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## Adherence to a daily flossing regimen in university students: Effects of planning when, where, how, and what to do in the face of barriers

## Abstract

Objectives: Regular (daily) dental flossing is recommended for preventing oral diseases, but adherence is unsatisfactory. Social cognitive theory specifies determinants of dental flossing: Cognitions about risk, positive and negative outcome expectations and the perceived ability to perform behaviour predict motivation, which in turn predicts behaviour. Recent research suggests that motivation alone may not suffice to predict behaviour, and proposes if-then-planning. This study aims to predict flossing adherence from social cognitive variables and planning.

Materials and Methods: Questionnaire data from 157 non-dental university students on flossing, social cognitive theory variables and planning were gathered at 3 measurement points over six weeks. Residual floss was used to validate behaviour self-reports.

Results: Social cognitive variables and planning correlated significantly with flossing at all times. Discriminant function analysis suggests that after controlling for Time 1 flossing, planning Time 2 (Wilk's  $\lambda=.77$ ;  $p<.01$ ) is more important in discriminating between adherent and non-adherent participants at Time 3 than Time 1 social cognitive measures. Regression analyses confirmed this result with planning as only predictor of flossing change ( $p<.05$ ).

Conclusions: These results suggest targeting planning in interventions to increase compliance with flossing recommendations. Implications for such interventions are discussed.

## Clinical Relevance

Scientific Rationale: Daily flossing has been recommended by all major dental associations to prevent periodontal diseases. However, even motivated patients fail in adhering to these recommendations. This longitudinal study examined psychosocial determinants of daily flossing, especially the roles of planning and motivation.

Principal findings: Participants who flossed daily at the last measurement did not differ from those who failed regarding motivation. Planning Time 2 emerged as only significant predictor of Time 3 adherence.

Practical implications: Planning is a promising target for economic interventions. Forming concrete if-then plans for regular flossing can easily be implemented in the practical setting.

## Key words

Oral self-care, Dental flossing, Compliance, Planning, Health Behaviour Theories

## 2.1. Introduction

Although there have been major improvements in prevention and therapy of periodontal disease by mechanical and chemotherapeutical measures, the disease itself continues to be a major health problem. Medium to severe periodontitis, as assessed with the Community Periodontal Index, has been diagnosed in about 30% to 60% of the adult population, depending on the region of assessment (Petersen, 2003). Several studies have shown the usefulness of regular dental flossing for removing interdental plaque and preventing calculus (Bauroth et al., 2003; Bellamy et al., 2004). Both the American Dental Association (ADA, 2005), and the British Dental Association (BDA, n.d.) recommend the daily use of dental floss in addition to brushing teeth.

While brushing teeth daily is relatively well accepted, only few adhere to the recommended daily flossing regimen. Among university students, Rimondini et al. (2001) found 92% of their sample to brush at least twice a day, whereas only 15% flossed their teeth daily. Referring to the general population, Bader (1998) stated that the majority never flosses at all. Even if patients have been instructed and motivated in multiple sessions to use dental floss, adherence to recommendations often drops as soon as supervision is ceased (Stewart & Wolfe, 1989). The lack of patient compliance in home care can therefore be seen as the key problem in the prevention of periodontal disease (Ciancio, 2003; Widstrom, 2004). Psychological models of health behaviour can help identifying and understanding the processes responsible for patient motivation and compliance in terms of adherence to recommendations.

### 2.1.1. Determinants of health behaviour

Research has provided compelling evidence that health-relevant behaviour is predominantly determined by cognitions such as prospective beliefs, expectations and goals (Bandura, 1998). Social cognitive theory (SCT; Bandura, 1998) is among the best-evidenced theories of health behaviour. SCT assumes that the motivation (*intention* or *goal*) to engage in health behaviour is a result of three types of expectations, namely expectations about possible outcomes if no action is taken (i.e., current personal risk), about the consequences of adopting preventive measures and about one's ability to perform preventive behaviour successfully. *Risk perceptions* (situation-outcome expectations) describe the degree to which a person feels at risk to be affected by illnesses, e.g., periodontal disease without taking precautionous action. *Outcome expectations* are beliefs about the positive and negative consequences of performing preventive behaviour such as flossing (e.g., positive: reduction of periodontal risk; negative: aching gums). *Self-efficacy*, the subjective perception of an individual's capability to perform behaviour refers to both technical (e.g., the knowledge of the proper flossing technique) and personal aspects (e.g., the belief in one's ability to perform behaviour regularly).

According to SCT, people who feel at risk of periodontal disease, expect predominantly positive consequences from regular dental flossing (e.g., periodontal plaque reduction) and are confident that they have the necessary competences to apply dental floss correctly and to use it regularly are motivated to act. The strength of motivation is indicated by intentions. Previous research on the determinants of oral health behaviours provides support for the key assumptions of SCT: Intentions and self-efficacy are predictive of dental flossing (Rise et al., 1998; Tedesco, Keffer & Davis, 1991; Tedesco, Keffer & Fleck-Kandath, 1991). Self-efficacy with regard to flossing has also been shown to be strongly correlated to lower levels of dental plaque as a result of interdental hygiene behaviour (Stewart et al., 1999). Syrjälä et al. (2002) found higher intentions alongside with positive attitudes to be related to a higher frequency of tooth brushing in diabetic patients. In summary, SCT proposes determinants for oral self-care behaviours, which could be targeted in psychosocial and behavioural interventions (e.g., Philippot et al., 2005).

However, motivation alone is not enough. The less than perfect predictions of behaviour from SCT variables leave significant room for improvement in the understanding of the determinants of adherence. Observations from clinical practice support these findings: Even if patients are informed and motivated to change their interdental hygiene behaviour during periodontal treatments, this by no means guarantees that they will adhere to the recommendations when they are at home.

### 2.1.2. Planning and behaviour

Research on self-care behaviours has identified an “intention-behaviour-gap” (Orbell & Sheeran, 1998). After the decision to engage in self-care behaviour such as regular flossing, actual behaviour must be *implemented* and *maintained* over time. Here, it is important to identify good opportunities to act and to shield the intended behaviour from distractions, competing goals or motivation lapses. Recent research suggests that the formulation of concrete *if-then plans* facilitates the enactment of good intentions (Gollwitzer & Sheeran, in press; Sniehotta, Schwarzer, et al., 2005). Effective plans are simple and comprise of a precise description of a situation (by specifying when, where and how to act) and a concrete description of the intended behavioural response. Thus, planning creates active cognitive representations that make situational target cues more easily accessible and critical situations more easily detectable. Consequently, planned responses can be performed immediately and with little effort.

Planning can serve two purposes, the execution of intended action and the resistance from distractions and temptations. Forming *action plans* when, where and how to act facilitates behaviour by setting situational cues that activate cognitive processes needed to execute the action (e.g., "Every evening just before I go to bed I floss my teeth in the bathroom"). When the specified

situation is entered, the intended action will be carried out almost automatically (Gollwitzer, 1999). *Coping plans* are a strategy to overcome external (e.g., lack of time) and internal (e.g., motivation lapses) barriers to action (Sniehotta, Schwarzer, et al., 2005). Here, it is important to imagine in advance which obstacles could occur and formulate a cognitive or behavioural response that makes action more likely despite of barriers (e.g., "Whenever I don't have the time to floss in the evening I put the floss next to the toothbrush in order to floss the next morning."). Planning can be easily adapted to behavioural interventions in order to increase flossing behaviour. There is compelling evidence that forming if-then plans facilitates intended behaviour in other domains of self-care behaviour (Gollwitzer, 1999; Gollwitzer & Sheeran, in press; Sniehotta, Scholz, et al., 2005). To our knowledge, no study so far has examined the role of SCT variables and planning with regard to dental health behaviours.

### 2.1.3. Research questions

In this study, it will be examined whether measures of the SCT, namely risk perceptions, outcome expectations, self-efficacy and intentions, as well as planning would be correlated with dental flossing. Additionally, the relative contributions of these variables in predicting flossing will be investigated in a longitudinal setting.

## 2.2. Materials and Method

A prospective study with three points of measurement over a six-week-period was conducted in a group of 258 undergraduate psychology and educational science students in Berlin, Germany. The study was conducted in accordance with the WMA declaration of Helsinki (2002). The participants were approached during lectures (Time 1) and were sent postal questionnaires for Time 2 and Time 3 assessments. 252 students (97.7%) participated in the measurement after giving informed consent. Of these, 181 (70.4%), 140 of them female, filled in the Time 2 questionnaires two weeks later. 157 participants (62.3% of the Time 1 sample), 125 of them female, completed the Time 3 measures six weeks after Time 1.

In order to explore the relatively high attrition rates, dropout analyses were conducted comparing participants who discontinued participation after Time 1 with those who participated at Time 2 and those who participated at all times with regard to Time 1 measures of flossing, risk perceptions, outcome expectations, self-efficacy intentions and planning by means of independent sample *t*-tests. No significant differences were found, which indicates that the longitudinal sample is representative for the whole sample with regard to these variables. Mean age of the longitudinal sample was 25.3 years with a range from 18 to 51.

At Time 1, participants completed a self-administered questionnaire assessing SCT variables as well as dental flossing frequency and received samples of dental floss (Oral-B Satin Floss, 5 m). Additionally, they were given flossing instructions according to ADA recommendations. Time 2 questionnaires assessing planning and dental flossing were sent by post two weeks after Time 1 measurement together with a new sample of floss and a prepaid return envelope. The rationale for this time lag is that planning requires elaboration. In the weeks between the Time 1 and Time 2 assessments, participants had time to make experiences with floss and to form concrete plans, especially to overcome barriers. At Time 2, participants were also asked to return the used floss packets from Time 1 with residual (unused) dental floss. The returned packets were opened, residual dental floss was measured in cm and subtracted from 500cm (as new packets contain 500 cm), in order to validate the self-reported flossing measures. Time 3 questionnaires assessing dental flossing frequency were sent by post four weeks after Time 2 measurement with a prepaid return envelope.

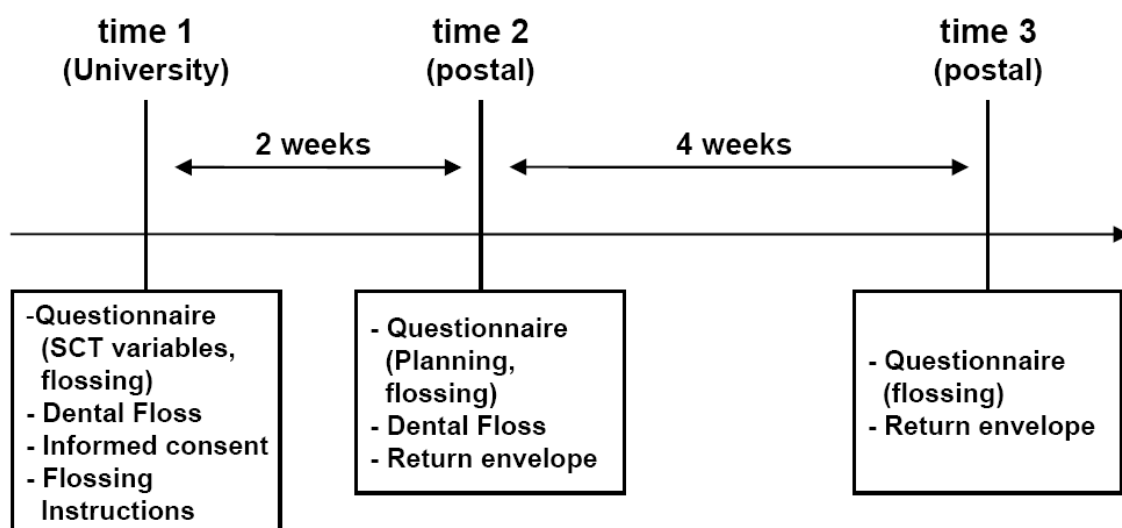


Figure 2.1: Longitudinal design of the study

The SCT variables were assessed using measures validated in previous research (Rise et al., 1998; Tedesco, Keffer & Fleck-Kandrath, 1991; Stewart et al., 1997). All items were answered on four-point scales from “completely disagree” to “completely agree”. *Risk perceptions* (Cronbach’s  $\alpha=.79$ ) were measured with three items; the stem “Not using dental floss...” was followed by a) “...increases the risk of periodontal disease”, b) “...increases the risk for tooth loss”, c) “...increases the risk for caries”. *Outcome expectations* (Cronbach’s  $\alpha=.81$ ) were measured with six

items such as “If I floss my teeth regularly, my risk for periodontal disease will decrease”. *Self-efficacy* (Cronbach’s  $\alpha=.76$ ) was measured with three items approximately based on the task self-efficacy scale by Rodgers et al. (2002) adapted to dental flossing, such as “I am confident that I can clean my interdental spaces as recommended”. *Intention* to floss regularly (Cronbach’s  $\alpha=.87$ ) was measured with three items such as “I intend to use dental floss regularly”. *Planning* at Time 2 (Cronbach’s  $\alpha=.93$ ) was assessed with the Action Planning and Coping Planning Scales (Sniehotta, Schwarzer, et al., 2005) adapted to dental flossing. Action planning was assessed with five items following the stem “I have made a detailed plan regarding...” a) “...when to floss my teeth”, b) “...how often to floss my teeth”, c) “...how to use dental floss”, d) “...how much time to spend with flossing” and e) “...with which regular behaviour (e.g., brushing teeth) to combine flossing”. Coping planning was assessed with six items following the same stem “I have made a detailed plan regarding...”: a) “...what to do if something interferes”, b) “...what to do if I forgot it”, c) “...how to motivate myself if I don’t feel like it”, d) “...how to prevent being distracted”, e) “...how to cope with eventually bleeding gums” and f) “...how to cope with eventual pain”.

*Dental flossing* at Time 1 was assessed with the item “How often did you floss your teeth during the last week?” At Time 2 (Time 3), dental flossing was assessed with the question “How often did you floss your teeth during the last two (four) weeks?” For the four-week time span between Time 2 and Time 3, participants who reported 28 or more times flossing (i.e., at least once a day) were considered to adhere to the dental recommendations. Consequently, the item was recoded into *adhering to dental recommendations* ( $n=29$ ) vs. *not adhering to dental recommendations* ( $n=128$ ).

### 2.2.1. Statistical Analyses

Mean scores were computed from the risk perceptions, outcome expectations, self-efficacy, intention and planning scales after assessing scale reliability in terms of internal consistency (Cronbach’s  $\alpha$ )<sup>3</sup>. Pearson’s correlation coefficient was used to examine the correlation between the self-report of dental flossing at Time 2 with the residual dental floss, thus evaluating the validity of the self-report measure.

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<sup>3</sup> Missing values in the study variables did not exceed 5% on any variable. Therefore, missing values were imputed using the Estimation Maximization imputation method in SPSS 12.0.1.

Variable	Range	Mean	SD	Cronbach's $\alpha$
Risk perceptions	1-4	2.83	.79	.79
Outcome expectations	1-4	2.94	.63	.81
Self-efficacy	1-4	3.19	.59	.76
Intentions	1-4	2.88	.91	.87
Planning Time 2	1-4	2.36	1.03	.93
Flossing Time 1	0-12	1.85	2.32	<sup>a</sup>
Flossing Time 2	0-23	4.85	4.09	<sup>a</sup>
Flossing Time 3	0-75	11.56	12.78	<sup>a</sup>
Residual dental floss	0-500	314.91	319.46	<sup>a</sup>

Table 2.1: Scale ranges, scale means, standard deviations and Cronbach's  $\alpha$  for risk perceptions, outcome expectations, self-efficacy, intentions (Time 1), planning at Time 2, flossing self-reports (Longitudinal sample,  $n=157$ ), and residual floss ( $n=95$ ).

Pearson correlations between all study variables were computed in order to examine the relations between the variables and the data set's suitability for logistic regression analysis (Table 2.2).

To examine whether use of risk perceptions, outcome expectations, self-efficacy, intention Time 1 and planning Time 2 would be able to differentiate between participants who adhered to the recommendations at Time 3 and those who did not, a stepwise discriminant function analysis with adherence Time 3 as grouping variable was conducted (Tables 2.3 and 2.4).

Regression analyses were used to determine the relative unique contributions of risk perceptions, outcome expectations, self-efficacy and intentions and planning to the prediction of Time 3 adherence to flossing recommendations, when Time 1 flossing is controlled for. Logistic regression analysis (Table 5) was used to predict a dichotomous measure of flossing (flossing daily/not flossing daily) at Time 3, indicating adherence to the recommendations for daily interdental hygiene (ADA, 2005; BDA, n.d.) and to take into account the non-normal distribution of the dependent variable (Tabachnick & Fidell, 2001). Additionally, a linear regression analysis with the same set of predictors treating flossing as continuous variable was conducted in order to control for possible artefacts of the dichotomization due to variance reduction in flossing. A  $p$ -value of .05 or smaller was considered to indicate significant contributors to the prediction of Time 3 flossing adherence. For all statistical analyses, SPSS for Windows release 12.0.1 was used.

### 2.3. Results

Relatively few participants adhered to the recommended flossing regimen at Time 3 ( $n=29$ ), but this is a significant increase compared to 18 participants who adhered to flossing recommendations at Time 1 ( $\chi^2=23.84$ ,  $df=1$ ,  $p<.01$ ). Residual dental floss was available from  $n=95$  partici-

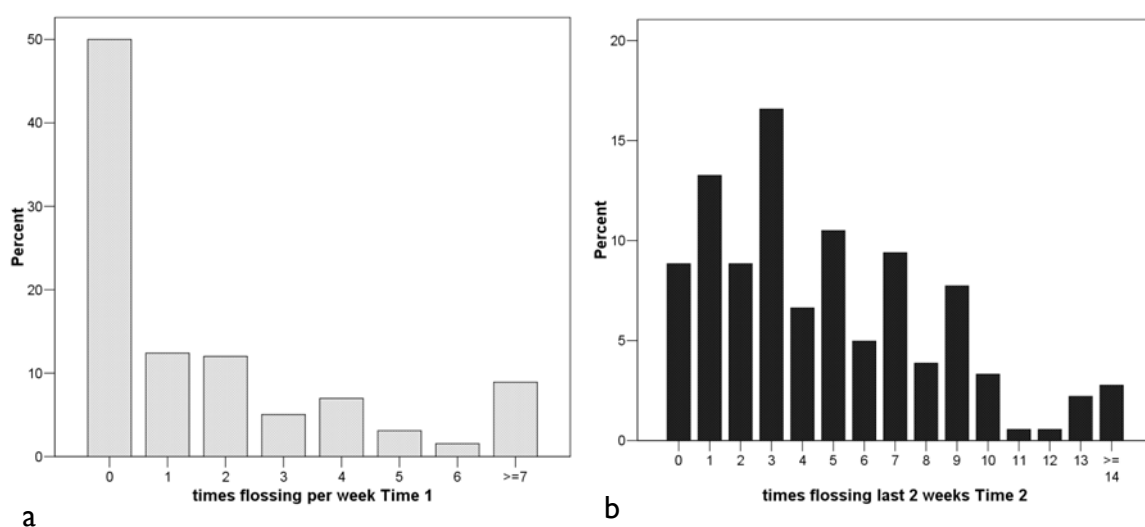


pants. Of the 86 participants who didn't return floss, 27 indicated that they threw away the samples, and 27 indicated "other reasons" for not returning the floss. On average, the returned packets contained 314.91 cm of residual floss, thus indicating that participants used on average 185.09 cm of floss during the two-week period from Time 1 to Time 2. Residual dental floss and the flossing self-reports correlated at  $r=.69$  ( $p<.01$ ), indicating satisfying validity of the self-report measure of flossing. A t-test indicated no significant baseline differences in flossing between those who returned residual floss and those who did not. Figures 2.2a) to 2.2c) show the frequency distributions of flossing during the 3 measurement points.

Variable	2	3	4	5	6	7
1. Risk perceptions	.73**	.14	.50**	.35**	.40**	.15
2. Outcome expectations		.25**	.60**	.43**	.40**	.20*
3. Self-efficacy			.26**	.20*	.18*	.22**
4. Intentions				.64**	.62**	.33**
5. Flossing Time 1					.47**	.46**
6. Planning Time 2						.37**
7. Flossing Time 3						

Note. \*\* $p<.01$ ; \* $p<.05$

Table 2.2: Pearson's correlation matrix of social cognitive theory variables, planning and flossing



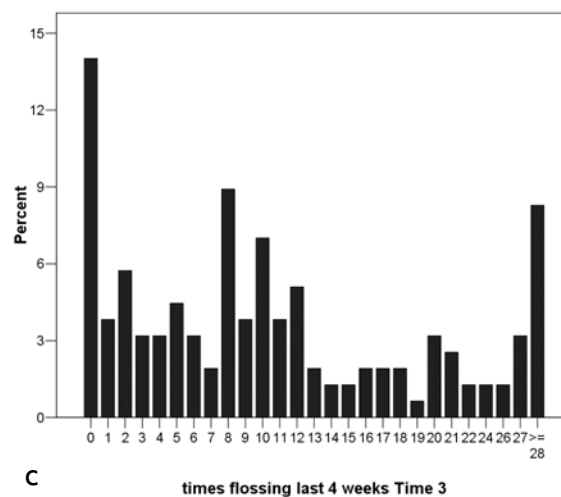


Figure 2.2: (a) Frequency distribution of flossing at Time 1 ( $n = 252$ ). (b) Frequency distribution of flossing at Time 2 ( $n = 181$ ). (c) Frequency distribution of flossing at Time 3 ( $n = 157$ ).

### 2.3.1. Social cognitive theory variables and flossing

Correlations between the SCT variables and flossing are reported in Table 2. As predicted by SCT, risk perceptions, outcome expectations and self-efficacy correlated significantly with intentions to use dental floss regularly. All SCT variables except for risk perceptions were substantially correlated to flossing frequency at Time 1 and Time 3. Risk perceptions were correlated with Time 1 flossing, but not with Time 3 flossing.

Predictor Variable	Participants <i>not</i> flossing daily Time 3		Participants flossing daily Time 3	
	M	SD	M	SD
Risk perceptions Time 1	2.84	.77	3.12	.74
Outcome expectations Time 1	2.95 <sub>a</sub>	.62	3.26 <sub>a</sub>	.56
Self-efficacy Time 1	3.13 <sub>b</sub>	.43	3.43 <sub>b</sub>	.43
Intentions Time 1	2.75 <sub>c</sub>	.96	3.50 <sub>c</sub>	.56
Flossing Time 1	1.22 <sub>d</sub>	2.00	3.92 <sub>d</sub>	2.66
Planning Time 2	2.01 <sub>e</sub>	.81	2.82 <sub>e</sub>	.78

Note. Means with the same subscript differ significantly at  $p < .01$ .

Table 2.3: Means and standard deviations of predictor variables as a function of daily flossing at Time 3

Step	Predictor Variable	Variables in discriminant function	Wilks's $\lambda$	Equivalent $F(2, 142)$
1	Flossing Time 1	1	.80	34.93**
2	Planning Time 2	2	.77	20.87**

Note. \*\* $p < .01$

Table 2.4: Predictor variables in stepwise discriminant function analysis

The results from the stepwise discriminant function analysis ( $n=157$ ) however suggest that although there are mean differences on most variables, only the behavioural baseline (Wilks's  $\lambda = .80, p < .01$ ), and planning Time 2 (Wilks's  $\lambda = .77, p < .01$ ) are able to differentiate between participants who adhered to recommendations at Time 3 and those who did not. Including Time 1 flossing is necessary in order to ensure that possible differences on the psychological variables are not due to previous flossing.

Variable	B	SE	Odds ratio (95% C.I.)	Wald statistic
Risk perceptions	-.45	.53	.64 (.23-1.79)	.72
Outcome expectations	.50	.63	1.65 (.48-5.73)	.63
Self-efficacy	.77	.49	2.15 (.83-5.57)	2.48
Intentions	-.09	.46	.92 (.37-2.26)	.04
Flossing Time 1	.35	.13	1.41 (1.10-1.81)	7.47**
Planning Time 2	.77	.37	2.16 (1.04-4.49)	4.26*

Note. \*\* $p < .01$ ; \* $p < .05$

Table 2.5: Summary of logistic regression analysis predicting adherence to flossing recommendations at Time 3.

### 2.3.2. Prediction of adherence to flossing recommendations

Logistic regression analysis ( $n=157$ ) was conducted in order to examine the predictive utility of SCT and planning with regard to the adherence to flossing recommendations (Table 2.5)<sup>4</sup>. The model yields a Nagelkerke- $R^2$  of .35, and the Hosmer and Leweshow test is not significant ( $\chi^2=5.95, df=8, p=.65$ ). The model is able to classify 86.8% of participants correctly. Planning Time 2 (OR: 2.16,  $p < .05$ ) is the only significant predictor of Time 3 flossing when Time 1 floss-

<sup>4</sup> A second logistic regression analysis with the interaction term intention\*planning was conducted in order to examine a possible moderation effect of intentions (Baron & Kenny, 1986). The interaction term yielded no significant B value. Planning was the only significant predictor, thus indicating a main effect.

ing (OR: 1.41,  $p < .01$ ) is controlled for. This means that an increase of planning by one unit doubles the likelihood of being in the daily flossing group. Controlling for Time 1 flossing is necessary to ensure that individual changes in flossing are analysed instead of describing interindividual differences that persist over time. In order to control for possible statistical artefacts due to dichotomisation of the dependent variable, a linear regression analysis ( $n=157$ ) was conducted treating flossing Time 3 as continuous variable and using the same predictors as in the logistic regression analysis. The prediction patterns replicated those of the logistic regression with baseline flossing ( $\beta=.40$ ;  $p < .01$ ) and planning Time 2 ( $\beta=.19$ ;  $p < .05$ ) as only significant predictors, accounting for 43% of the variance in Time 3 flossing.

## 2.4. Discussion

This study is the first to examine the effects of planning and social-cognitive theory on adherence to a regular dental flossing regimen. In a longitudinal design, it was examined whether planning at Time 2 had an additional effect on dental flossing after previous flossing and motivation at Time 1 -as indicated by social cognitive theory- have been controlled for. The results from the discriminant function analysis indicate that participants who adhered to the dental recommendations of flossing once a day at Time 3 employed more planning when, where and how to act (*action planning*) and what to do in the face of barriers (*coping planning*) at Time 2 than those who did not. There were no differences between these groups with regard to intentions, outcome expectations, risk perceptions and self-efficacy at Time 1. Furthermore, planning was found to be the only significant predictor of adherence to recommendations in linear and logistic regression analyses.

### 2.4.1. Social cognitive beliefs and flossing

According to SCT, outcome expectations, risk perceptions and self-efficacy are important motivational variables for the formation of intentions. Results of the present study support this assumption, because intentions were significantly and substantially correlated with these variables, indicating that higher levels in risk perceptions, outcome expectations and self-efficacy covariate with higher levels of intentions. Providing patients with information about their personal risk, the benefits of dental flossing and the easiness of performance can therefore enhance their motivation to act, but this may not be enough for actual behaviour. The finding from the discriminant function analysis that there were no differences between those who adhered to recommendations at Time 3 and those who did not with regard to motivation at the first measurement point replicates research on other preventive and self-care behaviours (e.g., Orbell, Hodgkins, & Sheeran, 1997; Sniehotta, Scholz, et al., 2005). These studies found motivational variables to be insufficient

to predict actual behaviour and indicate that processes other than information about personal risk and outcomes of behaviour are responsible for performing behaviour.

This however does not suggest that social cognitions are not relevant for oral self-care. The present study suggests that these processes are important correlates of the motivation to take up an oral self-care regimen and of flossing behaviour. The finding that the proportion of adherent participants increased over time without an intervention could be attributed to the study situation. Participants motivated to floss might have perceived the study as cue to action and employ self-regulatory strategies in order to floss more regularly.

#### 2.4.2. Planning and flossing

Previous studies on health behaviour suggest that self-regulatory strategies such as planning are only effective if participants are already motivated to change their behaviour and hold strong intentions to act (Gollwitzer, 1999). In this study, this assumption was not supported. A main effect of planning rather than a moderated effect was found.

Planning when, where and how to act forms active mental representations of the target situation (Gollwitzer, 1999). These representations are easily accessible, thus participants who have formed an active image, e.g., of themselves flossing in the bathroom before going to bed, can remember this image more easily when they enter the target situation and remember to floss. Planning might have also ensured that flossing has priority over competing goals, both with beginning to floss and with maintaining it over time.

The finding that planning Time 2 emerged as only significant predictor of flossing adherence at Time 3 when flossing at Time 1 and motivational variables at Time 1 were controlled for speaks in favour of its usefulness in the context of oral health promotion. According to the odds ratios in the logistic regression analysis, an increase in planning by one unit increases the probability of being in the flossing adherence group more than twice. This result is also in accordance to recent research on planning (e.g., Gollwitzer & Sheeran, in press; Orbell et al., 1997; Sniehotta, Scholz, et al., 2005).

What remains open to further research is to examine the ability of planning to predict behaviour when motivational variables are concurrently assessed at the same measurement point.

In the present study, planning was examined at Time 2, because planning what to do in the face of barriers requires experience with the particular behaviour. Planning alternatives for flossing in advance requires at least some knowledge about possible barriers to flossing. This knowledge increases with experience. Plans for behavioural alternatives in the face of barriers might have provided participants with good behavioural alternatives despite reasons to refrain from flossing. For example, a person who has planned what to do when they have no time to floss (e.g., put the

floss next to the toothbrush in order to floss the next morning) might also remember this plan more easily whenever this critical situation is entered, and thus act in accordance more likely (Sniehotta, Schwarzer, et al., 2005).

### 2.4.3. Oral self-care behaviours in university students

Young people such as undergraduate students are a major target for interventions in preventive dentistry. Many students leave their parent home when they enter the university and develop independent living and their own self-care patterns (Gall, Evans & Bellerose, 2000). This is a key point for interventions in preventive dentistry. However, little research has been conducted in similar samples.

Although the performance of oral self-care behaviours is usually better among higher-educated persons such as university students (Paulander, Axelsson & Lindhe, 2003; Rimondini et al., 2001), the patterns of oral self-care found in this study are alarming with only 9.3% of the sample flossing daily (Fig. 2a). Additionally, studying this age group gives important suggestions for sustaining oral self-care behaviour interventions.

### 2.4.4. Limitations of the study

There are some limitations that need to be addressed. The dependent variable, Time 3 adherence to recommendations, was assessed via self-report. Although the self-report at Time 2 was substantially correlated to the residual floss, only 95 participants (52.5% of the Time 2 sample) returned residual floss. This measure therefore can only be used to support the validity of the self-report measure, but not for further analyses due to the missing values. The finding that there were no baseline differences between those who returned floss and those who did not however suggests that this is representative for the whole sample. The measures used here allow for assessing flossing frequency, but not for flossing quality, that is, whether participants really followed the instructions concerning the areas to floss.

The attrition rate of 37.7% in this study from the first to the last measurement point was relatively high, exceeding the rates found in other longitudinal dental research (e.g., Philippot et al., 2005). This high rate might be due to the fact that study participation and continuation was voluntary and unpaid. Although no differences between drop-outs and participants continuing in the study were found on the Time 1 measures, no conclusions about the reasons for attrition can be drawn. Variables not assessed in this study might have caused systematic attrition and therefore might have influenced this study's results. The university student population with a majority of women is not generalisable to those most at risk for periodontal disease, e.g., a population with low socio-economic standard, although the flossing levels in the study sample are remarkably low

(see Fig. 2a). Additionally, previous research on planning has not provided evidence for different effects between groups with different levels of education or social-economic background (Gollwitzer & Sheeran, in press). However, replication in other samples is needed to gauge the generalisability of the findings in the present study.

Variables from social-cognitive theory were only measured at Time 1, thus the design allows not for examining whether changes in these variables occurred and whether changes in these variables are discriminately valid in predicting flossing at Time 3 in comparison to planning. Additionally, due to the non-experimental design of this study, no causal implications about the effect of planning can be drawn. Randomised controlled trials are needed to underpin these effects.

Finally, the time interval of six weeks may have been too short to draw final conclusions on long-term effects of planning on flossing, thus future studies might want to consider longer time intervals.

#### **2.4.5. Clinical implications**

The findings that participants who adhere to the recommendation to floss daily differ from those who do not with regard to planning and that planning Time 2 predicts adherence at Time 3 implicates that future behavioural interventions to enhance flossing should focus on both, motivational variables such as risk communication, enhancing self-efficacy and knowledge about benefits of interdental hygiene, but also promote planning. Interventions to promote planning could take place in a face-to-face-setting, e.g. in the dental practice, or in written form. Patients should specify when, where and how they plan to use dental floss. Additionally, they should plan behavioural alternatives for personal risk-situations that may keep them from flossing. Interventions according to this scheme are simple and economic and have been successfully employed in the domain of physical exercise (Sniechotta, Scholz, et al., 2005). Considering these interventions and results from the present study, psychosocial interventions might be a useful means to improve the periodontal risk state sustainably, especially in younger-aged persons.

### **2.5. Acknowledgement**

Flossing samples by courtesy of oral-b Gillette Germany. We thank two anonymous reviewers for their helpful comments on an earlier draft of this paper.

### **2.6. References**

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