presentation of pathology.

Key words: Twins, Mirror imaging, Sleep, Sleep disorders, Genetic

INTRODUCTION

The study of twins is a classical scientific method, which was established in the last century. It has been widely used for differentiating genetic from non-genetic factors in the pathogenesis of various diseases and conditions. In its traditional form, "twin study" consists of comparing the frequency of concordance and discordance of a specific

disorder or phenomenon in monozygotic (MZ) and dizygotic (DZ) twin pairs. If the concordance of disease "X" is significantly higher among MZ compared to DZ pairs, genetic factors are considered to be dominant in the pathogenesis of the "X" disorder. In contrast, if the difference in concordance between MZ and DZ pairs is not significant, environmental rather than genetic influence is considered most important. The fact that concordance between identical twins in a particular study rarely if ever achieves 100%, is generally explained by the influence of environment [3].

The attractive simplicity of the classical twin method enhanced its popularity and made twin study an indispensable scientific tool [3,7,10]. In recent years, however, serious questions have been raised regarding the validity of the method and the subsequent interpretation of results derived from it. A complete review of this debate has been presented by Parisi [10]. Identical twins are no longer considered a truly homogeneous group. For example, data support the presence of important differences in dentition among identical twins [2,9,11,16] and it has been shown that identical twins may differ psychologically [8] and, may not always be genetically identical [5,16]. Identical twins sometimes also differ in hand preference, or lateralization [1,12,13,18]. The process of lateralization is frequently characterized as "the mirror imaging phenomenon".

Recognition of the mirror-imaging phenomenon in twins by physicians and other interested parties dates back several centuries, but relatively little attention has been paid to this subject recently, with two notable exceptions. Mirror imaging is clearly demonstrable in the dental findings pertaining to normal twins, as well as those with facial dysmorphologies such as cleft lip, cleft palate, and supernumerary teeth [2,11,17]. Mirror imaging in twins has also been discussed extensively as a secondary phenomenon of lateralization [1,13,18]. Despite these observations, it is not clear how often mirroring occurs. It is also unclear whether mirroring is merely a superficial epiphenomenon, or a reflection of a deep biological subdivision, or biological polarization. Furthermore, the clinical significance of mirror imaging is unknown. Because the literature on sleep patterns in twins is scant [6,13], in this paper we will present some of our findings from a recent clinical study, and attempt to relate them to what is known about mirroring in the form of a hypothesis.

MATERIALS AND METHODS

The present study was conducted during the Annual Twins Day Festival, in Twinsberg, Ohio (1990). A standardized questionnaire containing 50 questions was used. Questions were grouped into three major areas: 1) individual twins' experience regarding perinatal development and past medical history; 2) physical and emotional similarities and differences; and 3) anatomical, functional, medical and psychological evidence of "mirroring". Details of sleep patterns were included as a fourth and subjectively neutral factor of unknown significance to the research subjects, thus making them difficult to manipulate. Questions about sleep patterns, especially parasomnias, were based on the 1990 International Classification of Sleep Disorders [15]. Zygosity was determined on the basis of the responses from the individual pairs, or from data obtained from their past involvement in twin studies. In some cases, confirmation of zygosity status was provided by medical documentation sent at a later date.

After the survey document was completed by both members of the twin pair, additional information was obtained by informal interviews with each twin, first separately, then together, and in some instances with accompanying relatives and close friends. Verbal interactions followed the principles generally applicable to the interview processes used in psychiatric and sleep research. During these interviews, numerous candid photographs were obtained by an unobtrusive photographer who attempted to capture the interactions of the twins and the interviewer. The subjects willingly cooperated with the survey, interview, and photography processes. Approximately 200 individuals walked up to the research team and asked to participate; the remainder were referred by other research groups at the festival, or responded enthusiastically to verbal requests as they walked by the survey station.

Data analysis was conducted in two phases. The first included all 286 twin pairs (230 MZ, 46 DZ, and 10 of unknown zygosity) who answered the field study questionnaire regarding sleep patterns and subjective understanding of similarities and differences that might reflect mirroring. The second phase was a more comprehensive analysis of a subset of 80 of the original 230 MZ pairs with known MZ, and 24 of the 46 DZ pairs. Children under 6 and adults over 55 years old were eliminated from the study.

We classify mirroring as follows 1) *Anatomical Mirroring*: facial structure (e.g., eye, nose, teeth, and chin asymmetry), opposite hair whirls and hairline direction; 2) *Functional Mirroring*: opposite eye, or ear dominance; nasal cycle (right or left nostril breathing dominance); hand and foot dominance; 3) *Medical Mirroring*: history of opposite dental or skin lesions, or opposite tendencies in blood pressure, blood sugar, and/or thyroid function tests; and 4) *Psychological Mirroring*: opposite temperament, educational, or vocational interests, and sexual orientation. A group of 27 mirror MZ twins was compared with a group of 53 pairs of non-mirror MZ twins and 24 DZ pairs. Analysis of variance was used to test the significance of the differences found.

RESULTS

The initial analysis of questionnaires from the 230 pairs of MZ twins and the 46 pairs of DZ twins, using the individual respondents' subjective understanding of mirroring, showed a surprisingly high percentage of mirroring among identical (51, or 22%) compared to fraternal (4, or 9%) twins. The distribution by age and sex of the 230 MZ and 46 DZ pairs are presented in Tables 1 and 2.

The distribution of mirroring by age is consistent among MZ twins. In contrast, mirroring among fraternal twins disappears after adolescence. The sex distribution of "mirroring" was equal among the DZ pairs, but was wholly confined to females in the DZ group. The second phase of the analysis used data from the subset. Based on the same criteria for the identification of mirroring, an even higher proportion were identified who considered themselves as mirror twins: 27 of 80 MZ twin pairs (33.1%) compared to 4 of the 24 DZ twins (16.6%).

The distribution of sleep related patterns (parasomnias) between mirror and non-mirror MZ as well as DZ twins is different (see Graph). Several findings are worthy of mention. First, discordance of parasomnias in the mirror MZ twins is much higher than in non-mirror MZ, or DZ twins. In fact, it may reach 100% in specific parasomnias,

Table 1 - Age distribution of mirror twins among identical (MZ) and fraternal (DZ) twins

	Twin type					
	Identical twins			Fraternal		
Age	Total	Mirror	%	Total	Mirror	%
<-7	64	16	25.6	22	2	9
7-13	41	10	24	9	2	22
14-17	35	8	23	2	0	0
18-24	29	7	24.1	8	0	0
25-44	61	12	19.4	3	0	0
45-60	8	2	25	1	0	0
>60	13	3	23	1	0	0
Total	230	51	22.2	46	4	9

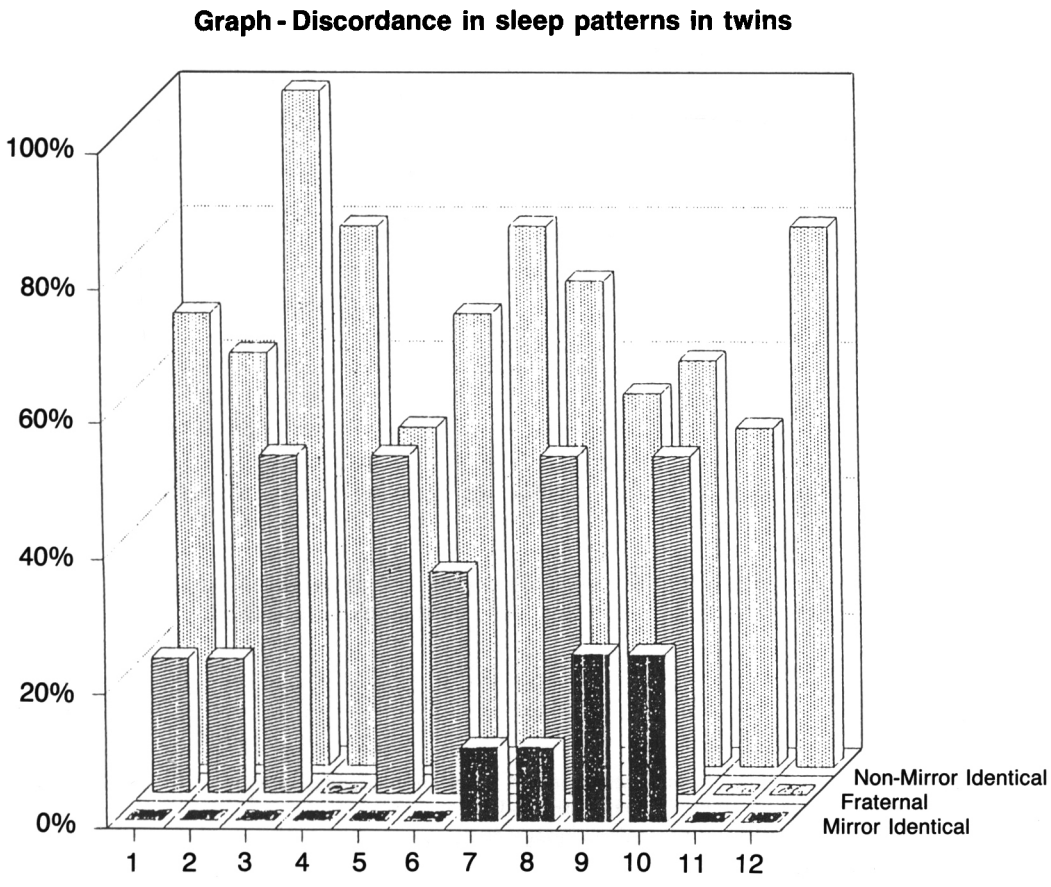
Table 2 - Sex distribution of mirror twins among identical (MZ) and fraternal (DZ) twins

	Twin type					
	Identical			Fraternal		
Sex	Total	Mirror	%	Total	Mirror	%
M	87	20	23	10	0	0
F	143	31	22	36	4	11
Total	230	51	22	46	4	9

such as bedwetting, rocking, and sleep violence, as well as sleep paralysis and daytime sleep attacks. In contrast, non-specific symptoms such as difficulties in falling asleep, multiple awakenings, and late sleepiness were discordant to a lesser degree. In some parasomnias in which 100% discordance was achieved, it is reasonable to characterize these differences as "polarization". For example, in the "mirror" MZ twins, 11 sets out of 30 (36.6%) exhibited complete polarization. Among fraternal twins, on the other hand, "polarization" was less frequent (5 out of 30, or 16.6%). Second, discordant symptoms were often multiple and clustered in one twin (comorbidity). For example, one twin had bedwetting, episodes of sleep apnea, and bruxism, whereas the other twin had none of these symptoms. In 14 out of 27 mirror twins, twin A had up to 6 separate symptoms while twin B had none. Third, in mirror twins, opposite tendencies occured with respect to blood pressure, glucose levels, sexual orientation, and certain psychological (temperament) and psychiatric (depressive versus hypomanic) symptomatology.

DISCUSSION AND CONCLUSIONS

Our data permit us to postulate that mirror imaging relates not only to structural features, but may also relate to specific functional and pathological conditions. We



hypothesize that mirroring may be an indicator of biological polarization. In some of our cases, we might substitute the term "polar twins" for "mirror twins" to emphasize the possibility of biological heterogeneity. The question that remains, however, is just what is the underlying mechanism of this phenomenon?

Evidence presently exists that mirroring relates to the organism as a whole, not just to its surface structures. For example, a twin study of insulin-dependent diabetic patients has shown that identical twins are not homogeneous, and that detectable genetic differences exist between concordant and discordant pairs [7]. Given these circumstances, it is reasonable to pose the following questions: 1) Is the process of polarization completed on the genetic level or on the embryonic level?; 2) Is mirroring the final step in the development of asymmetry?; 3) Can different aspects (stages) of mirroring be

documented?; and 4) Is mirroring unique to MZ twins? The syndrome of situs viscerum inversus is an example of internal polarization [4].

The phenomen of polarization of symptomatology also raises several questions for future research. These include: 1) Is observable discordance in some monozygotic pairs the result of mirror polarization rather than environmental influence?; 2) Is it possible that a discordant mirror twin will never have a disease afflicting its cotwin because of genetically induced polarization?; and 3) Is mirroring an adaptive phenomenon? We believe that twin data should be re-examined from these perspectives. These questions and those raised previously would seem to open a whole new area for twin research which, if fully addressed, may relate to issues of fundamental biological importance rather than to superficial dichotomies.

We are fully aware of the limitations of our study, which was executed during an outdoor festival. This work should be carried out again under controlled conditions. Nonetheless, on the basis of our initial observations, we believe that mirroring is not merely a superficial phenomenon, related to facial structures, but rather a phenomenon reflecting biological polarization. Testing this hypothesis is the next step.

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REFERENCES

1. Boklage CE (1981): On the distribution of non-righthandedness among twins and their families. Acta Genetic Med. Gemellol 30:167-187.
2. Carton A, Rees RT (1987): Mirror image dental anomalies in identical twins. British Dental Journal 162:193-4.
3. Elston RC, Boklage CE (1978): An examination of fundamental assumptions of the twin method. In Nance, WE, Allen G, Parisi P. (eds): Progress in Clinical and Biological Research. New York: Alan R. Liss, Inc.
4. Gedda L, Sciacca A, Brenci G, Villatico S, Bonanni G, Guels N, Talone C (1984): Situs viscerum specularis in monozygotic twins. Acta Genetica Med Gemellol 33:81-85.
5. AC Health (1990). Evidence for genetic influences on sleep disturbances and sleep pattern in twins. Sleep 13:318-335.
6. Kehler WC (1969): Sleep EEG pattern in identical twins with developmental discordance. Southern Medical Journal 62:17-22.
7. MacGillavray I, Campbell DM, Thompson B (eds) (1988): Twinning and Twins. A. Wiley.
8. McConaghy N, Blaszczynski, A (1980): A pair of monozygotic twins discordant for homosexuality: sex dimorphic behavior and penile volume responses. Archives of Sexual Behavior 9:123-131.
9. Nik-Hussein NN, Salceda AH (1987): Double teeth with hypodontia in identical twins. Journal of Dentistry for Children 54:179-81.
10. Parisi P, Keith D (forthcoming, 1995): The Twin Method in Multiple Pregnancy, Epidemiology, Gestation and Outcome. Eds. Keith L, Papiernik E, Luke B. London: Parthenon Publishing Group.
11. Potter RH, Nance WE (1976): A twin study of dental dimension. I. Discordance, asymmetry and mirror imagery. American Journal of Physical Anthropology 44:391-395.
12. Runner MN (1984): New evidence for monozygotic twins in the mouse: Twinning initiated in

the late blastocyst can account for mirror image asymmetries. Anatomical Record 209:399-406.
13. Schrader H, Gotlibsen OB, Skomedal GN (1980): Multiple sclerosis and narcolepsy/cataplexy in monozygotic twins. Neurology 30:105-108.
14. Sognnaes NF, Rawson RD, Gratt NM, Nguyen YBT (1982): Computer comparison of Bite-mark patterns of identical twins. Journal of the American Dental Association 105:449-451.
15. The International Classification of Sleep Disorders Diagnostic and Coding Manual (1990). Lawrence, Kansas: Allen Press Inc.
16. Townsend GC, Brown T, Richards LS, Rogers JR, Pinkerton, SI, Travan GR, Burgess VB (1986): Metric analyses of the teeth and faces of South Australian twins. Acta Genetic Med Gemellol 35:179-192.
17. West VC (1985): Case reports. Mirror-image twins. Australian Orthodontic Journal 9:243.
18. Yager J (1984): Asymmetry in monozygotic twins. [Letter]. American Journal of Psychiatry 141:719-720.

Correspondence: Dr. Alexander Golbin, Department of Psychiatry, Cook County Hospital, Chicago, IL, USA.