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## The Duchenne smile with open mouth in infants with Down syndrome

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### Abstract

Duchenne and non-Duchenne type of smiles were studied in infants with and without Down syndrome while they looked at their mother's face or at objects. In infants with Down syndrome the Duchenne smile with open mouth was the most frequent, regardless of the direction of their gaze. The study of different type of smiles may be related to sociocognitive development in children with Down syndrome. © 2002 Elsevier Science Inc. All rights reserved.

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It is well known that adults from the general population express different types of smiles according to the social context. The common morphology of these smiles is the bilateral or unilateral raising of the lip corners as a part of various more or less complex facial configurations with different functional meaning. The type of smile universally associated most clearly with a discrete positive emotional state is that which includes, in addition to the bilateral raising of the lip corners, the raising of the cheeks (Ekman, Davidson & Friesen, 1990). Although also referred to by other terms, such as "felt smile" or "full smile," this type of smile is most commonly known as the Duchenne smile, in reference to the nineteenth-century French anatomist who defined the expression corresponding to frank joy (Ekman, 1989). It is also well known that each type of smile is in some way sensitive to social learning, so that even cultural differences have been described in relation to frequency of Duchenne smiles in typically-developing infants, with higher frequencies being observed in Euro American and Japanese infants than in Chinese infants (Camras et al., 1998).

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With regard to typically-developing infants, the Duchenne smile and other smile morphologies have been described according to social context as follows: a) when infants direct a smile at their mother they display mainly the Duchenne type (Fogel, Nelson-Goens, Hsu & Shapiro, 2000; Fox & Davidson, 1988; Messinger, Fogel & Dickson, 1997), almost always with the mouth slightly open (Jones, Raag & Collins, 1990); b) when infants are in play situations demanding some visual activity (e.g., looking at a storybook), however, they display non-Duchenne smiles, characterized simply by the oblique retraction of the lip corners with relaxed cheeks, generally with mouth closed (Dickson, Walker & Fogel, 1997); and c) during play situations involving tactile stimulation, infants display Duchenne or non-Duchenne smiles with open mouth and a marked dropping of the jaw (Dickson, Walker & Fogel, 1997; Fogel et al., 2000). In conclusion, it can be stated not only that type of smiles may reflect how young infants differentially perceive diverse elements in their environment, but also that their emotional expressions (at least in relation to type of smiles) constitute well-differentiated facial responses that reflect their particular relationship with that environment.

Bearing in mind the above, it may be interesting to analyze the evolution of type of smiles in infants with Down syndrome in order to better define their level of sociocognitive development at a any given point. Considering the cognitive deficit of these children, which manifests itself with time, the studies by Legerstee and cols. (Legerstee & Bowman, 1989; Legerstee, Bowman & Fels, 1992) show that their socioemotional behavior is comparable to that of typically-developing infants, in that they smile and direct their vocalizations more frequently at people than at the objects around them (see also Carvajal & Iglesias, 2000). Nevertheless, these authors did not analyze the kind of smile the infants produced, and we might therefore ask to what extent infants with Down syndrome emit facial expressive responses that are similar to those of typically-developing infants. To date, research has only provided data on type of smiles for children with Down syndrome from age 22 months onwards in child-experimenter interactions, with no differences in frequency of Duchenne smiles reported in comparison to typically-developing infants of equal mental age, although children with Down syndrome do present a higher frequency of non-Duchenne smiles (Kasari, Mundy, Yirmiya & Sigman, 1990). In the light of this result, it would be interesting to determine whether in the first year of life the relative distribution of Duchenne and non-Duchenne smiles in infants with and without Down syndrome is similar to that reported for children over 22 months old.

In an attempt to determine whether infants with Down syndrome react differentially, with different type of smiles, to persons and to objects, as a first step we compared Duchenne and non-Duchenne smiles displayed by infants with and without Down syndrome when they look at their mother's face or when they look at the objects around them in natural interaction conditions with the mother. Despite the differences observed between infants with and without Down syndrome in quantitative parameters such as frequency, duration or intensity of facial expressions associated with emotions, if we assume a similar pattern of emotional development in the two cases (Cicchetti & Sroufe, 1976, 1978, among others; for a review, see Carvajal & Iglesias, *in press*), it could be expected that both typically-developing infants and infants with Down syndrome direct mainly Duchenne-type smiles at the mother and non-Duchenne type at toys, all of these smiles being mainly with open mouth.

In particular, we studied 30 infants, half with Down syndrome with regular trisomy and the other half with a development considered as typical, paired in three age subgroups: ten were aged between 3.2 and 4.6 months, ten between 6.8 and 8.8 months and ten between 10.8 and 13.6 months. Facial behavior was recorded in the family home by means of a video camera situated at a distance of two meters, so that a full-face close-up of the child's face could be obtained. Two 15-min recording sessions were carried out in consecutive weeks; in these sessions the mother sat in front of the infant and interacted with her child in a normal way, spontaneously using any toys or other objects from her immediate environment that she felt appropriate, with the only provision that she should not use a pacifier.

We analyzed the five central minutes of each recorded session, selecting all the expressive sequences in which infants presented, as a minimum requirement, the oblique retraction of the lip corners (AU 12 of Ekman and Friesen's FACS, 1978) and, in order to ensure that these expressions were easily identifiable in real time, it was also required for them to last for more than one second. Each smile selected in this way was subsequently analyzed in the half a second in which the AU 12 acquired its maximum intensity, taking into account the presence or absence of two other facial actions: the raising of the cheeks that pulls inwards the skin surrounding the eyes (AU 6 of the FACS) and the opening of the mouth by means of dropping of the jaw (AU 26 of the FACS).

Four types of smile were thus observed: (1) Duchenne with open mouth (AUs 12 + 6 + 26); (2) Duchenne with closed mouth (AUs 12 + 6); (3) non-Duchenne with open mouth (AUs 12 + 26); and (4) non-Duchenne with closed mouth (AU 12). We also recorded the objective at which each smile was directed: mother's face or toys; verifying that direction of gaze was clearly selective in each case. An independent codification was made of approximately half of the smiles corresponding to the first session recorded for each infant. The agreement index between the two authors was 0.85, according to Cohen's kappa. Table 1 shows the percentages with which infants with and without Down syndrome emitted the different types of smile according to whether they looked at their mother's face or at the toys.

Given that we found no differences according to age (Kruskal-Wallis tests,  $p > .05$ ), we grouped the data and carried out two analyses using the Friedman test, one with the data from typically-developing infants and another with those from the infants with Down syndrome, in which the dependent variable was percentage of smiles and the within-group variable was type of smile. These analyses showed significant effects both in the case of typically-developing ( $\chi^2(3, N = 15) = 26.1; p < .0001$ ), and infants with Down syndrome ( $\chi^2(3, N = 15) = 27; p < .0001$ ). Subsequent analyses showed that, in both cases, Duchenne smiles with open mouth appeared more frequently than the rest (Tukey,  $p < .05$ ). Further analysis using the Mann-Whitney test indicated that infants with Down syndrome presented a higher percentage of Duchenne smiles with open mouth than typically-developing infants ( $z = 3.1, p < .01$ ).

In order to analyze each type of smile according to whether the infant looked at the mother or at the toys, we applied Wilcoxon tests. When infants looked at the toys: a) in the typically-developing group, there were no significant differences between the percentages of Duchenne and non-Duchenne smiles, and all were with open mouth ( $z = 1.18, p = .23$ ); and b) in the case of the infants with Down syndrome, all the smiles were Duchenne with open mouth. On comparing smiles directed at the mother's face and those directed at the toys,

Table 1

Estimated percentages of smiles according to type of muscular configuration, infant's chromosomal condition and objective of smile

N	Typically-developing infants		Infants with Down syndrome	
	Face 15	Toys 7	Face 15	Toys 5
Non Duchenne-closed mouth				
<i>M</i>	0.9%	0%	0.8%	0%
<i>SD</i>	3.5	0	2.9	0
Duchenne-closed mouth				
<i>M</i>	0.5%	0%	1.6%	0%
<i>SD</i>	1.7	0	6.1	0
Non Duchenne-open mouth				
<i>M</i>	14.9%	67.8%	1.6%	0%
<i>SD</i>	17.2	43.7	4.1	0
Duchenne-open mouth				
<i>M</i>	83.6%	32.2%	96%	100%
<i>SD</i>	17.4	41.8	8.7	0

*Note:* In typically-developing infants we recorded 145 smiles directed at the mother's face and 25 directed at toys; we also recorded another 15 smiles that were not analyzed (8 directed at other objectives and 7 in which it could not be determined whether the infant was looking at the mother's face or at a toy). In infants with Down syndrome we recorded 111 smiles directed at the mother's face, 12 directed at toys and a further 4 that were not analyzed (one directed elsewhere and 3 whose objective could not be determined).

Wilcoxon tests showed that the typically-developing infants emitted a higher percentage of Duchenne smiles when looking at their mother's face than when looking at the toys ( $z = 2.02$ ,  $p < .05$ ). These differences were not observed in the case of the infants with Down syndrome ( $z = 1.34$ ,  $p = .18$ ).

Taken as a whole, the results obtained in this work confirm that smiles displayed by infants with and without Down syndrome were, in general, similar, and that, as expected, they were mainly with open mouth. As far as the results corresponding to typically-developing infants are concerned, it should be noted that they supported the findings of other studies (i.e., Fogel et al., 2000; Fox & Davidson, 1988; Jones, Raag & Collins, 1990) about the associations between smile morphologies and the object at which smiles are directed. The fact that typically-developing infants display similar frequencies of Duchenne and non-Duchenne smiles when they look at toys, and that, nevertheless, these infants display a higher frequency of Duchenne smiles when they look at their mothers, leads us to consider that, as Messinger, Dickson and Fogel (1999) suggest, Duchenne smiles may be an expression of a highly positive internal state, and this strongly supports the affiliative role attributed to this facial expression.

Another finding of this study is that, in the case of infants with Down syndrome, the Duchenne smile with open mouth was the most frequent, regardless of whether it was directed at the mother or the toys. The question remains as to whether this differential result is related to greater cortical control of facial expression by typically-developing children from an early age, and to what extent the difficulties in modulation of muscular tone

experienced by children with Down syndrome affect their facial expression (Ganiban, Wagner & Cicchetti, 1990). If, as Messinger, Dickson and Fogel (1999) suggest, Duchenne and non-Duchenne infants' smiles are part of a continuous emotional process, the interaction of the two factors referred to above may lead to the presence of alterations in the expressive continuum of infants with Down syndrome and explain the differences observed in this study.

In any case, we should like to emphasize the considerable similarity between the early facial expression of infants with and without Down syndrome; in fact, in our study the difference in the frequency of smiles in infants with and without Down syndrome was 0.31 smiles/min if we consider the total frequency of smiles, but only 0.10 smiles/min if we consider only Duchenne smiles. In this same line, Kasari et al. (1990) pointed out that, between age two and four years, infants with and without Down syndrome continue to present similar frequencies of Duchenne smiles but not of non-Duchenne smiles. This would appear to indicate that Duchenne smiles and non-Duchenne smiles do not follow the same developmental course in infants with and without Down syndrome, with the changes that occur basically affecting non-Duchenne smiles. With a view to integrating our results with those obtained by Legerstee and cols., and in order to better understand the developmental changes in type of smiles in infants with Down syndrome, we consider that future research should analyze reactions, not only to the mother and to toys, but also to other elements of the environment, such as strangers, and should differentiate between, for example, conditions of mobility and immobility (Legerstee, 1989), or employ procedures such as the Ainsworth Strange Situation (Ainsworth, Blehar, Waters & Wall, 1978). Such an approach would help to improve our understanding of the relationship between type of facial expression, particularly smiles observed during interaction, and level of sociocognitive development in young infants with Down syndrome.

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