Anxiety, fainting and gagging in dentistry: Separate or overlapping constructs?

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It is not that I’m afraid of the dental drill. I’m not even afraid that it hurts. I can’t stand the feeling of losing control during treatment. It reminds me of other experiences in my life, when I completely lost control.

”

CHAPTER 3

The factor structure of dental fear

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Submitted

Introduction

Fear of the dental treatment is a relatively common fear in the general population. About 30%-40% of the adult population in Western Societies report moderate levels of dental fear (Halonen et al., 2014; Singer et al., 2012), while 5 to 15% indicate to suffer from high fear levels (Hill et al., 2013; Humphris & King, 2011; Nicolas et al., 2007; Schuller et al., 2003). High levels of dental fear are likely to induce avoidance behavior, thereby increasing the risk of negatively affecting individuals' oral health (Vermaire et al., 2008; Mehrstedt et al., 2007; Schuller et al., 2003; Cohen et al., 2000; Stouthard & Hoogstraten, 1990).

Although the term "dental fear" suggests an unidimensional construct, it, in fact, encompasses a broad constellation of fears of objects and situations within the dental setting (e.g., Oosterink et al., 2008; De Jongh et al., 1998). Bearing the above in mind, to optimize treatment success, specifying individuals according to their fears of objects and situations within the dental setting, and classifying them into distinct typologies (Milgrom et al., 1985), is important (De Jongh et al., 2011).

To this end, Milgrom proposed a classification system consisting of dentally fearful patients having (I) a simple conditioned fear of specific dental stimuli; (II) somatic reactions during dental treatment; (III) generalized anxiety states, or (IV) distrust of dental personnel (Milgrom et al., 1985; Locker et al., 1999). However, although the authors used their broad clinical experience to classify patients in particular fear categories, using a more sophisticated method or model, to empirically identify groups of patients with similar response patterns is warranted.

Until now, only two studies have attempted to determine the underlying structure of fear of stimuli pertaining to different objects and situations present in the dental setting using a statistical method. Oosterink and colleagues (Oosterink et al., 2008) performed an exploratory factor analysis on a set of 67 stimuli present in the dental setting using a sample of almost 1,000 individuals. They identified a two-factor solution, with the first factor being an invasive treatment-related stimuli factor, and the second being a non-invasive-treatment related factor. However, close inspection of the results suggested that the two factors were very general in nature, with only modest explained variance (51.4%). A possible explanation for this relatively low proportion of explained variance might be the small number of individuals in relation to the large amount of stimuli included in the analyses. Moreover, a number of items showed low factor loadings and/or low communalities.

Building on the work of Oosterink (Oosterink, De Jongh & Aartman, 2008), Wong and colleagues (Wong et al., 2015) conducted an exploratory (EFA) and confirmatory factor analyses (CFA), and performed these on 73 dental objects or situations. Their EFA revealed a seven-factor solution (i.e., dental check-up, injection, scale and drill, surgery, empathy, perceived lack of control, and clinic environment) explaining 71.3% of the variance. However, the sample was relatively homogeneous as it consisted of university students with average levels of dental anxiety and a narrow age range. Additionally, the use of statistical procedures that create optimized linear combinations of variables using a low sample size (i.e., 160 and 300 for the EFA and the CFA, respectively), in combination with a high number of items, have been found to yield problematic outcomes, as these increase the probability of errors, minimize the accuracy of population estimates, and reduce the generalizability of the results (Osborne & Costello, 2004).

Therefore, the purpose of current study was to develop a descriptive framework for the classification of dental fear by describing the multidimensional structure of a set of common stimuli present in the dental setting using a large sample with a broad age range and diversity in level of education. This was done using exploratory factor analysis (EFA), whereas a second, independent sample was used to confirm the newly derived model by means of confirmatory factor analysis (CFA).

Material and Methods

Data collection and participants

Participants were members of twin families (i.e., twins and their relatives) registered with the Netherlands Twin Register (NTR, (18). Participants with an age ≥18 years (n = 27, 892) received an invitation to participate in a study on lifestyle and personality. Of them, 11,771 individuals (42.2%) completed the relevant questions in an online or offline version of the questionnaire (see for a detailed description of the sample and data collection van Houtem *et al.* (van Houtem et al., 2015) and Ligthart *et al.* (Ligthart et al., 2014).

Measures

Sociodemographic variables. The survey included questions regarding age and sex. Based on previous questionnaires (Willemsen et al., 2013) information regarding country of birth (i.e., The Netherlands *vs.* other country of birth) was available for 10,781 participants (91.6%), as well as information about the level of education (i.e., primary-low *vs.* intermediate-high), which was available for 8,500 individuals (72.2%).

Dental trait anxiety. Severity of dental trait anxiety was assessed using the Dental Anxiety Scale (DAS, (Corah, 1969). Responses to a total of 4 questions are scored from 1 to 5, resulting in total scores ranging from 4 (not anxious at all) to 20 (extremely anxious). DAS scores of 13 or higher are indicative of a high level of dental fear (Corah et al., 1978).

Fear of stimuli comprising the dental setting. To assess the fear of objects and situations related to the dental setting a set of 28 potentially fear-provoking stimuli present in the dental setting were used. These consisted of the most frequently feared stimuli from the set of 67 used in our previous study (Oosterink, De Jongh & Aartman, 2008), supplemented with three more physically related and clinically meaningful stimuli (i.e. the sense of gagging, vomiting and fainting) not used in previous studies. For the complete set of stimuli we refer to van Houtem et al. (van Houtem et al., 2015). The fear provoking nature of each stimulus was scored on a four-point scale, from 1 ('not at all fear provoking ') to 4 ('extremely fear provoking').

Statistical analyses

Descriptive statistics were obtained using IBM SPSS Statistics Version 20 (IBM Corp, Armonk, NY). The χ^2-test was used to analyze associations between categorical variables, the independent-samples t-test was used to compare groups on continuous variables. In order to explore the underlying structure of the most prevalent fears related to the dental treatment, an exploratory factor analysis (PCA) was performed on a random half of the sample. Factors with eigenvalues > 1 were extracted and Varimax rotation was performed to increase interpretability of the factor solutions. In order to derive a stable factor structure, the following stepwise procedure was followed. First, factor analysis was performed on the entire set of items. Factor loadings in the rotated component matrix were examined. An item with either a primary factor loading (i.e., the highest factor loading on a given factor) below .50, or an ambiguous item (a difference of less than .20 between the highest factor loading and the factor loading on a different factor) was deleted from the set of items. Next, a factor analysis was performed on the remaining set of items. This procedure was repeated until all items were non-ambiguous and showed a strong primary factor loading on one factor. Subsequently, factors were interpreted by looking at the content of the items with the highest factor loading on the respective factor. This factor structure was then fitted to the data on the other random half of the sample using confirmatory factor analysis (CFA) performed with IBM SPSS AMOS 22. Model fit was evaluated using the traditional χ^2-statistic with df and p-value, the RMSEA (<0.07), SRMS (<0.08), CFI (>0.95) and GFI (>0.95) (24). For all statistical analyses, a *p*-value <0.05 was considered statistically significant.

Results

Socio-demographic characteristics and dental anxiety

Table 1 presents data on the socio-demographic characteristics of the entire sample (n = 11,771 individuals). Of the participants 61.8% (n = 7,260) was female. Women had a sig-

Table 1. Socio-demographic characteristics and mean level of dental trait anxiety of the entire sample

	N	Proportion	Mean	*P-value*
Gender	11,771			
Male	4,501	38.2%	-	-
Female	7,270	61.8%	-	
Mean age (±SD)	11,771	-	44.38 (15.67)	
Male	4,576	-	46.44 (16.13)	< 0.001
Female	7,366	-	43.37 (15.36)	
Country of birth	10,781			
The Netherlands	10,556	97.9%	-	-
Any other country	225	2.1%	-	
Level of education	8,500			
primary-low	1,729	20.3%	-	-
intermediate-high	6,771	79.7%	-	
Mean level of dental anxiety (4-20; ±SD)	11,572	-	7.46 (2.73)	
Male	4,420	-	6.76 (2.31)	< 0.001
Female	7,152	-	7.90 (2.88)	

nificantly lower mean age than men ($p < 0.001$). Most of the participants were born in the Netherlands (97.9%) and had an intermediate or high level of education (79.7%). Women showed significantly higher mean levels of dental trait anxiety than men ($p < 0.001$).

The samples

The entire sample was randomly divided into two subsamples. The first sample consisted of 5,920 individuals, and the second sample consisted of 5,851 individuals. Firstly, the socio-demographic distributions of the two subsamples were compared. It appeared that the samples differed on gender ($\chi^2(1) = 4.30$; $p = 0.038$), i.e. the first subsample consisted of 37.3% males versus 39.2% in the second subsample. However, this difference was relatively small, but obviously significant as a result of the large sample size. Accordingly, no further action was undertaken. For the fear provoking stimuli “dentist drilling your tooth or molar” ($p = 0.016$), and “the sound of the drill” ($p = 0.032$) significantly higher mean scores were observed among the individuals of the first subsample. The two subsamples did not differ on any of the other variables, including the remaining 26 of the stimuli comprising the dental setting.

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Exploratory factor analyses on the severity ratings of the fear provoking stimuli

Exploratory factor analysis was performed on the set of responses to the 28 fear provoking stimuli from a random half of the sample (subsample 1). The Kaiser-Meyer-Olkin measure of sampling adequacy was 0.97. The Bartlett's test of sphericity was significant ($p<0.001$), indicating that the data were suitable for factor analysis. The initial solution of the exploratory factor analyses revealed four factors with an eigenvalue >1, explaining 64% of the variance. Next, the stepwise procedure was followed until all items had a primary factor loading of >.50, and the second loading of at least .20 less than the primary factor loading. The final solution yielded a three-factor solution with 70.7% explained variance (see Table 2 for the rotated factor solution). When looking at the content of the items for each factor, the following interpretation was made: (1) an invasive-treatment-related factor; (2) a factor associated with lack of self-control; and (3) a factor associated with physical (internal) sensations.

Given this study was conducted among twin family members we tested the possible presence of some degree of dependency between the observations by repeating the EFA in a subsample comprising a random selection of only one person per family (n = 5,246). This analysis gave identical results compared with the EFA conducted in the original sample, with a three factor solution with 70.1% explained variance and the same items loading on each factor.

Table 2.Final rotated factor solution for the 3-factor model

Item	Factor loadings *			Communalities
4 Having surgery	.75			.67
5 Dentist drilling a tooth or molar	.76			.73
8 Extractions of tooth or molar	.81			.74
18 Having a root canal treatment	.79			.74
21 Cutting or tearing in soft tissue	.74			.69
23 Pain	.70			.63
25 Insufficient aneasthetics	.65			.67
3 Lying in the dental chair (position)		.68		.51
6 Not knowing what's happening in the mouth		.75		.73
12 The fact that you don't know what is going to happen	.40	.74		.73
15 Objects in the mouth		.66		.63
16 Lack of explanation by the dentist		.67		.65
17 Feeling helpless		.67		.67
26 Gagging			.87	.86
27 The sense of vomiting			.89	.90
28 Fainting			.81	.76

* FL < .40 are not displayed

Confirmatory factor analyses (CFA) on the severity ratings of the fear provoking stimuli
Using the individuals of the second subsample, a CFA was performed to fit the 3-factor structure model to the data. Statistics concerning model fit are reported in Table 3. The first model did show an acceptable fit to the data. Fit indices in general were just below the

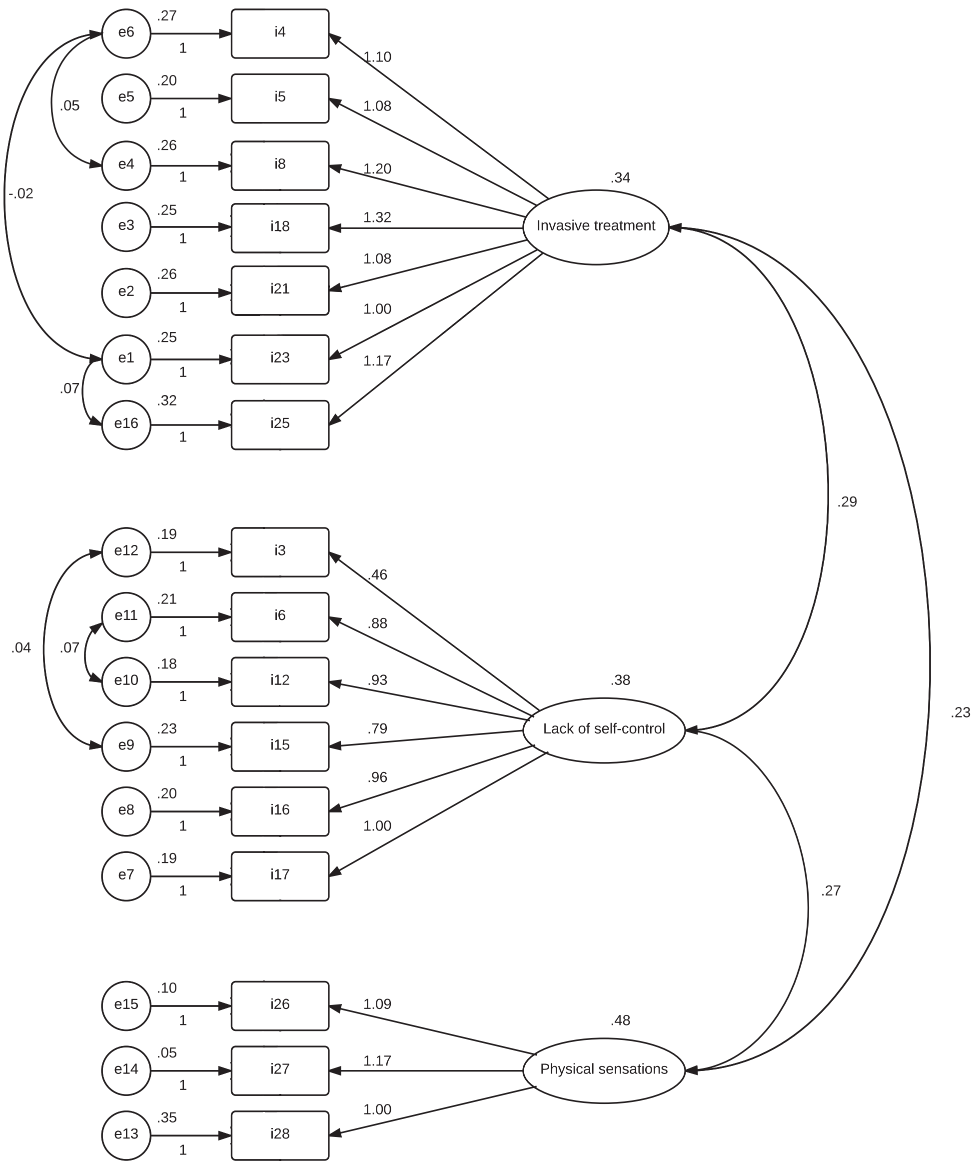

Figure 1. Factor structure of the CFA model

Table 3. Confirmatory factor analyses (CFA) on the severity ratings of the fear provoking stimuli

Model	RMR	GFI	CFI	RMSEA
3-factor	0.30	0.913	0.943	0.081
3-factor adjusted	0.029	0.941	0.961	0.069

criteria for a good fit. Inspection of the modifications indices showed that the model could be improved by correlating a number of error terms. The following items were considered to be comparable in content and were therefore allowed to correlate: (1) "undergoing a surgical operation" (item 4) and "having a tooth or molar extracted" (item 8); (2) "feeling pain" (item 23) and "insufficient anesthesia" (item 25); (3) "undergoing a surgical operation" (item 4) and "feeling pain" (item 23); (4) "lying back in the chair" (item 3) and "objects in the mouth" (item 15); and (5) "not knowing what is happening" (item 12) and "not knowing what is happening in your mouth" (item 6). These modifications led to a slight improvement of model fit (see Table 3). Overall, the model showed acceptable fit to the data. Therefore, the 3-factor structure underlying these data can be considered stable. Figure 1 shows the factor structure of the CFA model.

Discussion

The results of the present study, using a sufficiently large sample with a broad age range, showed a factor structure reflecting three different constructs underlying dental fear (i.e., "fear of invasive treatment", "lack of self-control", and "physical sensations"), together explaining about 70 percent of the variance of in total 28 anxiety provoking stimuli. Of these, 25 were rated as most prevalent in a previous study (Oosterink et al., 2008), while three clinically meaningful items were added for the purpose of the present study. The CFA carried out on the data of the second sample resulted in an acceptable fit for the two models that were examined. This suggests that the three-factor structure that was identified as underlying our data is stable, thereby supporting the notion that fears related to the dental treatment have a heterogeneous rather than an unidimensional nature (Oosterink, De Jongh & Aartman, 2008).

At first glance, the three factors identified seem at odds with those described by Wong et al. (2015) who identified seven factors, and Oosterink et al. (Oosterink et al., 2008) who found only two independent factors. Some of these differences can probably best be explained by variation in the description of the items included in the factor analyses, the cut-off point of the factor loadings and cross-loadings, the subjective interpretation of the results, and the relatively small sample sizes in relation to the large amount of stimuli which could have incurred relative limitations on the statistical power to detect the presence of other, overall or independent factors of smaller magnitude. The items that loaded on the third factor of our model (i.e., “physical sensations”), relate to typical internal (i.e., bodily) sensations, were all added for the purpose of the present study, and had never before been part of any of the previous studies (Oosterink et al., 2008; Wong et al., 2015). However, there are a number of clear similarities between our framework and the previous ones. For example, both earlier studies identified factors related to invasive treatments. More specifically, the items that loaded on the “injection”, “scale and drill” and “surgery” factor, identified by Wong et al. (2015), and most of the items used by Oosterink et al., (2008) that loaded on their “invasive treatment-related stimuli factor” can be subsumed under our “fear of invasive treatment factor”. Similarly, Wong’s et al. (2015) “lack of control-factor” corresponds by and large with the “lack of self-control” factor of our model.

A descriptive framework for the classification of dental fear categories may be important as this might contribute to the development of new questionnaires for assessing dental fear subtypes. Currently, most questionnaires for the assessment of dental fear and dental anxiety include only a small set (4-15) of potentially anxiety provoking stimuli (e.g., the IDAF-4C+ (Armfield, 2010); Dental Anxiety Scale (Corah, 1969); the MDAS (Humphris et al., 1995); the S-DAI (Aartman, 1998); and the Dental Fear Survey (Kleinknecht et al., 1984)) which do not fully cover all fears present in the dental setting (see Oosterink (Oosterink et al., De Jongh & Aartman, 2008)), but also fail to provide enough information about the specific stimuli the individual patient fears.

The validity of the three-factor structure is further supported by the fact that this model seems to almost perfectly relate to the three distinct types of treatment strategies that are already applied to various subgroups of dental patients to tailor a specific treatment to patients’ individual problems in clinical practice. For example, as to the first factor in our model, for fear of invasive treatment (with stimuli as “dentist drilling a tooth or molar”’ or “having a root canal treatment”) there is one primary, evidence-based treatment and that is *in vivo* exposure to patients’ anxiety provoking stimuli (Armfield & Eaton, 2013; De Jongh et al., 2005). For lack of self-control, the second factor in our model (with stimuli like “not knowing what is going to happen” or “feeling helpless”), it is generally recommended to provide a sense of control and to heighten predictability during treatment, for instance by offering the patient the ability to use a stop signal, in order to initiate a break during treatment, and to provide the patient with information about the dental procedure which help correct misconceptions about dental treatment (Armfield & Eaton, 2013; De Jongh et al., 2005). For the third factor in our model, the experience of physical sensations which are related to, for example, “fainting” or “gagging”, it is recommended to focus treatment on reducing these bodily sensations (De Jongh et al., 2005). For instance, the evidence based approach to prevent fainting in response to a confrontation to blood or injury during dental treatment is “applied tension” which consists of tensing all muscles to increase blood pressure (Ayala et al., 2009; Öst et al., 1991). Hence, each factor in our newly derived model reflects a distinct type of fear related to dental treatment, requiring a specific intervention to treat that particular condition. To this end, the three-factor structure model may facilitate guiding oral health professionals in appropriate decision-making about tailoring particular interventions to individual patients.

Given the heterogeneity of the dental fears as supported by the factor structure, the present findings support the notion that the constructs as indicated by the terms “dental fear” or “dental phobia” alone are not tenable designations to classify individuals with fear of the dental setting (see also De Jongh et al., 2011; Oosterink et al., 2008; De Jongh et al., 2005; Milgrom et al., 1997; De Jongh et al., 1995) as these fail to account for the broad spectrum of fear evoking objects and situations present within the dental setting. Therefore, the present findings may be helpful to develop a new descriptive framework for the classification of dental fear by making distinctions among the various fear typologies, rather than by using the global term ‘dental fear’ or ‘dental phobia’ *per se*.

A few limitations need to be mentioned here. Given that participants were asked to rate the fear provoking nature of the stimuli, it is conceivable that a part of the participants had never been exposed to at least some of the objects or situations as presented in the questionnaire prior to the study. This could have resulted in either an overestimation or underestimation of the fear provoking nature of particular stimuli. Finally, since we included only 28 stimuli in our analyses, we cannot rule out the possibility that still other factors are underlying the construct of dental fear.

In conclusion, the present findings suggest that dental fear should best be considered a heterogeneous fear reflected by at least three separated factors: fear of invasive treatment, lack of self-control and the experience of physical sensations. This classification in distinct fear typologies may improve our understanding of the nature of dental fear, and might encourage the development of new measures to better guide clinicians in choosing appropriate fear reducing interventions for individual patients.

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