NeuroReport 10, 3253–3256 (1999)

Incidences of asymmetries for the palmar grasp reflex in neonates and hand preference in adults

Uner Tan[CA] and Meliha Tan[1]

Departments of Physiology and [1]Neurology, Medical Faculty, Blacksea Technical University, Trabzon, Turkey

[CA]Corresponding Author

IT was hypothesized that adult handedness might be predicted from the neonatal grasp reflex. Grasp reflex was measured from right and left hand (10 trials for each hand) in neonates. According to significance for the difference between the mean grasp reflex strength from the right and left hands, the subjects were designated as right-, left-, and mixed-handers. Adult hand preference was assessed by Edinburgh Handedness Inventory. The percentage of left-handedness (8.3%) in neonates coincided with adult left-handedness (6.3–9.2%). The percentage of consistent right-hand preference in adults coincided with percentage of right-handedness in neonates (25.7%). The high percentage of neonatal mixed-handedness was similar to that to be expected from the right shift model of hand preference. It was concluded that left-handedness and consistent right-handedness may be determined prenatally, under genetic and/or hormonal control, and that a large majority of neonatal handedness, mixed-handers, might change their hand preference in favor of right-handedness under socio-cultural and developmental influences of speech centres. *NeuroReport* 10:3253–3256 © 1999 Lippincott Williams & Wilkins.

Key words: Cerebral lateralization; Handedness; Neonate; Reflex; Spinal cord

Introduction

Touching the ulnar part of a baby's hand causes the thumb to come over and lock the object; the other fingers then lock the object very tightly. This is the palmar grasp reflex, which belongs to primitive, cutaneo-muscular polysynaptic reflexes. It emerges at around 11 weeks in utero and is inhibited or suppressed at about 2–4 months after birth. The palmar grasp reflex is due to an inborn coordination of the movements, wich were ascribed to as an instinctive motion allowing a baby to practice grasping and letting go of objects [1]. It is important for grasping the mother's hands, arms and breast for nutrition. It also shares one of the most important functions of the polysynaptic reflexes, i.e. protective action.

The asymmetries in the newborn primitive reflexes were previously studied in relation to later emergence of human hand preference. Interestingly, some of these studies showed similarities to hand preference in adults. Roughly 90% of adults are right-handed and 87% of stepping reflexes were first shown with the right foot [2]. Newborns were observed to turn their hand toward the right 88% of the time [3]. Several models were proposed to account for these observed asymmetric preferences. For instance, the left cerebral hemisphere may be more active than the right at birth, providing a stronger activation of the contralateral limbs and producing orientation in the contralateral direction [4].

The palmar grasp reflex can be divided into three groups: no side diference [5–7]; grasp reflex from the left better than that from the right [8–10]; and a right dominance in grasp reflex [11–13]. Interestingly, Hepper *et al.* [14] and McCartney and Hepper [15] have recently observed that 83.0–85.0% of human fetuses at 10–27 weeks of gestational age move their right arm significantly more often than their left arm. These incidences are very close to hand preference in humans (about 90%). Therefore, these authors have suggested that asymmetrical motor control may be under spinal rather than cortical control; lateralized motor behaviour in early gestation may play a potential causative role for subsequent asymmetrical motor behaviour and brain development. Accordingly, an asymmetric grasp reflex may be important for the asymmetric cortical development regarding hand preference in adults.

The cultural and hormonal milieu may also play a role in the development of human handednes.

Therefore, a comparison between handedness groups in neonates and adults would throw some light on the origins of human handedness. In other words, the incidences of right-, mixed-, and left-handedness for grasp reflex in neonates may have important links to the incidences of the right-, mixed-, and left-handedness in adults. To test this hypothesis, the right-, left-, or mixed-handedness for grasp reflex was assessed in human neonates and hand preference was assessed in adults. The incidences of right-, mixed-, and left-handedness for neonates and adults were compared with each other in the present study.

Materials and Methods

This study was conducted at the Research Hospital of Ataturk University, Erzurum, Turkey. Following approval of Ethical Committee, 327 neonates were recruited for grasp reflex analysis within the 3–5 days after birth. The mothers were visited in the lying-in ward and asked for permission to test the babies. No mother denied our request.

To measure the grasp reflex strength [16], a small balloon was attached to the piston ring of an injector, which was connected to an ohm meter and ammeter. As the balloon was brought into contact with the palmar surface of the neonate's hand, the fingers were reflexely closed (grasp reflex); resistance decreased and the current increased, which was read from the ammeter. Ten reflexes were measured for each hand alternately in fully awake babies. Arbitrary units were used for reflex strengths. The mean values for the right and left hands were compared by using the paired-samples *t*-test. If the mean grasp reflex strength was significantly greater for the right than the left hand, the baby was considered as right-handed; the opposite was left-handed. If there was no significant diference between both hands, the baby was considered as mixed-handed.

A large sample of 1589 female and 2385 male students from Ataturk University was taken for the assessment of hand preference in adults. These subjects ranged in age from 20 to 22 years, and were healthy and devoid of neurological and psychiatric symptoms (self report). No-one declined to participate in the study, i.e. a volunteer bias was absent. Hand preference was assessed by a Turkish translation of the Edinburgh Inventory [17]. The questions pertained to which hand was used for writing, drawing, throwing, scissors, toothbrush, knife, spoon, holding the handle of a shovel (upper hand), striking a match and twisting off the lid of a jar. These students, and some more students, were asked for their hand preference: how do you describe your hand preference, are you right-handed, left-handed or mixed-handed? These comprised the self-described handedness group.

Results

Neonates: Table 1 presents the incidences of the right-, mixed-, and left-handed male ($n = 167$) and female ($n = 160$) neonates. The remarkable feature of this distribution was the relatively high incidence of mixed-handedness (66.1% for the total sample). Another remarkable feature was the incidence of left-handedness (8.3% for the total sample), which was close to that observed in adult samples. There was no significant sex difference in handedness groups ($\chi^2 = 0.65$, d.f.=2, $p > 0.05$).

Adults: Among the self-described handedness group, 3627 of 4037 subjects (90.1%) described themseves as right-handed, 149 (3.7%) as mixed-handed and 251 (6.2%) as left-handed. Table 2 presents the frequencies and precentages of left- and right-handed actions assessed by Oldfield's handedness questionaire in 3974 subjects. As seen in Table 2, the percentages of left-handed actions ranged from 6.3% (writing, drawing, and holding a fork) to 24.7% (holding a shovel). Out of 2645 subjects, 249 (9.4%) preferred the left foot for kicking a ball. The percentages for right-handed actions ranged from 57.8% (shovel) to 93.7% (writing). The proportion was 23.7% (N = 941) for consistent right-handers (always right answers for 10 items).

Discussion

The incidences of right-, left-, and mixed handedness for the grasp reflex in neonates and hand prerence in adults were compared in this study, to reach some conclusions about the development of handedness in humans. The percentage of left-handedness ranged from 7.2% for males to 9.4 for females (8.3% for

Table 1. Incidence of right-, mixed-, and left-handed male and female neonates

Subjects	*n*	%
Right-handers		
Total	84	25.7
Males	42	25.1
Females	42	26.3
Left-handers		
Total	27	8.3
Males	12	7.2
Females	15	9.4
Mixed-handers		
Total	216	66.1
Males	113	67.7
Females	103	64.4

Table 2. Frequencies and percentages of right- and left-handed male and female adults

Actions	LH actions		RH actions	
	Frequency	Percentage	Frequency	Percentage
Writing	249	6.3	3724	93.7
Drawing	249	6.3	3706	93.3
Jar opening	366	9.2	2940	74.0
Knife	269	6.8	3517	88.5
Match	266	6.7	3395	85.4
Scissors	268	6.7	3607	90.8
Shovel	981	24.7	2298	57.8
Tooth	266	6.7	3135	78.9
Throw	276	6.9	3412	85.9
Fork	251	6.3	3224	81.1
Kicking a ball	249	9.4	2037	77.0

LH: left-handed; RH: right-handed

total). Similarly, percentages of items performed by the left hand ranged from 6.3 to 9.2% in our adult sample (see Table 2). The incidence of left-handedness in neonates was, therefore, quite close to that for adults. The left-foot preference in adults (9.4%) was also close to left-hand preference in grasp reflex in neonates. These close proportions of left-handedness in neonate and adults suggest that left-handedness may have its roots before birth.

McCartney and Hepper [18] reported that 11.8% of 17 fetuses exhibited signifiantly more left-hand movements than right-hand movements. In accord with our conclusion, these authors have also suggested that behavioral lateralization would be well established in human fetuses early in the prenatal period. Out of 327 subjects, 84 (25.7%) exhibited right-hand dominance in grasp reflex (see Table 1). Although the incidence of right-handedness is known to be much higher than this in the general population, 25.7% right-handedness matches with the proportion of consistent right-handers (23.7%) in the present work. These similar proportions of consistent right-handedness in neonates and adults suggest that right-handedness might also be prenatal in origin as left-handedness. A large proportion of neonates exhibited mixed-handedness in grasp reflex (66.1%). Annett [19] reported that 66.8% of 241 service recruits showed consistent right-hand preference. This sugests that the mixed-handed neonates may have an inherent tendency toward right-handedness. This tendency may facilitate the child's adaptation to a right-handed world, as a result of the socio-cultural interactions between the right-handed world and his or her self. In sum, we have around 25.0% prenatally determined right-handedness and around 65.0% mixed-handedness waiting to be determined later during postnatal development. If all of the mixed-handers were right-handed in later life, we would have 90.0% right-handedness in general population. This is what to be expected from Annett's 'right shift' genetic model of handedness, which states that ~85–90% of the population inherit a right shift factor (RS+) that predisposes left-hemisphere specialization for speech and right hand dominance [19]. The development of speech centres within the left cerebral hemisphere may, therefore, contribute to the postnatal development of right-handedness.

Conclusion

The incidence of grasp reflex asymmetries in neonates (right-, left-, and mixed-handedness) was compared with incidences of hand preferences in adults in the present work. Left-handedness occurred at nearly the same frequency in neonates and adults, sugesting that left-handedness may have its origins early in prenatal development (genetic or hormonal). On the other hand, the incidence of consistent right-handedness in adults coincided with proportion of right-handedness in neonates,sugesting that consistent hand preference may also have its origins in utero. However, the high percentage of mixed-handedness in neonates did not coincide with low percentage of mixed-handedness in adults. It was sugested that this prenatally indetermined portion of the neonatal handedness might develope as right-handedness as a result of socio-cultural influences and follow the development of the speech centres within the left cerebral hemisphere.

References

1. Lorenz K. *Naturwissenschaften* **25**, 289–300 (1937).
2. Melekian B. *Neuropsychologia* **19**, 707–711 (1981).
3. Turkewiz G. *Ann. New York Acad Sci* **299**, 309–318.
4. Drake RA and Ulrich G. *Int J Neurosci* **50**, 29–35 (1990).
5. McGraw MB. *Am J Dis Child* **60**, 799–811 (1940).
6. Pollack S. *Arch Neurol* **3**, 574–581 (1960).
7. Roberts AM and Smart JL. *Behav Brain Res* **2**, 275–276 (1981).
8. Halverson HM. *J Gen Psychol* **51**, 393–424 (1937).
9. Halverson HM. *J Gen Psychol* **51**, 425–449 (1937).
10. Yu-Yan M, Cun-Ren F and Over R. *Aust J Psychol* **35**, 81–84 (1983).
11. Caplan PJ and Kinsbourne M. *Child Dev* **47**, 532–534 (1976).

12. Petrie BF and Peters M. *Infant Behav Dev* **3**, 215–221 (1980).
13. Tan U, Ors R., *Kurkcuoglu M and Kutlu N. Int J Neurosci* **62**, 1–8 (1992).
14. Hepper PG, McCartney GR and Shannon EA. *Neuropsychologia* **36**, 531–534 (1998).
15. McCartney G and Hepper PG. *Dev Med Child Neurol* **41**, 83–86 (1999).
16. Tan U and Zor N. *Int J Neurosci* **75**, 9–18 (1994).
17. Oldfield, RC. *Neuropsychologia* **9**, 97–114 (1971).
18. McCartney G and Hepper P. *Dev Med Child Neurol* **41**, 83–86 (1999).
19. Annett M. *Br J Psychol* **63**, 343–358 (1972).

Received 9 August 1999; accepted 20 August