Sex Differences in Neonatal State and Lateralized Head Orientation*

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Abstract:
Sex differences in state and head orientation were examined 10 to 22 hours after birth for 50 healthy, full-term, normal, vaginally delivered neonates. None of the males had been circumcised at the time of testing. The procedure required videotaping for 30 min in three different conditions: supine, seated in an infant seat (inclined 35°), and seated in an assistant,s lap after having arms or legs manipulated for 10 s. Videotapes were analyzed for direction of infant,s head orientation and state. Males spent more time in sleep states than females, and females spent more time than males in alert states. The left or right direction of head orientotion was more associated with alert states for females and with sleep states for males. This sex difference may be relevant for sex differences in handedness and other forms of hemispheric specialization of function.

Article:
State is the dominant characteristic of the newborn behavioral repertoire, influencing the infant's display of specific behaviors and reflexes, orientation and responsivity to environmental stimulation, and posture (Casaer, 1979; Korner, 1969, 1972; Prechtl, 1974; Wolff, 1966, 1987). Of particular interest have been reports of the relation between the infant's state and pattern of supine head orientation (Cornwell, Fitzgerald, & Harris, 1985; Michel & Goodwin, 1979). The heads of supine infants are more likely to be oriented laterally during quiet-alert and active-alert states than during a fussy or crying state (Cornwell et al., 1985; Michel & Goodwin, 1979). The present study examines the relations of newborn state and sex to supine lateral head orientation.

The designs of the Cornwell et al. (1985) and the Michel and Goodwin (1979) studies limited the generality of their conclusions about the influence of state on newborn supine head orientation. Both studies assessed state during a very short time period (4 and 3 min, respectively). Cornwell et al. provided no data before the 2-week assessment. Therefore, the data from Cornwell et al. are not very revealing about the influence of state on newborn supine head orientation. The Michel and Goodwin study did focus on the newborn; however, not only was the assessment period extremely short, but the influence of state on head orientation was only a minor aspect of that study. In order to assess the influence of state on newborn behavior, either the length of the observation period must be long enough to insure alert states or procedures must be employed to provoke the alert states.

Control for potential differences between the sexes also must be made when assessing newborn state. Korner et al. (1988) reported that preterm males were more frequently in states of sleep or waking activity (fussiness) at 34 weeks postconceptual age, whereas same-aged preterm females slept less than males and were more often in a quiet-awake state. These sex differences were also found to be consistent across assessment examinations. Some previous reports of sex differences in irritability, responsiveness, and frequency of crying and sleeping in normal, full-term newborns were confounded by male circumcision (Richards, Bernal, & Brackbill, 1976). To our knowledge, there have not been any subsequent reports of sex differences in the organization of states of healthy, full-term newborn infants. Yet, if there are sex differences in newborn state and if state does affect

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newborn supine lateral head orientation, this would provide further information about the relation between newborn head orientation preference and the sex difference observed in later infant hand-use preference (cf., Michel & Harkins, 1986; Michel, Ovrut, & Harkins, 1985).

METHOD

Subjects

Head orientation and state were assessed for 50 healthy newborns (25 females), 10 to 30 hours after birth. Only 3 infants were less than 12 hours postpartum, but a total of 14 infants (7 males) were less than 16 hours postpartum at the time of testing. All were full term (38-42 weeks postmenstrual age), healthy (Apgar > 7 at 1 min and > 8 at 5 min), and vaginally delivered (52% of the mothers received numorphan analgesics during delivery) at the Beth Israel Hospital, Boston. None of the males had been circumcised at the time of testing, and 52% of the female newborns had mothers who received numorphan during delivery. An additional 31 infants (22 males) were lost because they either slept throughout the procedure or because they cried and could only be calmed by swaddling.

Procedure

The newborns had been recruited originally for a study of head-handmouth coordination which required that they be videotaped continuously for 30 min in three different conditions: supine in their bassinet, seated in an infant seat (inclined 35°), and seated in an assistant's lap. Videotaping was conducted in a warm room next to the nursery with the newborn wearing only a shirt and diaper. Each session began with the infant's head being held gently in a midline position for 60 s. The subsequent 9 min of each condition were divided randomly into six 1-min episodes, each of which was preceded by 10 s of stimulation (gentle shaking of the right, left, and both arms; the right, left, and both legs) and two 2-min episodes with no previous stimulation.

This procedure increased the probability that the newborn would exhibit states other than sleeping. Indeed, the procedure may have assessed the newborn's ability to maintain state under conditions of stimulation, to organize the awake/alert state, and to effect state transitions.

The videotapes were paused every 30 s to allow recording of the head orientation (moving, left, right, or midline—chin between left and right nipples) and state criteria that occurred during the 30-s interval. State was determined by noting the occurrence of mouth movements, smiles, vocalizations, startles, gross body movements, and whether the eyes were open or closed during the 30-s interval. According to Prechtl (1974), the pattern of expression of these activities may be used to distinguish five different newborn states (quiet sleep, active sleep, quiet alert, active alert, fussy/crying). We used Prechtl's criteria to assess the state of the newborn. Using a 3-min time window that moves in 30-s steps across the recording period, the infant was identified as being in a state only if the state assessment remained unchanged across six consecutively recorded coding intervals (3 continuous min). Then, the window was moved so that the initial 30-s interval was dropped and the next interval was added in order to make a 3-min window again. If the infant's state description remained unchanged by the addition of the new interval, it was identified as being in that state again. Failure to show 3 min of continuity of state assessment meant that the infant's condition was labeled "undetermined." It remained undetermined until the assessment again revealed 3 continuous min of unchanged state. Thus, it was possible for an infant to have one 3-min state (e.g., alert) separated from another 3 min of the same state by at least 30 s of either another state or an undetermined assessment. Interrater reliability was calculated for 10 infants and was greater than 96% for all categories.

Data for state were summarized in three ways: (a) frequency—the number of times each infant was in each of the six state categories (including undetermined) during the recording period; (b) duration—the length of time the infant was in each state; (c) stability—the number of times the infant changed state during the recording period. The stability measure is not completely independent of the other two. The head orientation preference of the infant was identified by the greater proportion of time (in 30-s intervals) that the head was oriented to one side as compared to the other. Because head orientation preference may be less distinct among newborns less than 12 hours after birth (Turkewitz, 1977) and because in previous research (e.g., Michel, 1981) infants were at least 16 hours postpartum at the time of assessment, some of the data were analyzed by analysis of variance with one factor representing whether or not the infant was less than 16 hours old at the time of testing. The second factor was the infant's sex.

RESULTS

Male and female newborns did not differ significantly in the average number of different states (M=3.0, SD=1.0; M=2.8, SD=0.7, respectively) that they exhibited during the testing period, t(48)=0.85 p<.10. Also, there were no significant sex differences in the average duration of the undetermined state category (male: M=3.1 min, SD=2.1; female: M=2.8 min, SD=2.6) during the testing period, t(48)=0.43, p>.10. However, there was a sex difference in the frequency of expression of the five states, x2(4)=12.90, p<.05. Females expressed State 3 (quiet alert) more often than males, and males expressed sleep states (States 1 and 2) more often than females (Table 1). There was also a significant sex difference in the duration of the five states (Table 2). Duration did not vary significantly among the states, F(4, 61)=1.76, p>.10, and there was no significant State by Sex interaction, F(4, 61)=2.05, p>.10. However, females remained in their states longer than males, F(1, 46)=4.08, p>.05. No other differences in duration were significant, including the difference in age groups, F(1, 46)=2.64, p>.10.

Analysis of variance for the stability measure showed that males made significantly more transitions among states than females (M=2.7, SD=1.2; M=1.9, SD=0.7, respectively), F(1,46)=6.23, p=.01. Again, no other differences in the state stability measure, including the two age groups, were significant. The majority of state transitions for females was from alert states to crying/fussy (52%) or from crying/fussy to alert (26%); whereas

TABLE 1
Mean Percent Frequency That Each State Was Expressed by Male and Female Neonates

	State				
Sex	Sleep 1	Sleep 2	Alert 1	Alert 2	Fussy/Crying
Males	37	20	6	6	31
Females	11	17	32	9	30

TABLE 2
Mean Length of Time (in Minutes) Spent in Each State for Male and Female Neonates

	State		
Sex	Sleep (1 & 2)	Alert (1 & 2)	Fussy/Crying
Males	6.3	4.0	5.0
Females	10.0	7.0	8.0

TABLE 3
Number of Male and Female Neonates Exhibiting Right, Left, or No Head Oreintation Preference According to Age Group

	Age Group (Hours Postpartum)			
	< 16 Hours		> 16 Hours	
Head Orientation Preference	Males	Females	Males	Females
Right	4	2	9	9
Left	2	5	2	2
None	1	0	7	7

the majority of state transitions for males was from sleep (States 1 and 2) to sleep (31%) and from crying to crying (33%). This means that for males, sleeping and crying/fussy states were often punctuated by periods of at least 30 s in which state was undetermined, thereby allowing more transitions from sleep to sleep and crying to crying.

There was no significant difference between males and females with respect to their head orientation preferences, x2 (3)=0.34, p<.10. However, Table 3 shows that the distribution of head orientation preferences may differ according to the age-group classification (above or below 16 hours of age at testing). Of the younger females (under 16 hours), 57% had leftward head orientation preferences; whereas only 7% of the older females had leftward head orientation preferences. However, the cell sizes are too small for reliable statistical assessment. There were no distinct age differences in distribution of head orientation preferences of the males.

There were significant sex differences in head orientation according to the state of the infant, x2(2)=18.30, p<.001, and this was independent of infant age group. For males, a head orientation was most likely to occur during sleep states (1 and 2); whereas, for females, a head orientation was most likely to occur during an alert state (Table 4). Thus, female newborns were more likely to be in an alert state and to remain in that state than were males. When in an alert state, females were more likely than males to orient their heads to one side.

TABLE 4
Association of Male and Female States With the Presence or Absence of Head Orientation
(Numbers are Mean Percent Time for Each State)

	Head Orientation			
	Present		Absent	
State	Males	Females	Males	Females
Sleep (1 & 2)	55	7	33	33
Alert (1 & 2)	12	63	13	13
Fussy/crying	33	29	54	54

DISCUSSION

During a half-hour examination period in which the newborn's limbs are frequently, but briefly, shaken, females are more likely to be in an alert state (quiet or active), and to remain in that state, than males. When in their alert states, females are more likely than males to orient their heads to one side. These results confirm the relation between newborn state and head orientation (Michel & Goodwin, 1979) and identify a sex difference in newborn head orientation that may prove relevant for understanding the sex difference in infant handedness (Michel et al., 1985). The data from female newborns confirm the report by Cornwell et al. (1985) that the heads of 2- and 4-week-old infants are likely to be oriented laterally primarily during alert states. However, the head of the newborn male infant is more likely to be oriented laterally during sleep states.

Perhaps the sex difference in the association between newborn state and head orientation is a consequence of the sex difference in state. Because males are more likely to be in sleep states, lateral head orientation is more likely to overlap with sleep than with other states. Likewise, because females are more likely to be in alert states, lateral head orientation is more likely to overlap with alert than with other states. Future studies will need to control for this potential artifact by comparing male and female head orientation during equivalent durations of alert and sleep states.

The newborn sex differences in state organization observed in the present study is coordinate with the results of Korner et al. (1988). They reported that female premature infants were more likely than males to remain in alert states during the ministrations associated with a neurobehavioral assessment technique. Together with our results, this suggests that the sex difference may be more a reflection of differences in the ability to initiate, maintain, and control a waking (alert) state during handling than a general sex difference in overall state regulation. Males may be less able than females to cope with the stimulation provided by the manipulations of the investigator. Males seem to return quickly to sleep or to move to a crying/fussy state. Females seem to be able to maintain the alert states.

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