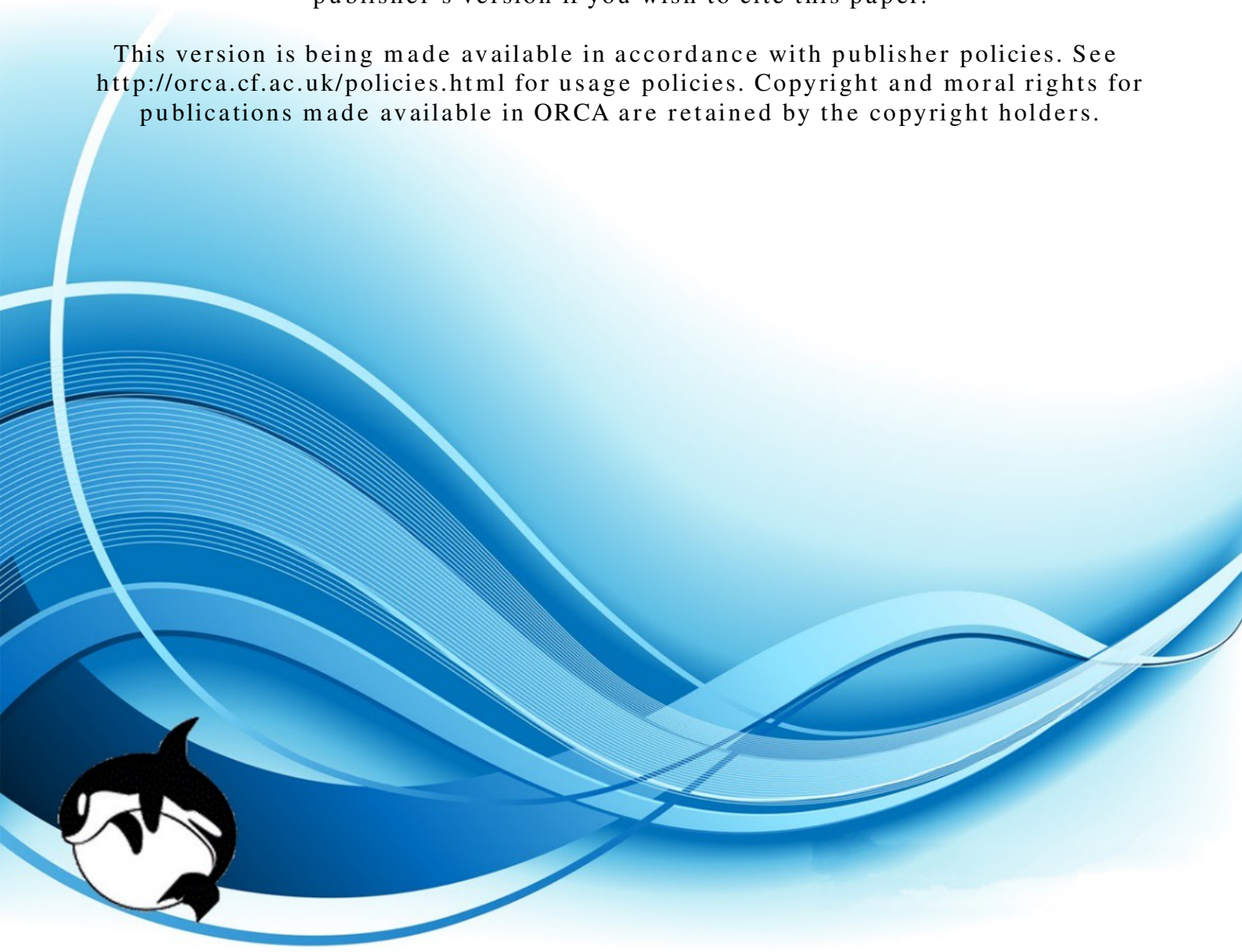

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Parental decisions about children's oral health behaviour: relative or absolute?

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Complete List of Authors:	Trubey, Rob; Cardiff University, South East Wales Trials Unit Moore, Simon; Cardiff University, School of Dentistry Chestnutt, Ivor; Cardiff University, School of Dentistry
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Abstract:	Objectives: To test the extent to which parents' judgements about their children's oral health behaviour conform to the principles of a specific theory of cognitive decision making – Range-frequency Theory. Methods: Experimental study with an opportunity sample of 121 parents of young children (3-6 years old) living in areas of relative deprivation in South Wales. Parents were allocated to 4 different experimental groups, and each completed a pen-and-paper exercise, which involved being presented with (and rating) how often other parents brushed their children's teeth. The brushing frequencies presented were varied between groups, in order to directly test the rank and range principle of Range-frequency Theory. Results: Parents' ratings of other toothbrushing frequencies were consistent with the range and rank principle of Range-frequency Theory. A comparison between Group 1 and Group 2 showed that parents' ratings of similar brushing frequencies were affected by their relative rank among other brushing frequencies presented. A comparison between Group 3 and Group 4 showed that parents in a group who were presented with a very high brushing frequency (21 times a week) rated all other brushing frequencies as relatively less healthy than the comparison group. Conclusions: The principles of Range-frequency Theory were shown to be consistent with parents' judgement about children's oral health behaviour – specifically toothbrushing frequency. These findings provide a theoretical framework on which to develop future oral health education and interventions aimed at promoting twice-daily toothbrushing to parents of young children.

Parental decisions about children's oral health behaviour: relative or absolute?

R.J. Trubey

Research Associate, Centre for Trials Research, College of Biomedical & Life Sciences, Cardiff University

S.C. Moore

Professor, Violence & Society Research Group, Applied Clinical Research and Public Health, Cardiff University School of Dentistry

I.G. Chestnutt

Professor and Hon. Consultant in Dental Public Health, Applied Clinical Research and Public Health, Cardiff University School of Dentistry

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Corresponding author:

Rob Trubey
Research Associate
Centre for Trials Research
College of Biomedical & Life Sciences
Cardiff University
7th Floor, Neuadd Meirionnydd
Heath Park
Cardiff
CF14 4YS

Tel: +44(0)29 20687548
Email: trubeyrj@cardiff.ac.uk

Abstract

Objectives: To test the extent to which parents' judgements about their children's oral health behaviour conform to the principles of a specific theory of cognitive decision making – Range-frequency Theory.

Methods: Experimental study with an opportunity sample of 121 parents of young children (3-6 years old) living in areas of relative deprivation in South Wales. Parents were allocated to 4 different experimental groups, and each completed a pen-and-paper exercise, which involved being presented with (and rating) how often other parents brushed their children's teeth. The brushing frequencies presented were varied between groups, in order to directly test the rank and range principle of Range-frequency Theory.

Results: Parents' ratings of other toothbrushing frequencies were predicted by the range and rank principle of Range-frequency Theory. A comparison between Group 1 and Group 2 showed that parents' ratings of similar brushing frequencies were affected by their relative rank among other brushing frequencies presented. A comparison between Group 3 and Group 4 showed that parents in a group who were presented with a very high brushing frequency (21 times a week) rated all other brushing frequencies as relatively less healthy than the comparison group.

Conclusions: The principles of Range-frequency Theory predicted parents' judgement about children's oral health behaviour – specifically toothbrushing frequency. These findings provide a theoretical framework on which to develop future oral health education and interventions aimed at promoting twice-daily toothbrushing to parents of young children.

Background

The benefits of regular fluoride toothpaste use for preventing dental caries in both children and adolescents are well established[1]. Clinical trials have demonstrated improved oral health outcomes for twice-daily brushing compared to brushing just once a day or less[2], and twice-daily brushing is widely recommended for all age-groups[3,4]. However, national surveys suggest that a significant proportion of parents of 5-year-old children fail to adhere to these guidelines, with less than twice-daily brushing particularly prevalent among socio-economically deprived groups[5].

Behaviour-change interventions targeted at parents and caregivers therefore represent an opportunity for reducing the prevalence of tooth decay in young children. Previous efforts to change oral health behaviours have, however, been largely unsuccessful and criticised by researchers for lacking a theoretical underpinning or for relying on "now dated attempts to use social cognition models to predict behaviour"[6]. Despite a growing acknowledgement of the important role that parents and carers play in determining their children's oral health behaviour, theoretical explanations for the way in which parents make decisions in this area are still lacking[3].

Through a combination of interviews and cross-sectional survey work, our group has previously shown that the frequency with which parents brush their young children's teeth is significantly associated with their perceptions of how often other parents brush their children's teeth. Our research also suggests that parents evaluate their own child's routine in relation to what they think others do[7,8].

The current study aimed to further develop this work by testing the extent to which parents' judgements about oral health behaviour are consistent with a specific theory of relative decision making: Range-frequency Theory (RfT). RfT argues that most value judgements are made by 'relative' rather than 'absolute' processes[9]. There are two underlying principles of Range-Frequency Theory: the range principle and the rank principle. Briefly, the range principle posits that objects are perceived to be more valuable if they are proximal to the object with the largest value in the 'contextual set', while the rank principle argues that the relative rank of an object influences its perceived value. Researchers have shown that the rank and range principles of RfT can be applied to understanding people's judgements in broader economic, social and health-related fields. The theory has been shown to accurately model people's judgements of their own personal happiness[10], their satisfaction with their job

salary[11], their perceptions of body image[12], and their perceptions of the health benefits of different levels of exercise. For example, Maltby and colleagues asked participants how many minutes they typically exercised per week, then showed them information about how often other people did so, before finally asking participants how healthy they considered their own exercise levels. They found that participants' were heavily influenced by the information they were given about others – a participant who did an hour of exercise a week might consider themselves healthy if shown information suggesting that it compared favourably with their peers, but unhealthy if shown information suggesting it compared relatively unfavourably with their peers[13]. Despite this growing body of work, Range-frequency Theory has to our knowledge never been tested in the context or oral health behaviours.

The aims of the current study were therefore to: (1) manipulate information shown to parents about how often other parents brush their child's teeth each week, in order to test whether their judgements about what constitutes a healthy or unhealthy brushing routine conform to the rank principle of RfT; (2) manipulate information shown to parents about how often other parents brush their child's teeth each week, in order to test whether their judgements about what constitutes a healthy or unhealthy brushing routine conform to the range principle of RfT; (3) manipulate information shown to parents about how often other parents brush their child's teeth each week, in order to test whether this has any subsequent effect on their perceived norm for weekly brushing among other parents; (4) manipulate information shown to parents about how often other parents brush their child's teeth each week, in order to test whether this has any subsequent effect on how satisfied they are with their own child's brushing routine.

Methods

Ethical approval for the study was granted by Cardiff University Dental School Research Ethics Committee (DSREC Ref: 13/11).

Participants were an opportunity sample of 121 parents or caregivers of children aged between 3-6 years old. The children were attending one of twelve nursery and infant schools that were participating in the national Designed to Smile toothbrushing scheme in the Cardiff and Vale University Health Board area, South-East Wales.

The twelve nursery schools and infant schools were randomly selected from the full list of 163 schools taking part in the Designed to Smile scheme in the Cardiff and Vale University Health Board. Designed to Smile is the Welsh national oral health improvement programme targeted primarily at areas of high social and economic deprivation[14]. At each school, eligible parents of children attending nursery (up to 3 years old), reception (4-5 years old) and Year 1 (5-6 years old) classes were invited to take part in the study. Recruitment was aided by staff from the Community Dental Service who distributed invitation letters, information sheets and consent forms to class teachers to circulate to parents.

Parents indicating a willingness to take part in the study were contacted by telephone, where they had the chance to ask questions about the study, and were then asked to confirm that they still wished to take part in the study. Where no contact could be made, parents were called a maximum of three times (at least once in the evening or at a weekend) with answerphone messages left where possible. For parents who could be contacted and who consented to take part, a convenient time and place was agreed upon for them to complete the exercise while the researcher was present – usually at their own home.

Participants were paid £10 in shopping vouchers for taking part in the study.

Study design and procedure

The experimental research design was adapted from a series of experimental studies carried out by Wood and colleagues[13,15–16], in which they tested whether people's judgements about alcohol consumption, exercise duration and gratitude adhered to the rank and range principles of RfT.

Parents were allocated to one of four experimental groups. Group allocation was quasi-randomised with parents assigned to groups sequentially, whereby the first participant to carry out the exercise was assigned to be in Group 1, the second participant in Group 2 and so on.

Participants completed a pen and paper exercise in their home or in a quiet location such as a cafe or their place of work. The researcher introduced the study as being related to their child's toothbrushing routine, and encouraged them to be as honest as possible with their answers, assuring them that all results would be anonymised and stored confidentially.

The researcher read each participant a set of standardised instructions, and then presented them with the exercise sheet. Parents were told to follow the instructions on each page and to take as much time as they needed. The researcher was present at all times during the exercise, and parents were encouraged to ask questions if there was anything they were unsure of. Otherwise, participants were left to complete the form on their own. The exercise typically took around 15-20 minutes to complete.

In all groups, parents were first asked for their child's age and gender, and then to indicate how often they brushed their child's teeth at home each week. Parents were subsequently presented with a table showing how many times nine other parents brushed their child's teeth in a normal week, and told that the data was taken from a previous survey of toothbrushing habits. On the following page, they were then asked to rate each of the nine brushing routines on an 11-point scale, ranging from 1 (very unhealthy) to 11 (very healthy). On the final page, parents were asked to use the same 1-11 scale to indicate how healthy they believed their own child's brushing routine was. They were then asked to estimate how often they thought an 'average' child in their son or daughter's school class might have their teeth brushed at home each week.

<Figure 1>

The participants were allocated to one of 4 experimental groups (Figure 1). All groups answered the same pre and post exercise questions. The main experimental manipulation was the set of nine brushing frequencies that each participant saw. Participants were shown one of four different sets of numbers, depending on their group allocation. In Groups 1 and 2, the distribution of brushing frequencies was manipulated to test the 'rank principle' of RfT, whereas in Groups 3 and 4, the distributions were manipulated to test the 'range principle'.

Rank principle

Table 1 shows the distribution of the brushing frequencies presented to participants in Group 1 and Group 2. Participants were told that the numbers represented the frequency with which various parents had reported brushing their child's teeth in a normal week, and were shown the brushing frequencies in a randomised order. The frequencies common to each group are highlighted in bold for the purpose of illustration. All frequencies were presented to the participants in plain black text.

<Table 1>

The range (=12) and sum of brushing frequencies (=72) was equal for both groups: that is, the difference between the maximum value (=14) and minimum value (=2) were the same, and the nine brushing frequencies added to the same value for both groups. The highlighted values (5, 8 and 11 times per week) were common to both groups and were used as reference points. The three reference points were of equal proximity to the minimum, maximum and mean values in each group.

The only way in which the reference points differed between groups was in their rank position among the other brushing frequencies. In Group 1, "5 times per week" was the second lowest value in the group (rank = 8th out of 9), whereas in Group 2, it was the fourth lowest value (rank = 6). "11 times per week" was the second highest value in Group 1 (rank = 2), whereas it was the fourth highest in Group 2 (rank = 4). In both groups, "8 times per week" was ranked in the middle of the group (rank = 5).

This allowed for a direct test of the rank principle: because their proximity to the range and distance from the mean was the same, any difference in the way that the two groups rated the "5 times per week" and "11 times per week" frequencies could only be accounted for by the fact that these values differed in their rank position.

Range principle

Table 2 shows the distribution of the brushing frequencies presented to participants in Group 3 and Group 4. Again, participants were told that these numbers represented the frequency with which various parents had reported brushing their child's teeth each week, and the order of brushing frequencies was randomly generated for each participant.

<Table 2>

Despite the different distributions, the range (=16) and sum of brushing frequencies was equal for both groups (=95).

The only difference between the groups was that in Group 3, the majority of the values were close to the top of the range (i.e., the distribution was negatively skewed), whereas in Group 4, the majority of the values were closer to the bottom of the range (the distribution was positively skewed).

This allowed for a direct test of the range principle. In theory, the average rating given to the nine brushing frequencies should be equal between the two groups, because the average

brushing frequency was the same for both groups. Any significant difference in the sum of subjective health ratings between the two groups could therefore only be accounted for by the proximity of the frequencies to the minimum and maximum values in each group.

Data analysis

Data were entered and analysed using SPSS v20[17].

To test the rank principle between Group 1 and Group 2, a two-factor mixed factorial ANOVA was used. Group (Group 1, Group 2) was a between subjects factor and brushing frequency (5 times per week, 8 times per week, 11 times per week) was a within subject factor. Analysis tested for main effects of brushing frequency and group, and for an interaction between the two factors. As is recommended with a mixed factorial ANOVA, effect sizes for significant findings are reported using the eta squared statistic (η^2)[18].

One-way ANOVAs were used to test mean differences between the two groups in terms of parents' ratings of their own child's brushing frequency and their estimated 'norm' for weekly brushing frequency. For one-way ANOVAs, effect sizes for significant findings are reported using the Cohen's *d* statistic[19].

To test the range principle, a one-way ANOVA was used to test mean differences in the average scores allocated to all nine brushing frequencies, with group (Group 3, Group 4) as the between subjects factor. To further test the range principle, a one-way ANOVA was employed to look at the mean healthiness score that each group assigned to the '14 times per week' frequency, which was common to both groups and ranked the same (3rd out of 9) in both. As above, one-way ANOVAs were used to test mean differences between the two groups in terms of parents' ratings of their own child's brushing frequency and their estimated 'norm' for weekly brushing frequency.

For each participant, a measure of socio-economic status was derived from their home post-code (provided on the consent form). Participants were allocated to one of five deprivation quintiles, assigned using the 2011 version of the Welsh Index of Multiple Deprivation[20] ranging from WIMD = 1 (least deprived) to WIMD = 5 (most deprived).

Results

<Table 3>

A one-way ANOVA showed that there were no significant differences between the groups in terms of the mean frequency with which parents reported brushing their child's teeth ($F(3, 117)=0.03$, $p=0.99$) or the child's age ($F(3,113)=0.23$, $p=0.88$). Chi-square analysis showed that there was no significant difference in the distribution of WIMD quintiles between the groups ($\chi^2 =9.09$, $p=0.70$), or any significant imbalance in children's gender ($\chi^2 = 6.26$, $p=0.10$) between groups.

Rank principle

There was a main effect of brushing frequency on the mean healthiness rating across the two groups ($F(1,59)=188.68$, $p<0.001$), whereby '11 times per week' was rated as generally more healthy than '8 times per week', which was in turn rated as generally more healthy that '5 times per week'.

When averaging the ratings assigned to 5, 8 and 11 times per week, there was no overall difference in healthiness ratings between the two groups ($F(1,59)=0.33$, $p=0.57$). However, there was a signification interaction effect between group membership and brushing frequency ($F(1,59)=6.98$, $p=0.01$; $\eta^2=0.08$) (Figure 2).

<Figure 2>

As predicted by the rank principle of Range-Frequency Theory, participants in Group 1 rated '5 times per week' as less healthy than participants in Group 2. The only way that the '5 times per week' frequency differed between groups was the fact that it was ranked lower among the other brushing frequencies presented to parents in Group 1 (rank = 8_{th} out of 9) compared to its rank in Group 2 (rank = 6_{th} out of 9). Conversely, parents in Group 1 rated the '11 times per week' brushing frequency as more healthy than those in Group 2. Again, the only way that this item differed between the groups was in its rank position among all brushing frequencies shown to parents. It was ranked higher in Group 1 (rank = 2_{nd} out of 9) compared to Group 2 (rank = 4_{th} out of 9). No difference in health ratings was observed for the '8 times per week' frequency, which had the same rank in both groups (rank = 5_{th} out of 9). This significant interaction effect therefore suggests that parents' judgements about toothbrushing frequencies comply with the rank principle of RfT. If parents made absolute judgements about the healthiness of different brushing frequencies, there should have been no

difference in the ratings assigned to the '5 times per week' and '11 times per week' frequencies between the two groups.

Range principle

There was a significant main effect of group on the average healthiness rating of all items ($F(1,58)=28.70$, $p<0.001$; $d=0.33$), whereby participants in Group 3 rated the nine brushing frequencies as significantly more healthy on average than those in Group 4 (10.5 v 9.3)

The nine brushing frequencies shown to the two groups had the same mean and sum value. If parents were making absolute judgements about the healthiness of brushing frequencies, there should have been no difference in the average ratings assigned to the nine items. This significant difference between the two groups is therefore consistent with the range principle of Range-Frequency Theory: the only difference between the two groups was that parents in Group 4 saw frequencies which were generally further away from the top of the range (the distribution was positively skewed, with a maximum value of 21 times per week) whereas those in Group 3 saw frequencies which were generally quite close to the top of the range (the distribution was negatively skewed, with a maximum value of 16 times per week).

Participants in Group 4 rated their own child's brushing routine as significantly less healthy than participants in Group 3 (8.0 v 9.6) ($F(1,57)=5.20$, $p=0.03$; $d=0.15$), despite no difference in the frequency which parents in the two groups reported brushing their child's teeth. Participants in Group 4 also estimated that the 'norm' for weekly brushing frequency was higher than those in Group 3 (11.1 v 10.3), but this difference was not statistically significant ($F(1,57)=0.87$, $p=0.36$).

Discussion

The findings of the study showed that parents' judgements about the healthiness of various weekly toothbrushing frequencies adhered to the rank and range principles of RfT. Parents tended to rate toothbrushing frequencies as more healthy when they were ranked relatively high among the other frequencies shown to them, and they ranked brushing frequencies as more healthy when they were closer to the maximum brushing frequency presented. The findings also demonstrated that showing parents different types of information about what others do, affected how healthy they rated their own child's brushing routine. Parents in Group 4, who were shown an example of a parent who brushed their child's teeth 21 times a

week (or 3 times a day), subsequently rated their own child's brushing frequency as significantly less healthy than those in Group 3. This difference existed despite parents from the two groups reporting similar frequencies for brushing their child's teeth at the beginning of the experiment.

Although a number of steps were taken during the design and administration of the study to ensure data quality and rigor, some limitations of the study must be acknowledged. One common criticism of experimental studies is that they may lack 'ecological validity' – that is, they may not be a realistic approximation of the way in which participants would make decisions in a similar 'real world' situation. In the current study, for instance, it is possible that parents were simply treating the brushing frequencies as numbers and comparing them with the other numbers presented. However, the instructions given to participants specifically mentioned that they should give an overall rating to the brushing frequencies, rather than comparing them to each other. Furthermore, when parents were verbally debriefed, they all indicated that they had understood the instructions and had assigned the ratings as instructed.

The researcher was present when parents completed the exercise, in order to help with any queries about the form. This helped to avoid measurement error by reducing instances of parents misunderstanding questions or ticking too many or too few boxes, for instance. It also allowed for greater standardisation of the process, ensuring that all parents were given the same instructions and that they completed the questionnaire one page at a time, as intended. However, despite reminding parents that there were 'no right or wrong answers', this may have led to some element of 'social desirability bias' where participants gave socially acceptable answers. Future work might look to see if there would be any difference in findings if parents completed a similar, self-complete questionnaire.

As the study population was deemed to be fairly homogenous in terms of socio-demographics, it was deemed unnecessary to deliberately balance the groups by matching participants on certain traits. Indeed, the groups were well matched in terms of children's age, the frequency with which parents reported brushing their child's teeth and socio-economic status, suggesting minimal selection bias.

Due to the deliberate focus on parents from areas of relatively high socio-economic deprivation, the findings reported here may have limitations in their generalisability to wider populations. To improve the external validity of the findings, future research may seek to explore whether parents from different socio-economic backgrounds, or older children and

adolescents exhibit the same tendency towards making relative judgements about toothbrushing frequency.

Finally, as this was the first study to test the principles of RfT in relation to oral health, it was not possible to accurately estimate means on which to base an *a prioi* sample size calculation. The sample size for each group was instead based on previous studies utilising the same experimental design. As a result, it is important to acknowledge the possibility of type II errors: that is, the chance that some of the non-significant findings may have been the result of a lack of statistical power.

Despite these limitations, this study is the first to apply the principles of RfT to trying to understand parents' decisions about what constitutes a healthy number of times to brush a child's teeth each week. These findings add to a growing research base showing that the two principles of RfT can accurately predict people's relative judgements in areas such as alcohol risk perception, body image, happiness and satisfaction with salary[10-13, 15].

The effect of showing people different information about what others do has been shown to influence people's subsequent judgements in other areas as well. Maltby and colleagues, of instance, demonstrated that participants were less likely to feel that their own exercise levels were healthy when previously shown examples of people who tended to exercise more than they did[13]. To our knowledge, this is the first study to demonstrate that presenting different types of information about what other people do can influence people's satisfaction with their own (or in this case, their child's) toothbrushing frequency. Participants shown information suggesting that other parents brush their child's teeth three times a day expressed less satisfaction with their own child's brushing routine. Such findings are consistent with the broader concepts of Social Comparison Theory[20], which argues that people have a natural tendency to compare themselves with others when making judgements – including those relating to health.

Assuming that parents who are less satisfied with how often they brush their child's teeth will be more motivated to improve their behaviour, this opens up a range of possibilities for designing oral health education messages or interventions which might bring about behaviour change through giving people different types of information about what their peers do.

Conclusions

The current study suggests that decisions about toothbrushing are influenced by the same cognitive processes (the rank and range principles) that predict people's judgements in other aspects of life. The Medical Research Council stress that an important stage in the development of complex interventions is the identification and development of appropriate theory[21]. The findings reported here suggest that Range-frequency Theory may offer one framework for designing oral health education messages or behaviour-change interventions aimed at parents of young children. Further research is required to explore how best to apply this theory to promoting adherence to toothbrushing guidelines among high-risk groups.

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Tables and figures

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Figure 1: Experimental procedure (attached PPT file)

Figure 2: Average health ratings assigned to selected brushing frequencies by participants in Group 1 and Group 2 – a test of the rank principle (attached PPT file)

Table 1: Brushing frequencies shown to participants in Group 1 and 2

Group 1	Group 2
Weekly brushing frequency	***Weekly brushing frequency***
2	2
5	3
6	4
7	**5**
8	**8**
9	**11**
10	12
11	13
14	14

Table 2: Brushing frequencies shown to participants in Group 3 and 4

Group 3	Group 4
Weekly brushing frequency	***Weekly brushing frequency***
0	5
6	6
7	7
11	8
12	9
13	10
14	14
15	15
16	21

Table 3: Demographic details of study participants

Variable	Group	N	Mean	Standard deviation	Min value	Max value
Frequency with which parents report brushing child's teeth (weekly)	G1	30	13.0	2.5	7	21
	G2	31	13.0	2.4	8	21
	G3	30	13.1	2.8	5	21
	G4	30	12.9	2.6	7	21
	Overall	121	13.0	2.5	5	21
Child's age (in months)	G1	28	60.4	11.0	40	81
	G2	30	61.8	12.4	34	81
	G3	29	59.8	13.3	38	75
	G4	30	59.3	13.6	25	74
	Overall	117	60.3	12.5	25	81

	Group	Male n (%)	Female n (%)
Child's gender	G1	15 (50.0)	15 (50.0)
	G2	12 (41.3)	17 (58.7)
	G3	20 (66.7)	10 (33.3)
	G4	11 (36.7)	19 (63.3)
	Overall	58 (48.7)	61 (52.3)

	Group	WIMD=1[a] n (%)	WIMD=2 n (%)	WIMD=3 n (%)	WIMD=4 n (%)	WIMD=5 n (%)
Parental socio-economic status	G1	2 (7.1)	2 (7.1)	6 (21.4)	9 (32.1)	9 (32.1)
	G2	1 (3.4)	0 (0.0)	10 (34.5)	6 (20.7)	12 (41.4)
	G3	0 (0.0)	2 (6.9)	6 (20.7)	10 (34.5)	11 (37.9)
	G4	1 (3.3)	4 (13.3)	7 (23.3)	7 (23.3)	11 (36.7)
	Overall	4 (3.4)	8 (6.9)	29 (25.0)	32 (27.6)	43 (37.0)

a=Welsh Index of Multiple Deprivation (Welsh Government, 2011*), where 1=least deprived and 5=most deprived

Figure 1: Experimental procedure flow diagram

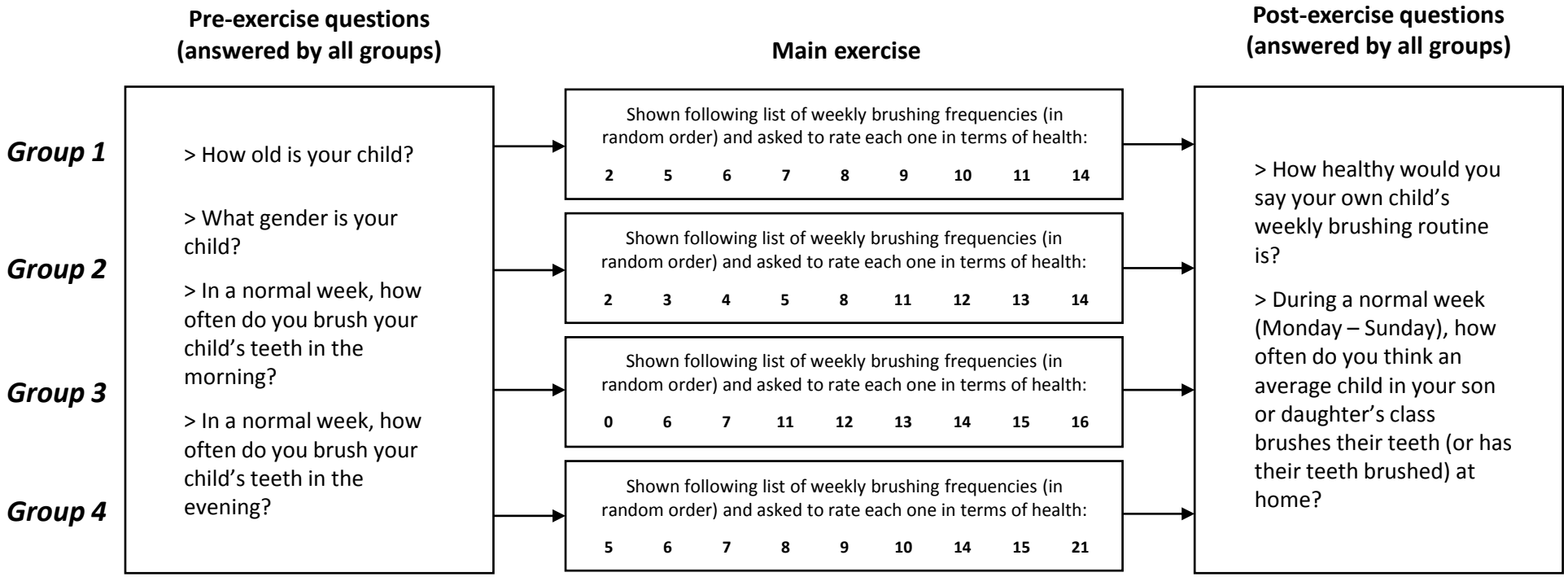

Figure 2: Average health ratings assigned to selected brushing frequencies by participants in Group 1 and Group 2 – a test of the rank principle