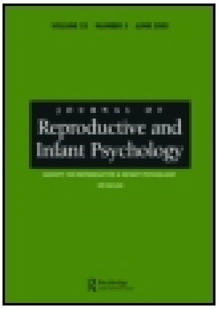

Journal of Reproductive and Infant Psychology
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/cjri20

Sucking rates of human babies on the breast; a study using direct observation and intraoral pressure measurements

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Version of record first published: 11 Dec 2007.

Journal of Reproductive and Infant Psychology 4:69–75 (1986)

Sucking rates of Human Babies on the Breast; A study using Direct Observation and Intraoral Pressure Measurements

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Sucking patterns of human babies on the breast were recorded using intraoral pressure measurements and direct observation. In a comparison of the presence or absence of sucking on each record for consecutive 2-sec periods, the records concurred 92% of the time; the contingency coefficient was 0.65; χ^2 was 1156.2, $p<0.001$. In a comparison of the number of sucks recorded by the two methods in each burst correlations (r_s) between the two for individual babies ranged from 0.82 to 0.99, with $p<0.001$ in each case. Both methods showed that intersuck intervals on the breast vary from 0.5 to 1.3 sec around a single mode of 0.7–0.8 sec. There is no distinction into two rates of sucking, nutritive and non-nutritive, but rather a continuous grading between the two.

Introduction

Many research problems concerning human lactation depend upon the measurement of sucking; of the time and patterning of nursing bouts (eg Konnar and Worthman, 1980; Howie & Ors, 1981) or of the sucking pattern within them (eg Woolridge & Ors, 1980). Psychologists have traditionally measured sucking patterns by feeding the baby on bottles equipped with pressure transducers (Crook, 1979; Kaye, 1967). But this is obviously not a suitable method if the focus of interest is the lactation itself: a practical method for recording sucking rates on the breast is to film the baby's mouth using a videotape recorder, and then determine the sucking pattern by analysis of the tape, as in Drewett and Woolridge (1979) and Bowen-Jones & Ors (1982). These studies showed that the behaviour of babies on the breast is organized into bursts of sucks separated by rests. The intersuck intervals (within bursts) range from 0.5 to 1.3 sec, and are determined by milk flow: the higher the milk flow rate the slower the sucking rate.

Babies on bottles are described as having two different modes of sucking—'nutritive' sucking, a regular pattern of sucks at about one a second, and 'non-nutritive' sucking, in which bursts of sucks at about two a second are separated by rests (Wolff, 1968). The 'nutritive' mode is seen when milk flows, and the 'non-nutritive' mode when it does not. We have not found a bimodality

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0264–6838/86/010069–07$05.00

of this kind on the breast: there is, rather, a complete grading of sucking rate, in response to milk flow. Particularly because of this difference, we wished to check the validity of recording sucking rates by direct observation. In this article we report the results of an experiment in which the sucks of breast-fed babies were recorded simultaneously by direct observation and by monitoring intraoral pressure.

Method

Eight breast-fed babies, 5–7 days old, were used as subjects. Five were boys and three were girls; mean birth weight was 3552 g. The sucking patterns were recorded in the John Radcliffe Hospital, Oxford, during a normal breast feed, as in Drewett and Woolridge (1979). The mother summoned us when a feed was imminent, and nursed the baby as usual.

Records of sucking were made from one breast only, once for each baby. For intraoral pressure measurement we used a sterile paediatric nasogastric tube. This was a flexible PVC tube 38 cm long, external diameter about 1.3 mm (5 fr. gauge). The end is sealed with two holes in the side. The tube was taped to the surface of the mother's breast so that it projected 1 cm beyond the end of the nipple into the baby's mouth. Changes in intraoral pressure were monitored with a Statham pressure transducer. Whenever the negative pressure fell below a threshold (set at about 75 mmHg) a 6 kHz signal was recorded on magnetic tape for subsequent computer analysis. For direct observation videotaped records of the sucking pattern were made using a portable Sony videorecorder (AV-3420CE) system. The camera was positioned 3–4 ft from the baby's face. In most instances it was easy to obtain an unobstructed view of the baby's mouth. The videotapes were subsequently viewed at normal speed and a button depressed by hand whenever a suck was observed, recording a 6 kHz signal onto magnetic tape for comparison with the intraoral pressure measurements.

Results

Figure 1 shows an example of the sucking record. Although the aim was to obtain simultaneous records by the two methods, there were inevitably times at which only one type of record was successfully made; for example, the video record was lost if the mother obscured the baby's mouth, and the pressure record was lost if the pressure line was blocked within the baby's mouth. Sucking was recorded simultaneously with both techniques for a total of 55 min 10 sec, and in five of the eight babies dual records were successfully obtained for at least 80% of the time. So we were able to assess the validity of our direct observational method by comparing it with the intraoral pressure measurements as follows:

1. *Presence and absence of sucking*

The traces were compared by noting the presence or absence of sucking in succeeding 2-sec sections of each trace. The data are summarized as a 2 × 2 contingency table (Table 1). The records concurred for 92% of the 2-sec epochs.

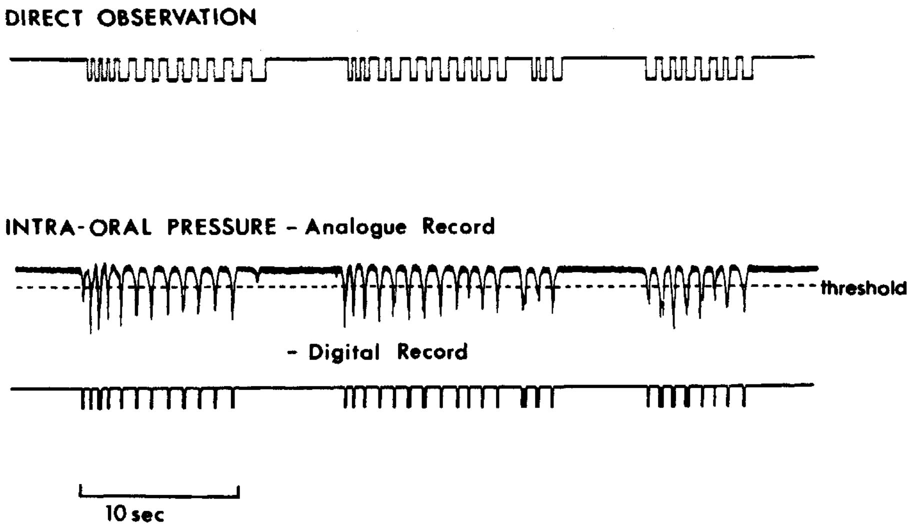

Figure 1: Sucking recorded simultaneously by direct observation and by intraoral pressure measurements. The top trace shows the record made by direct observation. The middle trace shows the pressure record, and the bottom the digital record derived from the pressure record

Overall, χ^2 was 1152.6 with 1 df, p<0.001. The contingency coefficient was 0.65.

Table 1 suggests asymmetry in the direction of errors; the most likely error is that the video method will record sucks when the automatic method does not.

Table 1: Presence (+) and absence (−) of sucking in consecutive 2-sec periods, as recorded by direct observation and intraoral pressure measurements. Contingency coefficient = 0.64; χ^2 = 1152.6, df = 1, p<0.001

		Direct observation		
		+	−	
Itraoral	+	888	33	
pressure	−	104	630	
				1655

In Table 2 the significance of this asymmetry was tested for each of the eight cases individually. In two (nos 4 and 6) it was significant. In both cases the threshold was set too low, resulting in the complete loss of 100 sec of sucking from the pressure record. Excluding these cases, the level of error fell between 2.5 and 8.5% for each case.

2. *Number of sucks per burst*

Babies suck in bursts. In this analysis we correlated the number of sucks in each burst as recorded by the two methods. A 'burst' was defined as a sequence of

Table 2: Presence and absence of sucking in consecutive 2-sec periods, as recorded by direct observation and intraoral pressure measurements. This table shows the error for each subject (ie % of 2-sec periods with sucking recorded by one and not the other techniques). Chi^2 with Yates correction values are from the McNemar test for the significance of changes, and are a test of consistency of the direction of the error

Subject	% errors	χ^2
1	2.6	0.17 NS
2	5.8	0.00 NS
3	2.5	1.50 NS
4	11.3	12.90 $p<0.001$
5	8.5	0.00 NS
6	27.8	35.5 $p<0.001$
7	5.3	1.07 NS
8	7.6	0.75 NS

sucks with intersuck intervals less than 2 sec. Agreement between the two recording methods was tested by a Spearman rank correlation, with sign tests used to check whether one technique produced a consistently larger number of recorded sucks.

Figures 2 and 3 show these records, summarized as in Drewett and Woolridge

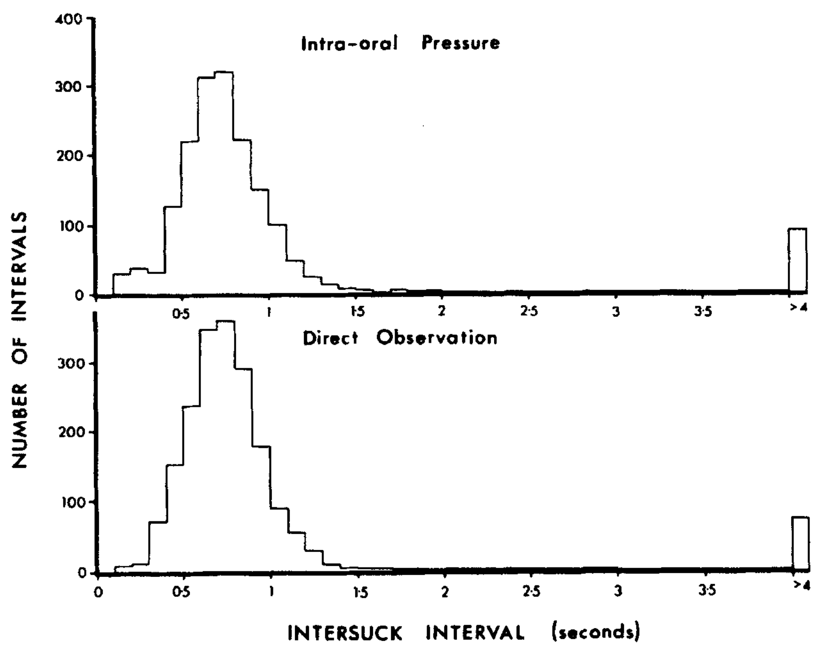

Figure 2: Histogram of intersuck intervals recorded by direct observation and by intraoral pressure measurement

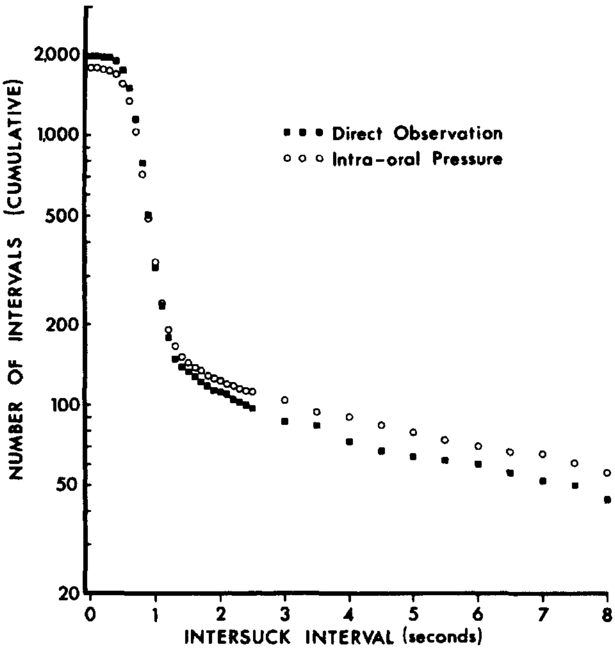

Figure 3: Log survivor function of sucking pattern on the breast recorded by direct observation and by intraoral pressure measurement

(1979) as histograms (Figure 2) and log survivor functions (Figure 3). These confirm our previous finding that intersuck intervals fall on two distributions, one of short (<1.3 sec) intervals within bursts and the other of long (>1.3 sec) intervals between bursts. Both types of record show the same graded distribution of intersuck intervals from 0.5 to 1.3 sec; there is no separation into the 'nutritive' and 'non-nutritive' rates found on bottles.

Table 3: Number of sucks per burst, recorded by direct observation and intraoral pressure measurement. The sign test tests for consistency and in the direction of the error, where the ranks differ

	Correlation coefficient			Sign test		
Subject	r_s	df	p	N	x±	p
1	0.99	21	<0.001	14	1−	<0.001
2	0.90	26	<0.001	19	6+	NS
3	0.99	23	<0.001	16	6+	NS
4	0.96	24	<0.001	14	5+	NS
5	0.82	14	<0.001	12	4+	NS
6	0.85	10	<0.001	10	3+	NS
7	0.98	29	<0.001	20	7+	NS
8	0.97	15	<0.001	14	5+	NS

There was a strong relationship between the number of sucks per burst recorded with the two techniques; correlation coefficients fall in the range 0.82–0.99 (Table 3). In every case, the correlation was significant at at least the 0.001 level. Although there was the tendency for the observational technique to record more sucks per burst, this difference was not significant in any individual. In one subject, however, the automatic technique recorded significantly more sucks per burst than the observational technique.

Discussion

These results show satisfactorily close agreement between sucking patterns recorded by direct observation and by intraoral pressure measurements. This agreement is shown in two ways:

(1) Sucking was recorded simultaneously using the two methods for a period of 55 m in 10 sec divided into a sequence of 2-sec sections, and each scored for the presence or absence of sucking by the two methods. The records concurred in 92% of cases. The contingency coefficient was 0.65. Since the upper limit for the contingency coefficient from a 2 × 2 table is 0.71, this indicates a high correlation.

(2) When the number of sucks per burst was measured by both methods the correlations ranged from 0.82 to 0.99 for individual babies. In only one case was there a significant difference in the number of sucks per burst recorded.

For research in which the focus of interest is on sucking pressures as such, clearly pressure measurements are indispensable. Such an interest might arise, for example, in relation to the aetiology of petechial lesions of the nipples, which have been attributed to high negative pressures maintained by the baby for excessively long periods during non-nutritive sucking (Gunther, 1945). There was no indication to us that the presence of the tube itself affected sucking directly, and the sucking rates and distributions of intersuck intervals were similar in this and in our previous studies in which sucking rates were recorded by direct observation without the pressure line in place (Drewett and Woolridge, 1979; Bowen-Jones & Ors, 1982).

There are two main sources of error with pressure recording. The pressure line can become blocked by the soft tissue of the mouth and breast; and small sucks or drift in the baseline pressures may lead to a failure of accurate detection by the recording system. The second problem could be overcome by a more sophisticated detection system, for example one responsive to rates of change rather than just pressure level. The first we have found intractable, and it is for this reason that the technique is not easy to use.

For many purposes, however, the method of direct observation would be adequate, and in some ways preferable. It does not interfere at all with the mother or baby, and can be used with ease in most circumstances. And as we have shown in this article, its use does not lead to any systematic error. The pressure recording obviously gives the most accurate record of the exact intersuck intervals, but these are generally not critically important as it is likely to be the average ISI over a period of time, ie the sucking rate, that is of interest (eg Woolridge & Ors, 1980; Bowen-Jones & Ors). This is unaffected by small unsystematic errors and is reliably measured with the observational technique (Figure 1).

The distribution of intersuck intervals on the breast (Figures 2 and 3) are essentially the same as we have previously found (Drewett and Woolridge, 1979). The log survivor function shows two distinct exponential distributions, one of intervals less than 1.3 sec (intersuck intervals within sucking bouts) and one of greater than 1.3 sec (pauses between bouts). As regards intersuck intervals, the modal interval is 0.7–0.8 sec, and there is a graded distribution of intersuck intervals from 0.5 to 1.3 sec. Although there are differences between breast and bottle feeding in the movements of the baby's tongue (Weber & Ors, 1986) we believe that the main difference between sucking patterns in breast and bottle fed babies derives from differences in milk flow. We show elsewhere that the sucking rate on the breast varies as a function of milk flow rate (Bowen-Jones & Ors, 1982). The relationship is linear, with an intersuck interval of 0.5–0.6 sec when no milk flows rising to 0.9–1.0 sec at a flow rate of 0.5 g/suck. The highest and lowest sucking rates on the breast do therefore correspond to the nutritive and non-nutritive rates seen on bottles; but sucking rates on the breast are graded continuously between the two, in response to graded changes in milk flow.

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