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A longitudinal study of coping, anxiety and glycemic control in adults with type 1 diabetes

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Abstract
Diabetes is a unique disorder in how much it requires a high degree of individual self management strategies. Anxiety and stress can affect glycemic control, and thus management of emotions may be key to good glycemic control. This study is the first to examine how anxiety and coping style, and their interaction, can affect long-term glycemic control. We measured anxiety, coping, and HbA_{1C}, a measure for mean blood glucose levels in the previous 6–8 weeks, in 115 patients with Type 1 diabetes at baseline and roughly 5 years later. We found that coping predicted outcomes, especially for those high in trait anxiety. Trait anxiety predicted limited increases in HbA_{1C} (mean increase = 0.02%). Lower levels of emotion-oriented coping predicted clinically significant increases in HbA_{1C}, but only for those high on baseline trait anxiety (mean increase = 0.92%). Task-oriented coping predicted decreases in state anxiety. Use of task- and emotion-oriented coping appears especially important for highly anxious patients, both for emotional regulation and glycemic control. So, coping styles, basal anxiety and their interactions should be considered in designing follow-up and interventions with diabetic patients.

Keywords: *Type 1 diabetes, coping, trait-anxiety, state-anxiety, HbA_{1C}*

Introduction

Type 1 diabetes is associated with long-term complications including heart disease and renal disease. Research strongly suggests that chronic hyperglycemia, resulting from poor blood glucose management, is a major factor contributing to

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long-term complications (DCCT, 1993). Therefore, it is of great interest to identify determinants of blood glucose management in subjects suffering from this disease. Among these factors, coping appears to be central in the adjustment of people with diabetes (Rubin & Peyrot, 2001). The theoretical background of this study is the interactionist model of anxiety, stress and coping which was formulated by Endler (1988). Coping behaviors or responses are one possible reaction to perceived threat and resulting changes in state anxiety. This model is focused on coping habits thought of as usual reactions to demands. These are conceptualized as high order task-oriented, emotion-oriented and avoidance coping styles (Parker & Endler, 1992; Tobin, Holroyd, Reynolds, & Wigal, 1989). This model is anchored in the behavioral tradition of coping. Task-oriented coping refers to efforts aimed at solving problems and restructuring situations cognitively in an attempt to modify them. The focus is put on the task, organizational activities and attempts to directly solve problems. Emotion-oriented coping describes the emotional reactions or expressions intended to reduce stress. These reactions include emotional responses, personal preoccupations and fantasies. Avoidance includes activities and thoughts that help one avoid the stressful situation such as seeking social support or distracting oneself.

Diabetes is a unique disorder in that it requires a high degree of individual self-management behaviors. From a mental as well as from a physical health perspective, how people usually manage difficulties may be central during the course of the illness. Studying these coping styles in diabetes is important because they may have an effect on emotional outcomes. In people with diabetes, some coping styles may help manage distress (e.g., expression) whereas some may be deleterious (e.g., repression), depending on various personal and contextual factors (Macrodimitris & Endler, 2001; Rubin & Peyrot, 2001). The influence on distress is all the more important since distress and depression have been recognized as correlates and may be a vulnerability factor for the development of complications in diabetes (Clouse et al., 2003; Lustman et al., 2000). Coping styles may also be directly associated with behavioral patterns relevant to diabetes management such as behavioral disengagement or problem-solving behaviors. So, coping styles may have an influence on adherence and self-care which might ultimately be reflected on metabolic control (Glasgow et al., 1999). People with Type 1 diabetes, in particular, may show these coping-health relationships, since their negative emotions can worsen their glycemic control, and stress reduction can help improve glycemic control (Attari, Sartippour, Amini, & Haghighi, 2006), as detailed subsequently.

Few studies have prospectively examined the effects of coping on physical health (Park & Adler, 2003; see Penley, Tomaka, & Wiebe, 2002, for a review). In Type 1 diabetes, previous studies mostly report cross-sectional positive correlations between problem-focused (or active) coping and metabolic control and negative correlations between emotion-oriented or avoidance coping styles and metabolic control, suggesting that problem-focused coping would have a positive impact and emotion-oriented or avoidance a negative impact on

metabolic control (Gåfvels & Wändell, 2006; Graue, Wentzel-Larsen, Bru, Rokne Hanestad, & Søvik, 2004; Peyrot, McMurry, & Kruger, 1999; Reid, Dubow, Carey & Dura, 1994; Smari & Valtysdottir, 1997; Turan, Osar, Molzan Turan, Damci, & Ilkova, 2002). Although this is in line with theoretical expectations from the coping literature and diabetes literature, the causal hypotheses can only be addressed through longitudinal designs.

To our knowledge, only three prospective studies have related baseline coping styles with glycemic control in a longitudinal design. Spiess et al. (1994) have followed 43 adult patients during the first 2 years after onset. They evidenced a relation between poor global coping quality at onset and lower metabolic control. Active coping predicted a decrease of HbA_{1C} over 2 years. However, coping style was measured with an unvalidated and unpublished measure. Grey, Boland, Davidson, Li and Tamborlane (1997) studied coping in 89 children aged 8–14 years and found that use at diagnosis of avoidance coping reactions was associated with higher glycated hemoglobin (HbA_1) 1 year later. This relation was not adjusted for baseline HbA_1 levels, calling into question whether coping affected HbA_1 levels over time. Finally, Seiffge-Krenke and Stemmler (2003) studied coping in 98 adolescents over a period of 4 years. They observed that adolescents who employed less avoidant or withdrawal coping had better metabolic control 2 and 3 years later compared with people who employed avoidant and withdrawal coping. Thus, studies in Type 1 youth suggest that active coping has important long-term prognostic value. However, there have been no long-term studies on a large sample of adults with stabilized diabetes, using a validated coping measure.

The role of dispositional anxiety has also been investigated. Recent results from a meta-analysis showed that anxiety was associated with hyperglycemia in diabetic patients, especially when clinical anxiety disorders were considered (Anderson et al., 2002). Various results suggest that individual differences in anxiety proneness and stress reactivity are core features in Type 1 diabetes. In fact, in stress-reactive individuals, daily stress has impacted blood glucose in follow-ups (Riazi, Pickup, & Bradley, 2004). Also, life stressors (serious life events) were associated with poorer metabolic control (Lloyd et al., 1999), as well as was acute and life-threatening stress (Inui et al., 1998). Finally, some interventions focusing on stress-reduction have been effective in lowering glycemia in a clinically significant way (see Surwit et al., 2002, in Type 2 diabetes). Moreover, baseline anxiety and coping styles could interact in predicting health outcomes. The measurement of coping reactions was found to vary according to emotional states and mood in a sample with major depression and anxiety disorders (Uehara, Sakado, Sato, & Takizawa, 2002): task-oriented coping was related with depression and emotion-oriented coping was related with anxiety levels. The core role of trait-anxiety was demonstrated by Lancastle and Boivin (2005) who have shown that the health benefits related to fertility treatment associated to optimism and coping were due to their shared variance with measures of trait-anxiety. These results advocate for controlling for basal anxiety when examining the coping – health outcomes relationship. It is probable that the effectiveness of

emotion-oriented coping may be better in people who are likely to experience acute emotional responses and therefore need to express and process their emotion, e.g., in people with a high basal anxiety.

To summarize, the literature lacks empirical prospective designs to determine the predictive power of coping styles on metabolic control in the long run. This issue is of primary importance to identify long-term costs or benefits of coping, and to subsequently integrate this knowledge into interventions. At present, it is also unclear whether the effect of coping would be different according to different levels of base trait-anxiety.

This study prospectively examines the impact of coping strategies on both mental and physical health markers in people with Type 1 diabetes, taking trait-anxiety levels into consideration. In order to explore for the effects of coping and anxiety on health in the long run, we chose an interval of 5 years, long enough to elicit psychological and biological changes in people with stabilized type 1 diabetes. Although practice is usually well-defined and data available at the beginning of the illness, stabilized chronic condition in middle-aged adults is understudied. In such populations, chronically emotionally disturbed patients may not need develop the same attitude as other patients towards difficulties in general, and diabetes management in particular. We considered blood glucose level and state-anxiety as primary outcomes and coping styles and stable trait-anxiety as predictors. We expected coping styles to predict changes in state-anxiety and blood glucose (improvements or deterioration). Given the type of demands imposed by Type 1 diabetes management we expected task-oriented coping to have a favorable influence whereas emotion and avoidance would have a negative influence on blood glucose and state-anxiety. We also expected trait-anxiety to predict deterioration in health outcomes. We hypothesized that the trait-anxiety would interact with coping styles in the long run, with some styles usually known as deleterious – emotion-oriented and avoidance coping – being more effective when basal anxiety level is high.

Method

Participants

The patients were recruited from two outpatient units in Paris (Pitié-Salpêtrière Hospital, Department of Diabetology) and Dijon (Bocage Hospital, Department of Endocrinology), France. Table I summarizes the main characteristics of the sample.

Inclusion criteria for the present study were as follows: (1) medical diagnosis made by an experienced diabetologist (Type 1 diabetes); (2) subjects suffering from Type 1 diabetes for more than 1 year; (3) no pregnancy, (4) age range 18–65 years. Subjects suffering from another chronic illness were excluded (such as heart disease or cancer or any psychiatric difficulties likely to seriously disturb reality testing or personal judgment). This screening was done by using a semi-structured interview by an experienced psychologist before inclusion, and based on

Table I. Description of variables and stability analysis over the 5-year period ($n = 115$).

	Baseline			5 years later					
Variables	*n*	*M*	SD	*n*	*M*	SD	χ^2	*t*	*r*
Illness									
Age		42.2	14.9		47.4	15.2			
Age at onset		23.5	11.3		–	–			
Diabetes duration		16.8	11.7		23	11.7			
HbA_{1C}		8.13	1.10		7.97	1.60		1.41	0.62***
Insulin treatment									
2–3 injections	75 (65%)			61 (53%)					
4 + injections	35 (30%)			48 (42%)					
Pump	5 (5%)			6 (5%)			3.57		
Diabetes education									
Yes	87 (76%)			110 (96%)					
No	28 (24%)			5 (4%)			18.71***		
Complications									
Yes	46 (40%)			64 (56%)					
No	69 (60%)			51 (44%)			5.65		
Retinopathy	39			50					
Nephropathy	4			8					
Peripheral vascular	3			6					
Blood glucose monitoring (times/day)		3.29	1.66		NC	NC			
0–3 blood checks	67			NC					
4 + blood checks	48			NC					
Coping (CISS)									
Task		44.02	14.50		53.50	14.98		−5.44***	0.18
Emotion		35.41	13.11		39.34	12.60		−2.82**	0.31**
Avoidance		37.02	12.46		41.01	11.25		−3.28**	0.38***
Distraction		17.65	6.92		19.11	6.16		−2.54*	0.54***
Social Diversion		12.08	5.02		13.59	5.20		−2.81*	0.35***
Anxiety (STAI-Y)									
Trait Anxiety		44.95	10.19		43.07	10.32		2.69**	0.73***
State Anxiety		35.59	11.16		39.71	11.42		−3.22**	0.23*

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$. NC = data not collected at Time 2.

their clinical judgment. Eligible patients were offered the opportunity to participate in the study. The study received full Institutional Review Board approval.

A total of 187 patients who met the criteria were invited to participate and 172 agreed to do so. Fifteen potential subjects refused participation. Among these 172, 147 actually completed the questionnaires at baseline (response rate = 85%). Those who did not send back questionnaires had a poorer metabolic control ($t = 2.99$; df = 138, $p < 0.01$) but did not differ in sex and age (p's > 0.36). Participants for whom data were collected at baseline were contacted by mail for follow-up four to six years later and asked to send back self-report questionnaires (Mean interval = 5.2 years, SD = 0.35, Min = 4.5, Max = 6.1). One hundred and fifteen patients sent them back with complete information (response rate = 78%). Dropouts had higher blood glucose levels than those enrolled at retest ($t = -2.10$; df = 147, $p < 0.05$). Reasons for attrition were: (1) death of the participants ($n = 6$); (2) moving to an unknown address ($n = 6$); (3) changing to another medical unit or private practice ($n = 11$); (4) no reply to mail and telephone calls ($n = 9$). The final sample of 115 is composed of 51 men and 64 women recruited on the two settings (Paris: $n = 69$; Dijon = 46). Patients from the two settings did not differ in age, sex, or other illness-related variables (metabolic control and complications) (all p's > 0.25). Yet people from Paris had a slightly higher level of education than Dijon ($Z = 2.01$, $p < 0.05$).

Measures

The following measures were used at baseline and retest.

Glycated hemoglobin (HbA_{1C}) provided a biological marker of glycemia over a 6–8-week period (Schiffreen, Hickingbotham, & Bowers, 1980). This was assessed by the High Pressure Liquid Chromatography (HPLC) technique which is the current standard. In the two settings, norms for controls range from 4 to 5.9%. In our sample, mean level for HbA_{1C} was 8.13 and 7.97% at baseline and retest, respectively. This is comparable to other samples in diabetic research (e.g., Smari & Valtysdottir, 1997). HbA_{1C} values and other sociodemographic and medical information were obtained from the medical file.

Coping Inventory of Stressful Situations (CISS, Endler & Parker, 1998). This is a 48-item inventory designed to assess coping styles. Each item is rated on a scale between 1 = 'not at all' and 5 = 'very much'. There are three main scales in the inventory: Task-oriented, Emotion-oriented and Avoidance coping styles, with possible score range 16–80. In previous studies, three general factors have been found in the inventory corresponding to these scales. The reliability was high with short-term test–retest and internal consistency coefficients above 0.80 (Endler & Parker, 1994, 1998). This was also observed in people with Type 1 diabetes (Smari & Valtysdottir, 1997). The Avoidance scale can be split into two subscales, Distraction and Social Diversion with possible score ranges of 6–30 and 5–25, respectively. A French version of this instrument has been tested in 1056 subjects of different occupations and age (Endler & Parker, 1998; Rolland, 1994). In our study, internal consistency α coefficients at baseline were

0.92, 0.91, 0.89, 0.82 and 0.82 for the Task-, Emotion-oriented, Avoidance, Distraction and Social Diversion scales, respectively. At retest, α coefficients for the same scales were 0.94, 0.87, 0.79, 0.68 and 0.76. Sample items are: (1) Task-oriented: 'schedule my time better' or 'outline my priorities'; (2) Emotion-oriented: 'become very upset' or 'blame myself for procrastinating'; (3) Avoidance: 'think about the good times I've had' or 'go for a walk'; (4) Distraction: 'try to go to sleep' or 'buy myself something'; (5) Social Diversion: 'try to be with other people' or 'spend time with a special person'.

State-Trait Anxiety Inventory (STAI-Y, Spielberger, 1983). This is a widely used two-part self-questionnaire with each part bearing 20 items. Each item must be rated on a four-point scale, depending on the intensity or frequency of the symptom for the subject. The first part deals with state anxiety. The second part deals with trait-anxiety mostly used to assess stable anxiety characteristics of the personality. The French version used in this study is similar to the original (Bruchon-Schweitzer & Paulhan, 1990). In our study, α coefficients for state and trait anxiety were respectively 0.90 and 0.89 at baseline and 0.84 and 0.81 at retest. Sample items are: (1) State anxiety: 'I feel afraid' or 'I am worried'; (2) Trait anxiety: 'I worry about unimportant things' or 'I feel nervous and restless'. Scores may range from 20 to 80 for both scales.

Procedures

A prospective longitudinal design was used. We collected baseline information in two waves: September 1995–September 1996 in Paris and November 2000–December 2001 in Dijon. Two half-day consultations per week were chosen at random during which all patients corresponding to inclusion criteria were systematically asked to participate. Retest data were collected on average 5 years later (Mean interval = 5.2 years).

The study was presented as dealing with psychological factors associated with diabetes management. At baseline, participants had an interview with a graduate psychology intern during which the aim and the design of the study were presented and the participant gave an informed consent. All data were anonymously recorded and nominative information necessary to the follow-up was erased from all files once the retest phase was completed.

Because of practical limitations, we used a different procedure for collecting data at baseline in each setting. In Paris, participants were asked to fill the questionnaires and return them by post whereas in Dijon, participants filled the questionnaires after the first contact interview and gave them back immediately. However, it appears that completing questionnaires in clinic *versus* home most likely did not affect participant's responses, as there were no differences in anxiety and coping styles by settings (all p's > 0.39). Follow-up data were collected the same way in both settings, with researchers contacting baseline participants by mail asking them to complete questionnaires and return them in a stamped envelope. Then, sociodemographic data and characteristics of illness (including blood glucose levels) were selected from the patient's file by the medical staff after

the medical consultation, including age, sex, age at onset, diabetes duration, education, presence of complication and type of complication.

A part of the baseline data collected in one of the two settings (Paris) was presented in a previous report dealing with a cross-sectional analysis (Sultan & Heurtier-Hartemann, 2001). Among the 97 patients who were described cross-sectionally, 69 were followed-up and included in the following analyses.

Statistical analyses

First, we presented descriptives of variables, baseline levels and change over time/stability using *t* tests and Pearson's correlations. Second, we computed Pearson's correlations between variables used in subsequent analyses (coping styles, anxiety measures and metabolic control). Third, we performed hierarchical regression analyses where Time 1 outcome was entered in Block 1. The predictors were then entered individually together with Time 1 outcome as alternative Block 2s. Within this approach, one can determine whether a predictor can explain additional variance in Time 2 outcome beyond what is already explained by Time 1 outcome, i.e., whether a independent variable explains changes in the outcome. Analyses were performed on standardized *z*-scores, as recommended by Aiken and West (1991).

Results

We first performed analyses to explore stability and changes between T1 and T2. For coping, we observed low to moderate stability coefficients (Min–Max range = 0.18–0.54, see Table I). Trait-anxiety appeared to be the most stable of psychological characteristics measured here ($r = 0.73$ over 5 years). We also noted that trait-anxiety decreased and state-anxiety increased between T1 and T2. Self-reported frequencies of Task- and Emotion- as well as Avoidance-oriented reactions increased. This means that participants reported more frequent coping efforts as a whole at retest. This is consistent with the increases in anxiety, in that distress drives more need for coping efforts. Patients appeared to have followed significantly more diabetes education sessions at follow-up than at baseline with 23 more patients reporting following a session during the interval. This is possibly related to the stable values on HbA_{1C} levels, with no deterioration over 5 years.

Table II summarizes correlation coefficients for subsequently used variables. Results showed that health outcomes correlated with coping and trait-anxiety in the following way. At T1, State-anxiety was highly positively correlated with Emotion-oriented and Trait-anxiety and to a lesser extent with Avoidance and its Distraction subscale. HbA_{1C} also correlated in expected ways with Task-, Emotion-oriented coping and the Distraction subscales. At T2, State-anxiety was positively correlated with the T1 Distraction subscale and Trait-anxiety. HbA_{1C} was negatively correlated to the T1 Task-oriented coping scale and Social Diversion subscale and positively related to T1 Trait-anxiety. Except for

Table II. Correlations between variables used in subsequent analyses.

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
T1 variables										
(1)	CISS Task	–								
(2)	CISS Emotion	0.361***	–							
(3)	CISS Avoidance	0.337***	0.308**	–						
(4)	CISS Distraction	0.139	0.316***	0.901***	–					
(5)	CISS Social Diversion	0.456***	0.212*	0.831***	0.553***	–				
(6)	STAI State Anxiety	0.145	0.571***	0.187*	0.214*	0.097	–			
(7)	STAI Trait Anxiety	0.094	0.636***	0.219*	0.291**	0.057	0.677***	–		
(8)	HbA_{1C}	−0.224*	0.265**	0.125	0.237*	0.009	0.331***	0.322***	–	
T2 variables										–
(9)	STAI State Anxiety	−0.178	0.089	0.141	0.227*	0.056	0.235*	0.297**	0.149	–
(10)	HbA_{1C}	−0.241**	0.101	−0.020	0.081	−0.183*	0.212*	0.310**	0.622***	0.250**

*$p = 0.05$; **$p = 0.01$; ***$p = 0.001$.

Table III. Hierarchical regression analyses of coping as predictor of anxiety and glycated hemoglobin ($n = 115$).

	Time 2 state anxiety				Time 2 HbA_{1C}			
Variable	*B*	SE B	β	ΔR^2	*B*	SE B	β	ΔR^2
Block 1								
Time 1 outcome	0.233	0.090	0.233*	0.054*	0.620	0.073	0.622***	0.387***
Block 2s								
CISS								
Task	−0.217	0.090	−0.216*	0.046*	−0.107	0.075	−0.107	0.011
Emotion	−0.065	0.111	−0.065	0.003	−0.068	0.076	−0.068	0.004
Avoidance	0.101	0.092	0.101	0.010	−0.100	0.073	−0.100	0.010
Distraction	0.186	0.092	0.185*	0.033*	−0.072	0.075	−0.072	0.005
Social Diversion	0.033	0.091	0.033	0.001	−0.189	0.071	−0.189**	0.036**
STAI								
Trait Anxiety (TA)	0.255	0.120	0.255*	0.035*	0.172	0.076	0.173*	0.030*
Interaction terms								
Task × TA	−0.153	0.090	−0.151	0.023	−0.077	0.074	−0.077	0.006
Emotion × TA	−0.178	0.094	−0.170	0.029	−0.254	0.073	−0.243**	0.058**
Avoidance × TA	−0.070	0.089	−0.071	0.005	−0.172	0.072	−0.175*	0.029*
Distraction × TA	−0.053	0.090	−0.053	0.003	−0.241	0.075	−0.245**	0.051**
Soc Divers × TA	−0.057	0.082	−0.063	0.004	−0.119	0.066	−0.131	0.017

Notes: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$; TA = Trait-anxiety. Block 2s consist in Time 1 outcome and one predictor (each predictor entered in turn). Regression models were computed on standardized scores. When predicting State-anxiety, β values for Time 1 outcome in Block 2 were: 0.265, 0.271, 0.215, 0.194, 0.230, 0.062, 0.228, 0.248, 0.240, 0.238, 0.236 (from top to bottom line); When predicting HbA1C, β values were: 0.598, 0.640, 0.635, 0.639, 0.624, 0.583, 0.628, 0.654, 0.666, 0.714, 0.630.

the relation implying Social Diversion, all correlations were in line with previous research. Also, as previously reported in the literature, we observed high correlations between Avoidance and the two subscales that are associated with this dimension (Distraction and Social Diversion) with both *r*'s > 0.83.

In regression analyses, each predictor was entered individually to explore its relation with outcome changes over the interval (see Table III). Results of this analysis can be summarized as follows. Taken individually, three variables were related to Time 2 State-anxiety once Time 1 State-anxiety was controlled for: Task-oriented coping predicted a decrease of anxiety ($\beta = -0.22$, $p < 0.05$) whereas Distraction ($\beta = 0.19$, $p < 0.05$) and Trait-anxiety ($\beta = 0.26$, $p < 0.05$) predicted an increase in anxiety levels over the period. Interaction terms were not related to Time 2 State-anxiety. When predicting changes in HbA_{1C}, Social Diversion coping was related to decreases in HbA_{1C} over the interval ($\beta = -0.19$, $p < 0.05$) and Trait-anxiety was related to increases ($\beta = 0.17$, $p < 0.05$). Interaction terms were related to Time 2 HbA_{1C} and accounted for a significant proportion of variance beyond what was explained by Time 1 HbA_{1C}, with higher levels on Emotion-oriented, Avoidance and Distraction coping styles predicting a decrease of HbA_{1C} (i.e., an improvement) when Trait anxiety levels at baseline

Table IV. Mean increase in HbA_{1C} according to anxiety and coping styles levels at baseline as determined by median splits.

	Trait anxiety low		Trait anxiety high	
	Mean increase	*n*	Mean increase	*n*
Emotion-oriented coping				
Low	−0.45	44	0.92	14
High	0.03	13	−0.27	44
Avoidance coping				
Low	−0.25	35	0.33	24
High	−0.50	22	−0.20	34
Distraction coping				
Low	−0.41	30	0.26	26
High	−0.26	27	−0.18	32

Note: An increase in HbA_{1C} means deterioration.

were high. Thus, a beneficial effect of Emotion-oriented coping, Avoidance and Distraction was evidenced in people who had higher scores in Trait-anxiety. We also took a more conservative approach controlling for the total coping score in each of these models. Results remained the same. Similarly, when gender was entered in the model, no effect was evidenced. To explore for effects of the two settings, this factor was entered in regression models as a cofactor. This produced no changes in the relations described previously.

When comparing changes on HbA_{1C} according to levels of Social Diversion (median split, Mdn = 12.00), those with high scores in this coping style had an average decrease of −0.52 (as compared to a moderate increase of 0.10 for those with low scores). Similarly, those with high scores in Trait-anxiety (Mdn = 45.00) had a stable HbA_{1C} over the period (average increase = 0.02) whereas those with low scores experienced a decrease of −0.34.

To further demonstrate the effects of interactions between Trait-anxiety and coping styles as previously observed in regression models, we split the sample according to anxiety levels and compared those above and below the median on Emotion-oriented (Mdn = 34.00), Avoidance (Mdn = 36.00) and Distraction (Mdn = 16.00) coping styles where an interaction effect was evidenced in regression analyses. As shown in Table IV, deterioration was evidenced in people high in baseline anxiety and low in coping styles. In high anxiety participants, increases in HbA_{1C} could be as high as 0.92, 0.33 and 0.26 for people having low scores in Emotion-oriented, Avoidance and Distraction coping, respectively.

Given recent discussions on the nature of emotion-oriented coping (cf. Austenfeld & Stanton, 2004), we conducted additional analyses to clarify which items of the emotion-oriented coping scale were related to positive outcomes. Improvements in HbA_{1C} levels were associated with items focusing on clear emotional expression of negative affects such as ''worrying'' or ''becoming upset'' (r's > 0.38, $p < 0.01$), but not fantasies or self-preoccupation.

Discussion

This is the first longitudinal study examining the effects of coping and anxiety with a follow-up longer than 2 years and using a validated measure of coping styles on glycemic control, in people with diabetes. Our primary finding was that coping and trait-anxiety directly predicted changes in health outcomes over 5 years. As expected, deterioration on State-anxiety was predicted by high levels in Distraction coping and Trait-anxiety at baseline. Improvement on this outcome was predicted by Task-oriented coping. Also in line with our expectations, deterioration on HbA_{1C} (increase in this measure) was best predicted in people high in anxiety showing low levels on Emotion-oriented, Avoidance, or Distraction coping. Finally, contrary to expectations, improvement on HbA_{1C} was related to baseline Social Diversion coping.

Given that dispositional anxiety is conceptualized as vulnerability to stress response, results on the predictive value of Trait-anxiety are in line with previous research which has related stress and metabolic control (Farrell, Hains, Davies, Smith, & Parton, 2004). However, research has also shown that the strength, and even the direction, of the relationship between stress and blood glucose may vary between individuals (Kramer, Ledolter, Manos, & Bayless, 2000). Psychological factors like coping styles and personality could explain this variability, as suggested by the effect of the interaction of Trait-anxiety with coping on long-term changes on HbA_{1C} observed here. We found that for people with high trait anxiety, emotion-oriented coping strategies appear beneficial to long-term glycemic control, in a range which is clinically significant (mean increase $= 0.92\%$ when scores were low, -0.27 when scores were high). In fact, small persistent elevations in HbA_{1C} are known to significantly increase the risk of major complications of diabetes (DCCT, 1993). A decrease in HbA_{1C} of around 1% is associated with nearly a 33% reduction in the progression of retinopathy (Morisaki et al., 1994).

There are many possible pathways that might explain these findings. Distress and negative affect have long been thought to relate to poorer self-care (Peyrot et al., 1999) although results are inconclusive yet (e.g., Lustman, Clouse, Ciechanowski, Hirsh, & Freedland, 2005). Biological pathways may be suggested: people with high trait anxiety tend to have exaggerated sympathetic reactivity (Hoehn-Saric & McLeod, 1988), as well as higher cortisol reactivity (Schlotz, Schulz, Hellhammer, Stone, & Hellhammer, 2006). Excessive exposure to cortisol is one factor that can promote insulin resistance and thus hyperglycemia and elevated HbA_{1C} (Reinehr & Andler, 2004). For people with higher trait-anxiety, greater use of emotional regulation strategies may add up in time to lower exposure to stress mediators, better insulin sensitivity and glycemic control. In fact, trait-anxiety is conceptualized as a vulnerability factor for acute stress or states of anxiety in response to environmental or personal demands (Spielberger, 1985). Also, the role of emotion-focused coping style underlines the adaptive potential of recognizing, processing and expressing emotions. Previous research has shown how suppression could have clear effects in both negative and

positive situations, including increased sympathetic activation of the cardiovascular system (Gross & Levenson, 1997). In our study, high anxiety participants not reporting (or underreporting) negative emotional responses to stressful events tended to deteriorate over a 5-year period. Another way to look at this result is to consider that emotion-oriented coping could demonstrate a positive impact on metabolic evolution only once distress had been controlled for, i.e., considering distress as a confound in emotion-centered coping measures (Austenfeld & Stanton, 2004; Stanton, Kirk, Cameron, & Danof-Burg, 2000). Our results show that coping styles such as Emotion-oriented, Avoidance and Distraction could be beneficial in specific contexts, i.e., when baseline Trait-anxiety is high. One possible reason is that a high level of anxiety does not allow people to concentrate enough for the planning and organizational tasks that compose the Task-oriented scale, or that planning and Task-oriented coping would lead to appraising threats differently, which anxious patients would not be able to do. Hence, for highly anxious subgroups, Task-oriented coping might not be the most appropriate style, as indicated in our data. This result is all the more important since most educational and psychosocial intervention put a stress on problem-solving skills. In high anxiety patients, interventions focusing on emotion management or reinterpreting threats might be more efficient in the long run.

Our results also support the need to consider separately both subscales of avoidance in further research with the CISS. The direct effect of social diversion should be compared to the traditional beneficial effect of social support (Cohen, 2003): being able to be with other people or spend time with a special person is directly related to the quality of the social support, as correlations between the CISS and social support scales suggest (Endler & Parker, 1998). Distraction is more clearly conceptually related to avoidance and therefore this coping style is expected to have deleterious effects on diabetes management (to which HbA_{1C} is a proxy), as was found here.

Finally, our results advocate for a beneficial role of task-oriented coping style on state anxiety levels in the long run. People who reported using planning and problem-solving strategies at baseline were more likely to experience improvements in their state anxiety levels. Although this is in line with previous cross-sectional results (Smari & Valtysdottir, 1997), no such longitudinal links had been yet evidenced. In contrast, people who had high trait anxiety levels were likely to experience a rise in their state anxiety. This is consistent with the trait-state anxiety theory which posits that higher dispositional anxiety levels will be related to higher likelihood to experience peaks in state-anxiety when confronted to a threat (Spielberger, 1985).

Apart from coping and anxiety, which were the focus of the study here, another factor to account for changes within the interval is the effect of time. During these 5 years, a high proportion of patients (20%) went through their first diabetes education session. Treatment protocols also were modified with the introduction and development of intensive insulin therapy: the proportion of participants with more than three daily injections increased by 13% within the 5 years.

This is probably why blood glucose remained stable in our sample whereas one would expect deterioration over 5 years. The progression of illness and the increasing demands of self-care probably explain the differential patterns of psychological characteristics observed at Time 1 and 2, including the increase in anxiety and coping efforts.

However, the observations made here may be limited. The fact that all psychological measures were self-report and a majority of data was sent by mail may have yielded in an under representation of people with poor management and/or poor relationship quality with current health care professionals although we were not able to evaluate this. Also, although participants came from two different settings, we did not detect any setting effect or differences that may bias our results.

The relation between coping and glycemic control and anxiety is all the more important since several intervention programs have proved to be efficient in modifying coping skills (Attari et al., 2006 for example). Our results are consistent with a body of literature which shows that there may be improvements in long-term HbA_{1C} in people who receive psychological therapies, including CBT (Cognitive and Behavioral Therapies) (Ismail, Winkley, & Rabe-Hesketh, 2004, in Type 2 diabetes). Also, self-management training has proved efficient in Type 2 diabetes, at least in the short-term (Norris, Engelnau & Venkat-Narayan, 2001). In Type 1 diabetes, clinical researchers have demonstrated that coping skills training and cognitive behavioral group training had long-lasting effects on metabolic control, self-care, quality of life and emotional well-being (Grey, Lipman, Cameron, & Thurber, 2000; Snoek et al., 2001).

To conclude, our results offer empirical support in favor of a direct influence of baseline coping, trait-anxiety and their interaction on state-anxiety and blood glucose variations over a 5-year period. These results advocate for integrating trait-anxiety in global assessment of patients and consider potential positive effects of coping styles other than task-oriented, depending on individual emotional characteristics.

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