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Varnost igrač - Obnašanje otroka pri stiku igrače z usti

Safety of toys - Children´s mouthing behaviour in contact with toys

Sicherheit von Spielzeug - Mundkontaktverhalten von Kindern

Sécurité des jouets - Analyse de la mise à la bouche des jouets par les enfants

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Sicherheit von Spielzeug - Mundkontaktverhalten von Kindern

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Contents

Page

European foreword

This document (CEN/TR 16918:2015) has been prepared by Technical Committee CEN/TC 52 “Safety of toys”, the secretariat of which is held by DS.

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Introduction

This CEN Technical Report presents the results of a European Study on “Children's mouthing behaviour in contact with toys”. The objective of the study was the measurement and quantification of the duration and frequency that children under 36 months introduce toys into their mouths spontaneously.

It presents information about the literature review focused on children's mouthing behaviour, including commonly used methodologies in addition to a review of significant results from previous research. It also includes the design of the research; methodology; data on the children and toy sample; complete results obtained in the frequency and duration that children mouthed toys and estimated data on the time children under 36 months spend mouthing toys each day.

Up to now, the study was the one with the largest sample (245 children and a total number of 1 680 observations) and the only one to be carried out in three different European countries (Germany, France and Spain). It was also the study with the highest representation of specific toys (54 different products) for children up to 36 months.

In addition to the results on the mouthing behaviour with regard to toys, Annex B contains information concerning children's mouthing behaviour in contact with childcare articles. This informative annex is, however, just a first approach, and of limited value.

Clause 7 of this CEN Technical Report contains a more detailed summary of the results of the European Study on “Children's mouthing behaviour in contact with toys”.

1 Scope

This Technical Report presents the results of a European Study on “Children's mouthing behaviour in contact with toys”. It provides statistical data on the duration and frequency that children under 36 months introduce toys into their mouths and estimated data on the time children under 36 months spend mouthing toys each day.

Furthermore, it provides information on:

— the literature focused on children's mouthing behaviour, including commonly used methodologies and significant results;

— the design and methodology of the study;

— the data on the children and toy sample;

— the forms used in data collection.

2 Literature review

2.1 General

Mouthing is an important component in childhood development. In early development, sucking provides essential nutrients in the form of breast or bottle-feeding, as well as a feeling of well-being and a sense of security (Juberg et al., 2001 [1]). If infants are not allowed unrestricted breast-feeding, they will suck on a dummy, thumb (or other fingers), blanket, or toy (Groot et al., 1998 [2]). As children develop, mouthing behaviour, in combination with looking and touching, allows children to explore and investigate their environment. Mouthing behaviour develops into an exploratory behaviour in which objects are placed into the mouth for a few seconds for purposes of discovery. During this stage of development, children will put their hands, and any object that they come in contact with, into their mouths (Ruff, 1984 [3]; Ruff and Dubiner, 1987 [4]; Davis et al., 1995 [5]; Groot et al., 1998 [2]: Tulve et al., 2002 [6]).

In the field of psychology, Freud named the stage between birth and 2 years of age the 'oral stage'. This first stage of development is characterized by the physical aspects of sucking, encompassed by the mouth, tongue and lips. During the oral stage, it is common for children to have a persistent tendency to put whatever falls into their hands into their mouths. It is the means by which they express their need to experience the world through their mouths. The pleasurable activity of sucking, biting and chewing, means the child starts to recognize objects and distinguish them as separate from himself. When a baby puts something in his mouth, he bites it with his gums, sucks it and moves it with his tongue. It is the first form of learning that children experience, as they begin to recognize textures, temperatures and forms through mouthing. Furthermore, it benefits verbalization processes, chewing and teething.

Teething is another reason that children will mouth fingers and objects. At this stage of development, mouthing alleviates the pain and discomfort associated with teething (Groot et al., 1998 [2]). Teething usually begins at 6 months to 8 months, but may start several months earlier or later. Teething continues in babies until approximately the age of 3.

The first teeth to appear are usually the two bottom front teeth, also known as the lower front incisors. Between 4 weeks to 8 weeks later, they are followed by the four upper front teeth. About a month later, the lower lateral incisors appear. Next come the first molars, and then finally the canines. Most children have their 20 milk teeth (which are the first teeth to appear) when they reach three years of age. The commencement of teething is the most important stage in babies' mouthing.

Young children's urge to suck and mouth is a natural developmental phase. Sucking may be divided into two distinct behavioural types: nutritive and non-nutritive sucking (Turgeon-O'Brien et al., 1995 [7]).

Nutritive sucking is the instinctive need to feed. Non-nutritive sucking (e.g. sucking on a dummy/soother) is thought to be adopted by infants as a response to frustration, or as a need for contact, or as a part of the child's psychological development in exploring the world around them through touching and tasting objects with the mouth and tongue (Norris and Smith, 2002 [8]).

Research on the mouthing behaviour of children has usually concentrated on the psychological development of the act, being concerned with the cause and motivation behind mouthing. There is, however, a child safety issue concerned with the safety of the items being placed into the mouths of young children. Some products, such as dummies, teething rings and bottle teats, are intended to be placed into the mouth. Unfortunately, products not intended for mouthing invariably end up in children's mouths, as this is how young children explore their world. Obviously, child safety is of paramount concern, and so products shall be as safe as possible, whether they are handled or placed into the mouth (Smith and Norris, 2003 [9]).

This is the reason why there is an increasing focus on children in exposure and risk assessments, as they are more sensitive to environmental contaminants than adults (Silvers et al., 1994 [10]). All items that are placed into a child's mouth have the potential to be a mechanical hazard. The most obvious hazards are choking or suffocation, although there is a risk of any item becoming stuck in the mouth and the resultant trauma may be serious. There is also the risk of foreign body incidents where a child swallows an item, which may then cause harm to internal systems of the body (Norris and Smith, 2002 [8]).

Because of their mouthing behaviour, children have a higher potential for exposure to available chemicals through the non-dietary ingestion route; thus, frequency of hand-to-mouth activity is an important variable for exposure assessments. Such data are limited and difficult to collect. Few published studies report such information, and the studies that have been conducted used different data collection approaches: e.g. videography vs. real-time observation, data analysis and reporting methods, ages of children, locations (indoor vs. outdoor), and even definitions of “mouthing” (Xue et al. 2007 [11]).

As children in all geographic regions spend most of their time indoors, at home, Silvers et al. (1994) [10] indicated that risk assessments should focus on indoor, on-site hazards. The same conclusion was made by Xue et al. (2007) [11], as was seen in the review of previous research. The present study is consistent with these conclusions: observing interaction with a sample of toys in the home environment (indoor parental observation). Furthermore, Hubal et al. (2000) [12] defined the general principles for studying children's exposure. In their review of factors in the Children's Exposure Assessment, they indicated that exposure assessments are developed to represent real-life situations.

Toxic chemicals can be transferred from contaminated surfaces or soil to the hand and then ingested via hand-to-mouth activity. Detailed information on children's mouthing activities helps researchers assess children's exposure to toxicants via the non-dietary ingestion route. Thus the frequency of hand-to-mouth behaviour is an important variable for children because, as part of their natural development, children mouth their fingers and other objects (Hubal et al. 2000 [12]).

2.2 Methodological review on children’s mouthing behaviour

Generally, children's mouthing behaviour is studied using both direct observation and video recording methodologies (Zartarian et al., 1996 [13]; Reed et al., 1999 [14]; Freeman et al., 2001 [15]; Ferguson et al., 2005 [16]). Data analyses from these studies are reported as either a frequency of contact (i.e. contacts/duration) or as an exposure period (i.e. minutes). Xue et al. (2007) [11] studied the frequency of hand-to-mouth contact; this research will also analyse hand-to-mouth duration data.

The general formula for estimating non-dietary ingestion of chemical residue via hand-to-mouth contact involves the product of hand residue or soil loading (μg/cm^2 or μg/g), hand-to-mouth frequency (contacts/h), hand surface mouthed per mouthing event (cm^2) and exposure duration (h/ day) (Norris and Smith, 2002 [8])

The statistical formula used by Norris and Smith (2002) [8], in which the estimated daily mouthing time is extrapolated from the mouthing behaviour recorded over the observation time, is calculated as follows:

$$t_{edmt} = \frac{t_{omt}}{t_{tto}} \cdot t_{tamp} \quad (1)$$

where

t_{edmt} estimated daily mouthing time;

t_{omt} observed mouthing time (amount of mouthing time recorded for each child);

t_{tto} total time observed (time available over the whole day for the child to mouth);

t_{tamd} time available to mouth per day.

Norris and Smith [8] calculated the average time spent mouthing per hour, multiplied by the total number of hours each day that each child has available to mouth; i.e. the number of hours they are awake during the day but not eating, or the number of hours they are awake and in contact with a toy (play time). This is based on the assumption that children are likely to mouth at the same rate throughout the day. They performed a Krustal-Wallis test, which showed no significant differences in observed mouthing between the different times of the day when children were observed.

Children's hand-to-mouth behaviour is difficult to measure for several reasons. Some of these reasons include the following: children's contact with surfaces and objects are frequent and intermittent; observational studies are labour-intensive for data collection and data analysis; and data analysis can be subjective. Interpretation of the results is also difficult. Some researchers express mouthing behaviour in terms of frequency of occurrence, others express mouthing behaviour as an exposure period (Xue et al., 2007 [11]).

Table 1 summarizes previous literature, focused on the types of activity collected by the various authors and the methodology used in their research, in order to have a complete picture of the methodological approaches used in the study of children's mouthing behaviour.

Table 1 — Summary of previous literature

Reference	Age Range	Number of children	Location of study	Activity collected	Method employed collection
AuYeung, W. et al. (2004) [17]	1 year to 6 years	38	California	Detailed information on children's mouthing activities.	Videotaping for 2 h per child during natural play time.
Norris and Smith (2002) [8]	1 month to 5 years	236	London, United Kingdom	Duration of each mouthing behaviour. What types of items were mouthed. The type of mouthing behaviour for each item mouthed. What was mouthed and in which room of the house.	5 h of observation in periods of 15 min
Black et al. (2004) [18]	7 months to 53 months	52	Texas	Hand-to-mouth Object-to-mouth Food-handling	Questionnaires to parents. Videotaping children for 4 h using a hand-held camcorder. Children were followed through the house and yard.

Reference	Age Range	Number of children	Location of study	Activity collected	Method employed collection
Ferguson et al. (2005) [16]	1 year to 12 years	83 (4 studies: 4–23–20–36)	Salinas Valley Menlo Park and Palo Alto, California	MLATS, describing intermittent dermal (i.e. a second-by-second account of contact with surfaces and objects) and non-dietary ingestion contact behaviour.	Videotaping human activity to assess exposure. 4 h/day to 8 h/day (sample 4 children) 2 h (sample 36 children) 2 h (sample 20 children)
Freeman (2000, 2001) [19]	3 years to 12 years	19	Minnesota	Mouthing behaviour	Videotaping observations
Groot et al. (1998) [2]	3 months to 36 months	42	The Netherlands	Mouthing duration	Parental Observation 2,5 h/day of 15 min periods
Juberg et al. (2001) [1]	0 months to 36 months	168	Western New York	Mouthing duration, mouthing behaviour	Parental Observation; 1 day; standard diary form
Madden et al. (1980) [20]	23 months to 33 months	3	Urban Maryland	Mouth-to-body, mouth-to-object	Trained observers 3 h to 6 h of observation; recorded mouthing activity; given a score based on frequency
Reed et al. (1999) [14]	2 years to 6 years	30	Urban New Jersey	Hand-to-clothing, hand-to-dirt, hand-to-hand, hand-to-mouth, hand-to-object, hand-to-other items (paper, grass, pets), hand-to-smooth/textured surfaces, object-to-mouth	Videotaping waking hours: approximately 1 day of tape per child; activities were quantified from 5-min periods and added up to give hourly frequency counts
Ruff (1984) [3]	6 months to 12 months	60	Undisclosed suburban location	Evaluation of exploratory behaviour	Videotaping play with specified objects; trained observer, timed interactive events
Ruff and Dubinier (1987) [4]	9 months to 12 months	29	Undisclosed suburban location	Evaluation of young children's ability to manipulate objects and their associated behaviour	Videotaping play with specified objects; trained observer, timed interactive events
KO et al. (2006) [21]	1 year to 5 years	37	Chicago	Children's touching and mouthing behaviour during outdoor play. Frequency, not amount of time.	Video observation. 2 h of video recording
Tulve et al. (2002) [6]	10 months to 60 months	90	Seattle	Describe and quantify the distribution of soil ingestion values.	Observational study in home environment by trained observers 5 min to 60 min per day for 1 day to 6 days, depending on scheduling, cooperation etc.
Xue, J. et al. (2007) [11]	review	review	review	review	Literature review.

Reference	Age Range	Number of children	Location of study	Activity collected	Method employed collection
Zartarian et al. (1998) [22]	29 months to 50 months	4	Salinas Valley, CA	Left and right hand contact frequency and duration for numerous categories of objects	Videotape of waking hours: approximately 1 day of tape per child; computerised translation software

NOTE SOURCE: Update of Tulve et al. (2002) [6].

2.3 Main results on the duration and frequency of children's mouthing behaviour in previous literature

2.3.1 General

There is more literature on the time and frequency of hand-to-mouth behaviour than on object–to-mouth behaviour. Furthermore, there is great uniformity in the conclusions that instances of indoor mouthing behaviour are always higher than outdoor mouthing behaviour. Xue et al. (2007) [11] indicated that the variation between indoor and outdoor behaviour is 60 %.

In their review of previous research, Xue et al. (2007) [11] indicated that average indoor hand-to-mouth behaviour ranged from 6,7 contacts/hour to 28,0 contacts/hour, with the lowest value corresponding to the 6 to < 11 year olds and the highest value corresponding to the 3 to < 6 month olds. Average outdoor hand-to-mouth frequency ranged from 2,9 contacts/hour to 14,5 contacts/hour, with the lowest values corresponding to the 6 to < 11 year olds and the highest values corresponding to the 6 to < 12 month olds. However, the authors stated that the analysis highlighted the need for additional hand-to-mouth data for the < 3 months, 3 to < 6 months, and 3 to 6 year age groups.

The results of the meta-analysis carried out by Xue et al. (2007) [11] and Tulve et al. (2002) [6] indicate that age and location are important for hand-to-mouth frequency, but type of study and gender are not. As age increases, both indoor and outdoor hand-to-mouth frequencies decrease. All research concludes that mouthing behaviour is significantly greater indoors than outdoors. The frequency and duration of hand-to-mouth, object-to-mouth and food-handling behaviours were all greater indoors than outdoors.

Another widely accepted coincident result is the clear trend that mouthing duration decreases as age increases. This is consistent with patterns of child development, which show a peak period for mouthing activity that is positively correlated with teething and negatively correlated with increased mobility (Juberg el al. 2001 [1], Groot et al. 1998 [2], Xue et al. 2007 [11], Norris and Smith, 2002 [8]).

One more accepted premise is that no significant differences in mouthing times were found between the sexes, and no significant difference was found for mouthing times at different times of the day (Xue et al. 2007 [11], Norris and Smith, 2002 [8]).

For this study, results that focused on object-to-mouth contact and the surface area of the objects mouthed are of primary interest, with a specific focus on toy-to-mouth contact. However, the majority of results obtained from previous literature featured data on objects in general (sometimes including toys, but not always).

The results of research indicate that children's mouthing behaviour depends on age and the items mouthed (e.g. teethers, dummies, toys, etc.). Dummies clearly dominated as the single item most frequently mouthed by children of all ages (Juberg et al., 2001 [1], Norris and Smith, 2002 [8]).

All studies demonstrated that children mouth many items other than dummies, teethers, and toys expected to be mouthed (i.e. those products specifically designed for mouthing). A huge variety of items are mouthed, particularly by children under 1 year, due to teething and using mouthing as a method of exploring their environment. The variety of objects mouthed indicates that young children have access to a wide range of non-toy objects, some of which could pose an immediate hazard to them.

Nevertheless, this study will focus exclusively on results concerning toys and mouthing behaviour in children under 3 years.

2.3.2 Daily time available to mouth not spent sleeping or eating

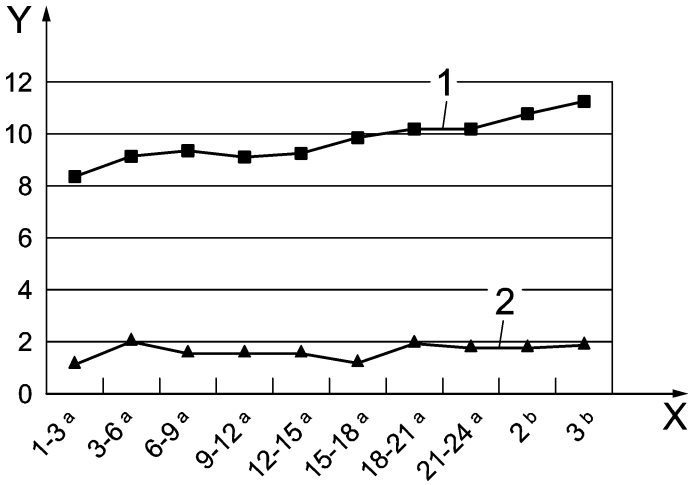
Around 9 h to 10 h is the average time each day not spent eating or sleeping, as obtained in the Norris and Smith research (2002) [8]. This is the time during a typical day that a child would have available to spend mouthing, that is, the time spent neither sleeping nor eating.

Table 2 — Mean, maximum and minimum times available to mouth not spent sleeping or eating

Age group	Mean (Hours:Minutes)	Minimum (Hours:Minutes)	Maximum (Hours:Minutes)
1 month to 3 months	8:22	3:51	13:30
3 months to 6 months	9:09	6:20	12:48
6 months to 9 months	9:21	7:10	11:50
9 months to 12 months	9:06	6:45	11:23
12 months to 15 months	9:15	7:20	11:05
15 months to 18 months	9:50	6:57	12:42
18 months to 21 months	10:10	8:30	12:15
21 months to 24 months	10:12	6:50	13:39
2 years	10:45	7:35	13:20
3 years	11:10	9:35	13:50
NOTE SOURCE: Norris and Smith, 2002 [8]			

In the data obtained there were no significant differences observed in mouthing between the different times of the day that children were observed. Neither were significant differences in mouthing time found between the sexes.

However, as can be observed in the following graph, Norris and Smith (2002) [8] found a great difference between the time available to mouth per day and the duration of children's mouthing behaviour in contact with objects.



Key

X age group
Y number of hours
1 time available to mouth per day (awake but not eating)
2 estimated children's mouthing behaviour in contact with objects
a months
b years
NOTE Based on Norris and Smith 2002 [8] data.

Figure 1 — Time available to mouth per day vs. mouthing behaviour in contact with objects

2.3.3 Frequency of mouthing objects

In their study to quantify children's handling and mouthing activities through a videotaping methodology, Reed et al. (1999) [14] found the mean frequency of contacts per hour: objects-to-mouth (including toys and other objects), was 16,3 objects, 90th percentile 77,1, and maximum contacts was 86,2 (for a sample of 30 3- to 6-year-olds, and 10 children aged 2 years to 5 years).

Analysis of the data collected by Tulve et al. (2002) [6] suggests that the mouthing data can, and should, be broken into two subsets based on age: < 24 months and > 24 months. The data further showed that toys and hands were preferentially mouthed compared with other body parts and household surfaces. They have obtained a more realistic estimate of a child's mouthing behaviour by using data collected on multiple observation days. The results reported in this study are focused on children who engaged in quiet play in an indoor environment. The data presented by Tulve et al. (2002) [6] shows that young children may mouth specific objects (e.g. toys) up to 48 events/hour.

The research by Black et al. (2004) [18] is presented as a table of results of the frequency of object-to-mouth events (see Table 3).