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The Need for Quantification Theoretical considerations of a construct and evaluation of a scale for its measurement

Henrik Gast[1], *Thomas Ostermann*[1], *Tugba Kapanci*[1] & *Stefan J. Troche*[2]

[1] Department of Psychology and Psychotherapy, University of Witten/Herdecke, Witten, Germany
[2] Department of Psychology, University of Bern, Switzerland

Abstract

There are growing possibilities to quantify aspects of life, and an increasing number of individuals use smartphone applications for such quantifications. This leads us to assume that there is a need for quantification (NfQ). We define NfC as an individual's need to grasp numbers about their body, their experience and behavior, and self-related aspects of the individual's surroundings. In contrast to lifelogging or self-tracking, NfQ focuses on the motivational (and more general) level. In two studies with 375 and 216 participants, we developed and evaluated the 7-item *NfQ scale* to assess individual differences in NfQ. In both samples, the scale was unidimensional and highly reliable. In Study 1, the NfQ scale correlated with quantification-related behavior in different areas of life (documentation of sports activities, weight control, comparing prices, preference for feedback in form of grades/numbers), pointing to the breadth of NfQ-related behaviors. NfQ correlated positively with the need for cognitive closure and external control convictions but negatively with self-efficacy. This pattern of results suggests that NfQ-related behavior compensates for deficient control beliefs and is part of a reactive coping strategy to reduce tension in the face of ambivalence and hardly controllable situations. The NfQ scale might be a promising tool in education, sports training, health, medical and psychotherapeutic interventions when high NfQ can be used to increase commitment and motivation.

Keywords: need for quantification; scale; assessment; lifelogging; self-tracking

Author Note

Correspondence concerning this article should be addressed to: Prof. Dr. Stefan Troche, Department of Psychology, University of Bern, Fabrikstr. 8, CH-3012 Bern, Switzerland, Email: stefan.troche@unibe.ch

Introduction

Quantification has a long tradition in psychology dating back to Wundt and Fechner. Already in the early years of psychology, the "need for quantification" was expressed to "obtain objectivity, precision and rigor" (Tafreshi et al., 2016, p. 233). With the rise of digitalization in psychology, quantitative data acquisition became common practice in all fields of psychology (Ostermann et al., 2021) and was (and still is) interpreted as a sign of increasing professionalism. However, private life did not directly follow this trend. According to Ruckenstein & Pantzar (2017), Norbert Wiener predicted as early as 1948 that the body would become part of a global information system in terms of established corresponding communication channels. However it took another 50 years for this idea to be implemented in in a larger proportion of the population through smartphones and wearbale devices. A very disturbing example of this idea, current at that time, was realized in the film π in 1998, in which the number theorist Max Cohen believes he can quantify everything: 1. Mathematics is the language of nature. 2. Everything around us can be represented and understood through numbers. 3. If you graph the numbers at any system, patterns emerge (Grassian, 2001). He does not only feel the need for quantification but develops an obsession to quantify and thereby understand the underlying principles of life Furthermore, in 2004, Alberto Frigo started his 36 Years Project to document various aspects of his life (Frigo, 2015).

Today the list of smartphone or smartwatch applications (apps) used to quantify aspects of private life has increased, and apps for quantifying fitness, health, weight, sleep, nutrition, finance, and emotions are currently offered in a broad variety (Brinson & Rutherford, 2020). Moreover, these apps are also used to document work productivity, internet and television usage, meditation, and even sexual behavior (Lupton, 2016). The reasons for this phenomenon lie not only in an expansion of application possibilities but also in the expansion and change of the audience and user groups (Ha, 2021; Tu et al., 2021). Practices of self-measurement, previously restricted to smaller groups, are increasingly generalized and used by a broader audience (Vormbusch, 2016). In particular, according to Przegalinska (2020), "a growing number of self-tracking individual consumers express vivid interest in tracking more refined aspects of their overall state than calories or steps" (p. 268). This has led to the "Quantified Self Movement" (QS) which "refers to individuals that engage in keeping track of their daily activities systematically, in an attempt to better understand their bodies and their needs, ultimately seeking fulfillment" (Constantin, 2019, p.44). While this movement originally focused on self tracking, it rapidly has expanded into the daily lives of families, e.g. by tracking eating speed using digital forks or baby bottles that detect milk consumption of babies (Sharon, 2017). According to a recent review, self tracking has increasingly become a pervasive part in many people's daily lives and in 2020, apps quantifying health and fitness ranked in the first third of categories of downloaded apps (Feng et al., 2021). In contrast to a pure (qualitative) observation of an individual's behavior and body language (i.e. feeling exhauseted or tired) the need for quantification focusses on the urge of making such conditions measurable and describes the need to realize this.

The need for quantification of course is closely related to *lifelogging* or *self-tracking*, which refers to different forms of digital self-measurement (Selke, 2016b). Lifelogging refers to the "specific practice of using wearable computing devices such as cameras, sensors, and other computerized and automated ways of collecting personal information over a period of time" (Lupton, 2016, p. 2). The term *self-tracking* also aims to measure one's behavior (e.g., food intake, sleep rhythm, work productivity, or internet use), body conditions (e.g., heart rate, blood pressure, or blood sugar), emotional states (in the form of moods, experiences of happiness or patterns of expression) or body performance (such as the number of daily steps, the duration and distance of running and cycling routes, or the number of fitness exercises) (Duttweiler & Passoth, 2016, p. 10).

As mentioned in de Freitas (2018), the achievements in digital technology support "demand new analytic frames that better integrate the qualitative with the quantitative". Therefore, the need arises to quantify data and connect them with feelings and sensations in a sense Hansen (2015) describes as "Feeling forward". Following this line of argumentation then, if e.g. self tracking or life logging is not possible, this may cause a feeling to not be able to communicate with the self (Lomborg & Frandsen, 2016) and thus may lead to behavioural change i.e. in feeling powerless, empty or angry. This is not limited to lifelogging or self-tracking, but also to a desire to put evaluations into numbers (rather than qualitative feedback) or to cook/bake by units of measure in recipes.

We thus assume that in such cases there is an underlying *need for quantification* and hypothesize that people strive, to varying degrees, to quantify their behavior and experiences, thereby finding joy or feeling a reduction of tension. Unlike the constructs of self quantification and lifelogging the *need for quantification* focuses on quantification as a need. This implies that people feel a deficiency or tension insofar as their need is not sufficiently satisfied (Metz-Göckel, 2014). Conversely, satisfying this need means experiencing joy, relief, or relaxation. Thus, the need for quantification focuses more on motivational and behavioural levels.

Interestingly, no scale is available to determine the need for quantification (see for general overview Feng et al. 2021).

Theoretical perspectives

The need for quantification can be linked to different psychological constructs and thus integrated into a nomological network. We expect that the strength of *achievement motivation* will correlate positively with the need for quantification. People with a strong inner drive to deal with incentives might also tend to test and optimize their behavior based on quantifications. The closeness between self-measurement and achievement motivation is also conclusive because quantification is often associated

with (or even understood as) a striving for self-optimization (e.g., Meißner, 2016). Performance-motivated behavior always requires dealing with a level of proficiency. Using numerous apps facilitates this behavior and is a characteristic of the quantified self-movement (Hepp, Alpen, & Simon, 2021).

The need for quantification can also be linked to the *need for cognitive closure* (Webster & Kruglanski, 1994). People differ in perceiving ambivalences and ambiguities as positive and stimulating or unpleasant and stressful. People with a high and situation-independent need for cognitive closure generally prefer unambiguous situations, find ambiguity uncomfortable, and typically make decisions quickly and safely (Schlink & Walther, 2007, p. 153). The more people perceive ambiguities as unpleasant and the more pronounced their need for cognitive closure is, the more likely they might develop a strong need for quantification. After all, quantifications are a method for transforming the ambiguous into something unambiguous, a number.

The concept of *self-efficacy*, which originated from Bandura's (1986; 2001) social-cognitive theory addresses the expectations of competence, which are essential for the execution of behavior. Expectations of self-efficacy refer to the assumption of whether new or difficult situations can be dealt with based on one's own (self-perceived) competencies. If the need for quantification expresses in the pursuit of self-optimization, then a positive association with self-efficacy should be expected. Such self-optimization is more likely in those individuals who assume that such a project can succeed and that they have the necessary skills. However, if the need for quantification reflects compensation for uncertainty and/or loss of control, there is another potential connection to self-efficacy. In this case, the need for quantification might be a reaction to a lack of self-efficacy. Selke (2016a) explicitly argues that the longing for positive experiences of self-efficacy and immediate feedback leads to self-measurement practices. From this perspective, the need for quantification might be negatively associated with self-efficacy.

The concept of Rotter's (1966) *control beliefs* might have a similar relationship to the need for quantification as self-efficacy. Control beliefs refer to the assumption about the location of the control of one's own life (Salewski, 2005, p. 431). An internal (generalized) control conviction exists when people are convinced they can influence their lives actively. An external (generalized) control conviction can occur in different forms (Levenson, 1974). Individuals might believe that other people or powers (social externality) or, alternatively, chance and strokes of fate (fatalistic externality) are the primary and most important factors influencing their life. If the need for quantification originates from situational or persistent uncertainty, it should be associated with a lack of internal control beliefs. Concurrently, from the same perspective, a positive correlation can be expected between the need for quantification and external control convictions (see also Weerdmeester et al., 2020).

The present study describes and evaluates a scale developed to determine the need for quantification. In terms of a working definition, the construct is defined as follows*: the need for quantification refers to an individual's need to grasp numbers about their body, their experience and behavior, and self-related aspects of the individual's*

surroundings. A scale measuring the need for quantification is useful for two reasons. Firstly, it could be beneficial to investigate the individual tendency towards quantification, which has previously been discussed primarily from a macro-sociological or philosophical perspective (Schulz, 2016; Vormbusch, 2012), on an individual-psychological level. Secondly, the scale could be advantageous from an interventional point of view. A strong need for quantification could be used in therapy, intervention, or training to activate clients' or patients' resources. For example, quantitative data on their symptoms or the course of treatment could be presented to them to strengthen their commitment to interventions. It might also encourage the individual to independently collect data about their psychological or physical state.

Method

The scale for measuring the need for quantification was developed in a psychological assessment class on test construction with 38 students of psychology at the University of Witten/Herdecke. Their task was to generate items, which the authors further discussed. Particular attention was paid to the fact that all items should address behavior related to the need for quantification. Some of these items should be specific to different areas of life like body and health, nutrition, sports and performance, technology, finance, and leisure. Other items, however, were explicitly formulated so that they were unspecific to areas of life. Seven items fulfilled the latter requirements referring to as *NfQ scale* from here on. The *NfQ* items are given in the appendix and a preliminary translation in Table 1. The response format is a 5-point rating scale from 1 (incorrect) to 5 (completely correct) so that test (sum) scores can maximally range from 7 to 35.

The *NfQ scale* was evaluated in two independent studies. The first study explored the factorial structure by means of exploratory and confirmatory factor analyses to probe the one-dimensionality of the scale and to determine its reliability. Furthermore, the first study investigated whether the *NfQ scale* in its general form was associated with more specific quantification-related behavior in different areas of life. The second study cross-validated the results on the factorial structure and reliability and examined correlations with other constructs to investigate the above-outlined assumptions on constructs theoretically associated with the need for quantification.

Table 1

Items of the NfQ scale

NfQ1	I enjoy collecting and analyzing data.
NfQ2	Entering data about me and my performance in different areas of life (sports, work, etc.) gives me a feeling of security.
NfQ3	I like it when I can record properties about myself in concrete numbers.
NfQ4	I often feel restless when I forget to document my results.
NfQ5	I like to observe and compare data about me, such as my weight, measured over several weeks (or months).
NfQ6	If I could, I would like to measure and express everything I need to do in numbers.
NfQ7	I feel insecure if I cannot collect data about myself for a month.

Note. The original German scale is given in the appendix. The items were translated in English to illustrate the content of the NfQ scale, but they were not .

Study 1

Participants.

Particpapnts were recruited via social media, mailing lists, and personal contacts of the students in the test construction class. We aimed for a sample size of N > 200, which can be considered large enough to yield sufficient statistical power for exploratory and confirmatory factor analyses, especially when only one latent variable is to be captured across relatively few manifest variables (cf., Kyriazos, 2018).

A total of 158 men, 216 women, and one individual, who did not report gender, participated in the first study. Their age ranged from 16 to 74 years (M = 29.8 years; SD = 12.3 years). While 290 participants reported being single, 73 were in a relationship, ten were divorced, and two were widowed. Two participants had no school leaving certification, 51 had visited a vocational school or completed an apprenticeship, 171 had a high-school diploma, and 151 had a university degree.

Measures.

Besides the above-described *NfQ scale*, single items had been developed to assess quantification-related behavior in different areas of life. These areas relate to "nutrition, sports, and health", "general evaluation of performance", "money and prices", and "not performance-related behavior". The specific items are given in Table 5.

Statistical analysis.

All calculations were done using the statistical software R (Version 4.1.0). Using the psych package (Revelle, 2015) and the cocor package (Diedenhofen & Musch, 2015), descriptive statistics, correlational analyses, reliability as well as exploratory factor analysis (EFA) were conducted. Based on the results of the EFA, a confirmatory factor analysis (CFA) was computed using the lavaan package (Rosseel, 2012) to determine the adequacy of the one-dimensional structure of the *NfQ scale* and its construct reliability by means of McDonald's omega. Lillefors's test for normality revealed that the assumption of normal distribution was not given for the answers on the seven items of the *NfQ scale*. Thus, the data were categorical and not normally distributed, so the DWLS estimator was used when computing CFA as recommended by DiStefano (2016). If not marked otherwise, the level of statistical significance was $\alpha = .05$. The data can be requested from the corresponding author of the manuscript.

Results

Descriptive statistics and reliability.

Mean scores, standard deviations, and part-whole corrected item-total correlations of the seven items of the *NfQ scale* are presented in Table 2. The mean scores of the forth, the sixth and the seventh item were quite small with less than 1.40 on a scale from 1 to 5. Thus, only a few people agreed with the respective statements. This contributed to the quite large values for skewness and kurtosis. Both indicate that, for these three items, the assumption of normally distributed responses does not hold and that these three items should be kept in mind and inspected carefully. The correlations between the seven items of the *NfQ scale* can be taken from Table 3. All correlation coefficients were substantial and statistically significant. Coefficients of Spearman's rho, appropriate for data deviating from the normal distribution, were somewhat smaller than Pearson correlations, but these differences were marginal and the pattern of correlations was highly similar – regardless of the type of correlation.

Table 2

Means (M), standard deviations (SD), Minimum (Min), and Maximum (Max) scores on the seven items of the NfQ scale as well as their Skewness, Kurtosis, and (part-whole corrected) item-total correlation in Study 1 (n = 375).

	M	*SD*	*Min*	*Max*	*Skewness*	*Kurtosis*	r_{it}
NfQ1	2.31	1.22	1	5	0.59	-0.69	.57
NfQ2	2.08	1.15	1	5	0.79	-0.42	.69
NfQ3	1.75	1.07	1	5	1.33	0.79	.76
NfQ4	1.39	0.80	1	5	2.28	4.89	.52
NfQ5	1.67	1.03	1	5	1.55	1.62	.67
NfQ6	1.34	0.76	1	5	2.45	5.66	.66
NfQ7	1.34	0.86	1	5	2.88	7.82	.65

Table 3

Correlations among the seven items of the *NfQ scale* in Study 1 (n = 375) with Pearson correlations above and Spearman's rho below the diagonal.

	NfQ1	NfQ2	NfQ3	NfQ4	NfQ5	NfQ6	NfQ7
NfQ1		.48	.54	.33	.43	.44	.38
NfQ2	.47		.67	.39	.55	.50	.50
NfQ3	.50	.66		.39	.60	.66	.50
NfQ4	.29	.36	.30		.42	.38	.55
NfQ5	.44	.54	.55	.40		.48	.57
NfQ6	.41	.49	.59	.34	.48		.53
NfQ7	.35	.47	.46	.50	.50	.44	

all ps < .05.

Factorial structure of the NfQ scale

To examine the factorial structure of the *NfQ scale*, the seven items were submitted to an exploratory factor analysis. With a Kaiser-Meyer-Olkin coefficient of .870, the prerequisites for a factor analysis were given. The Bartlett test for sphericity also indicated the suitability of the data for factor analysis, $\chi^2(21) = 1139.181$, $p < .05$.

The screeplot of the eigenvalues of the seven factors is given in Figure 1. Also presented in Figure 1 are the results of Horn's parallel analysis, which indicated two

factors with eigenvalues larger than the expected values for random data. However, according to Kaiser's eigenvalue criterion, only one factor was extracted because the second factor explained less variance than a single item. The decision for one factor was further substantiated by the finding that all items had their highest factor loading on the first factor and only low loadings on the other six factors (see Table 4). When one factor was extracted, it explained 50% of the total variance of all items.

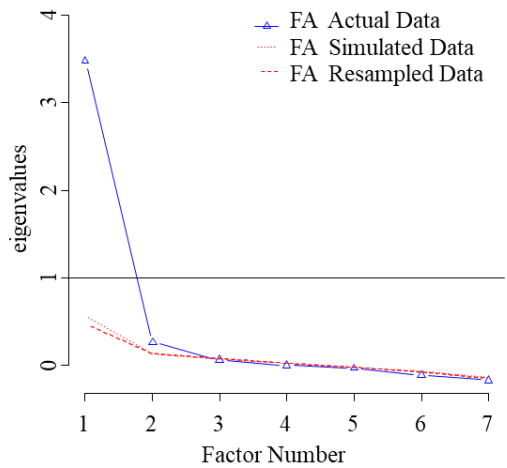

Figure 1.

Screeplot for the *NfQ* scale and Horn's parallel analysis results for random data.

Table 4

Factor loadings and communality (h^2) of the seven *NfQ* items on the seven possible factors resulting from the exploratory factor analysis.

	Factor							
	1	2	3	4	5	6	7	h^2
NfQ1	.60	-.14	.06	.16	-.01	.09	.00	.42
NfQ2	.74	-.13	.20	-.01	-.12	-.03	.00	.62
NfQ3	.85	-.34	-.01	-.05	.06	-.09	.00	.85
NfQ4	.58	.32	.03	.17	.05	-.06	.00	.48
NfQ5	.73	.05	.14	-.11	.09	.08	.00	.58
NfQ6	.73	-.11	-.34	.01	-.03	.03	.00	.66
NfQ7	.75	.43	-.06	-.10	-.05	.00	.00	.77

To evaluate how well a one-factor model described the *NfQ scale* data, a confirmatory factor analysis was conducted with the assumption of one factor underlying the covariance among the seven items. The resulting model is depicted in Figure 2, which also provides the factor loadings and residuals of the seven *NfQ scale* items on the latent variable reflecting the need for quantification. The model described the data well, $\chi^2(14) = 6.415$, $p = .955$, CFI = 1.000, TLI = 1.013, RMSEA < .001, SRMR = .042. This model fit describes the appropriateness of the one-factor model as a description of data obtained with the NfQ scale. However, the CFA results are not a replication of the EFA results since both analyses were based on the same data. Furthermore, the items 4, 6, and 7 had strong factor loadings on the NfQ factor despite their low mean values and the associated deviations in the distributions.

McDonald's omega indicated a reliability of $\omega = .87$. The computation of Cronbach's alpha led to a very similar value with $\alpha = .86$.

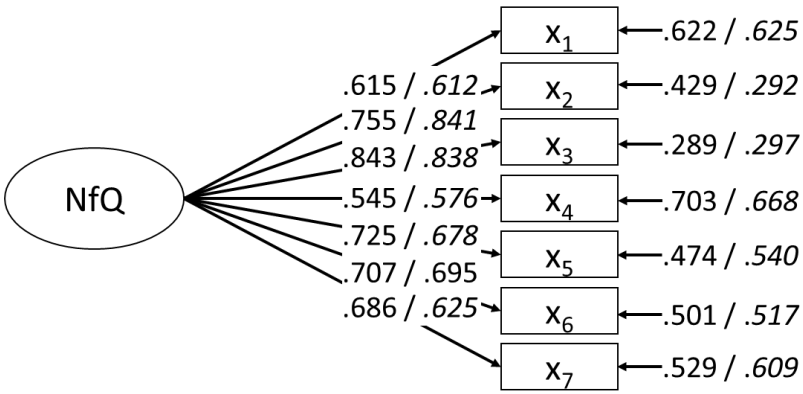

Figure 2.

One-factor measurement model of the *NfQ scale* with factor loadings and residuals obtained in Study 1 and Study 2 (italics).

Correlations between NfQ scale and behavior in specific areas of life

Table 5 provides the correlations between the latent NfQ variable from the measurement model depicted in Figure 2 and the responses to the various questions regarding quantification-related behavior in different areas of life. The first section of questions in Table 5 refers to quantification-related behavior in the area "nutrition, sports, and health". "Counting how much one drinks per day" and "computing the hours of sleep per night" correlated rather lowly with the need for quantification, while "counting

the calorie intake" and the "importance of using apps to document the athletic activities" showed higher correlations.

The second section of Table 5 contains questions about behavior related to achievement and performance. Higher NfQ scores were associated positively with a preference for performance feedback in the form of grades and with more agreement with the statement that "expressing the own achievement in concrete numbers feels good". In the last two sections, quantification-related behavior around money was positively related to NfQ, but also behavior like counting sheep when one cannot fall asleep or knowing the number of stairs in the own apartment building. These correlations show that NfQ is associated with quantification-related behavior in entirely different areas of life.

Table 5

Correlations (*r*) between the latent variable representing the need for quantification and specific quantification-related behavior.

	r
Nutrition, sports, and health	
How often do you count your calorie intake?	.542
How often do you measure how much you drink in a day?	.267
Do you calculate how many hours you can sleep at night before you go to bed?	.267
Do you frequently use apps to document your athletic activities?	.522
How important is it to you to weigh yourself regularly?	.514
Do you feel better when you check and note specific body characteristics daily (e.g., pulse, blood pressure, weight)?	.583
How important to you is the measurement of…	
… body functions (such as blood pressure and heart rate)?	.234
… your fitness (such as daily exercise, number of steps)?	.417
… your nutrition (number of calories, amount of sugar)?	.471
… daytime performance (such as productive time, period of rest)?	.286
General evaluation of performance	
It gives you a good feeling to express your achievements in concrete numbers (e.g., the number of daily tasks completed).	.687
You prefer feedback in the form of grades/scores for performance evaluations (e.g., school/study/sports).	.398
Money and prices	
You know how much money you have in your account.	.145

You create lists and Excel spreadsheets about your finances.	.360
You regularly check your account balance.	.242
You note and compare prices of food items.	.492
Numbers help you make decisions with a clear conscience (e.g., buying a car, a house, groceries, etc.).	.374
Not performance-related behavior	
It is important to you to have specific times on appointments.	.233
You tend to count "sheep" or numbers when you can't fall asleep.	.125
You count or know the number of stairs in your apartment building.	.255
You have been told many times that you document things too often.	.611

Note. All questions were answered on a five-point rating scale ranging from "completely true" to "not true at all", from "unimportant" to "very important" or from "never" to "almost always". All correlation coefficients were statistically significant with $p < .05$.

Study 2

Method

Participants

Subjects for the second study were recruited by promoting the survey via social media, direct communication, and mailing lists at Witten/Herdecke University. In addition, social network adverts were posted to draw attention to this survey. Students from the University of Witten/Herdecke were credited for their participation. As for Study 1, the aim was to obtain a sample size of N > 200.

The questionnaire battery lasted about 15-20 minutes and was completed online using the "LimeSurvey" platform. In the initial instruction, the test subjects were thanked, introduced to the survey topic, and assured anonymity.

The sample consisted of 90 men and 126 women aged between 18 and 75 years (M = 32.60, SD = 12.49). Most of the subjects were single at the time of the survey (141 out of 216), while 67 participants were married, six were divorced, and two lived in a registered civil partnership. Master's degree was the highest level of education of 80 participants; 27 participants had a bachelor's degree, 87 had a high school diploma, six had a high school diploma, nine had another degree, and seven had a secondary school diploma.

Further questionnaires

The *general self-efficacy expectation scale* (SWE) developed by Jerusalem and Schwarzer (2017) includes ten items and measures the optimistic expectation of competence, i.e., confidence in mastering a difficult situation. Thereby the success is attributed to one's competence (Jerusalem & Schwarzer, 2017). This scale does not measure a specific expectation but rather a general self-efficacy expectation understood as an aggregate over many self-efficacy expectations from different areas (Satow, 1999). Confirmatory factor analyses have shown the one-factor structure of this scale (Jerusalem & Schwarzer, 2017; Satow, 1999). Cronbach's α ranged between .80 and .90 (Jerusalem & Schwarzer, 2017).

The German version of the *Need for Cognitive Closure scale* (NCCS) by Schlink and Walther (2007) defines NCC as "desire for an answer on a given topic, any answer, […] compared to confusion and ambiguity" (Kruglanski, 1990, p. 337). Thus, test scores on the NCCS represent individual differences in the desire to develop precise solutions and avoid ambiguity. The NCCS shows a satisfactory reliability of $\alpha = .78$ (Schlink & Walther, 2007, p. 155).

The German *IPC scale* from Krampen (1981) assesses different control beliefs with three subscales, each containing eight items. The I-scale includes internal control beliefs, i.e., the subjectively perceived control over one's life and about events and reinforcements in the person-specific environment (Krampen, 1981, p. 8). The external control beliefs are differentiated again into two sub-scales. The P-scale records the externality, which refers to a subjective feeling of powerlessness as people perceive themselves as dependent on powerful others (Krampen, 1981, p. 8). The C-scale depicts those external control beliefs caused by fatalism which means the general expectation that the world is unstructured and disordered, and that life and events depend on fate, luck, and chance (Krampen, 1981, p. 8). Good internal consistency was demonstrated in several samples. For all three scales, Cronbach's α was between .91 and .98 (Krampen, 1981, p. 8). Factorial, convergent, and discriminant validity was documented for this survey instrument (Krampen, 1981, pp. 11-18).

The short version of the *achievement motivation scale* (LMI-K) by Schuler and Prochaska (2001) measures achievement motivation in a relatively broad sense. The authors understand achievement motivation as an orientation of the entire personality (or at least a large part) towards performance issues (Schuler & Prochaska, 2001, p. 5). The short version of the questionnaire comprises 30 items with an internal consistency of Cronbach's $\alpha = .94$ (Schuler & Prochaska, 2001).

Results

Descriptive statistics and reliability

Means, standard deviations, and part-whole corrected item-total correlations of the seven items of the *NfQ scale* are presented in Table 6. Overall, the mean values were slightly higher than in Study 2, but for items 7 it was still very low. With regard to skewness and kurtosis, only item 7 was still biased while the values for the fourth and the sixth item were less biased than in Study 1.

The intercorrelations between the items of the *NfQ scale* can be taken from Table 7. These correlations were similar to those reported in Table 3 for Study 1. The same was true for the item-total correlations (cf., Table 2 and Table 6).

Table 6

Means (M), standard deviations (SD), Minimum (Min), and Maximum (Max) scores on the seven items of the NfQ scale as well as their Skewness, Kurtosis, and item-total correlation in Study 2 (n = 216).

	M	*SD*	*Min*	*Max*	*Skewness*	*Kurtosis*	r_{it}
NfQ1	3.19	1.13	1	5	-.21	-.79	.57
NfQ2	2.67	1.13	1	5	.08	-.93	.76
NfQ3	2.53	1.12	1	5	.21	-.92	.76
NfQ4	1.86	.99	1	5	.94	-.13	.55
NfQ5	2.26	1.21	1	5	.49	-.99	.63
NfQ6	1.60	.88	1	4	1.44	1.22	.65
NfQ7	1.42	.77	1	5	2.08	4.20	.61

Table 7

Correlations among the seven items of the *NfQ scale* in Study 2 (n = 216) with Pearson correlations above and Spearman's rho below the diagonal.

	NfQ1	NfQ2	NfQ3	NfQ4	NfQ5	NfQ6	NfQ7
NfQ1		.55	.56	.30	.41	.44	.32
NfQ2	.54		.76	.47	.57	.52	.46
NfQ3	.56	.76		.45	.55	.57	.45
NfQ4	.29	.50	.49		.36	.47	.55
NfQ5	.41	.57	.54	.38		.45	.52
NfQ6	.42	.52	.55	.50	.49		.54
NfQ7	.34	.50	.49	.56	.56	.56	

all ps < .05.

Factorial structure of the NfQ scale

To confirm the one-dimensionality of the *NfQ scale*, the same CFA as in Study 1 was computed with the data from Study 2. As in Study 1, the one-factor model described the data well, $\chi^2(14) = 13.353$, $p = .499$, CFI = 1.000, TLI = 1.013, RMSEA < .001, SRMR = .051. The standardized factor loadings can be taken from the italic numbers in Figure 2. It should be noted that the factor loading of item 7 was again substantial and not the lowest one indicating that the restricted variance and biased distribution of responses to this item did not affect its relation to the need for quantification. McDonald's omega coefficient was again $\omega = .87$, which was again very similar to Cronbach's alpha with $\alpha = .87$.

Assessing the construct validity

The t test for independent samples showed significantly higher scores on the NFQ scale in men, $M = 16.46$, than in women, $M = 14.84$, $t(214) = 2.16$, $p < .05$, $d = .30$. Participants' age did not correlate significantly with the need for quantification, $r = -.018$, $p = .795$ and the same was true for the level of highest education, $r = .05$, $p = .48$.

Table 8 gives the coefficients of the correlations between scores on the *NfQ* scale and measures of other constructs. The positive and significant correlations between NfQ and *need for cognitive closure* (NCC) as well as *achievement motivation* were in line with our expectations. *Self-efficacy* (SWE) and *external control beliefs* (IPC-P-scale) were significantly and negatively correlated with NfQ, while the correlations between

NfQ and external control beliefs based on fatalism (C-scale of the IPC) and *internal control beliefs* (I-scale of the IPC) failed to reach statistical significance.

Table 8

Pearson correlations (above the diagonal) and Spearman's rho for the relations between NfQ scale, self-efficacy scale (SWE), need for cognitive closure (NCC) scale, achievement motivation inventory (LMI), and the IPC control belief scale (n = 216).

Skalen	1.	2.	3.	4.	5.	6.	7.
1. NfQ-Scale		-.17*	.31*	.14*	.10	.18*	.03
2. SWE-Scale	-.19*		-.30*	.42*	.34*	-.39*	-.21*
3. NCC-Scale	.29*	-.31*		-.29*	.02	.34*	.16*
4. LMI-Short Scale	.13	.43*	-.31*		.32*	-.21*	-.29*
5. IPC-I-Scale	.12	.31*	.03	.34*		-.18*	-.32*
6. IPC-P-Scale	.20*	-.35*	.35*	-.21*	-.17*		.52*
7. IPC-C-Scale	.02	-.21*	.15*	-.25*	-.31*	.54*	

* $p < .05$ (two-tailed).

Discussion

The primary goal of this study was to develop an instrument to determine the need for quantification. Despite its brevity, the *NfQ scale* is highly reliable. This statement is based on measures of internal consistency and construct reliability and we have no indication of the level of retest reliability to date. Exploratory and confirmatory factor analyses confirmed the one-dimensionality of the *NfQ scale*. With just seven items, the brevity of the scale displays considerable economic advantages. However, the small number of items might have prevented detecting a more complex factorial structure underlying the need for quantification. From this perspective, a longer scale covering more aspects of the need for quantification would be desirable.

One idea in this respect might be a more systemic approach. In the current version, only self-related items were used. However, the Need for Quantification can of course also include a broader surrounding. Thus, questions about the need for quantification e.g. for relatives (parents or small children) or in the environment (Traffic lights with

time indication) would be an enrichment of the current version, which would spread the Need-aspect a little more broadly. The challenge for such an extension is then to address not specific quantification-related behavior, but the underlying need for quantification as expressed in joy and relaxation when the need is met or in tension and unrest when the need is suppressed.

The items of the *NfQ scale* as introduced in the present study, fulfilled these requirements and might, therefore, be seen as a promising basis for the investigation of the need for quantification. Furthermore, the content validity of the NfQ scale could be demonstrated in Study 1, where quantification-related behavior in entirely different areas of life correlated positively with the *NfQ scale*. The correlations were especially high when the quantification-related behavior referred to the documentation of sports activities (e.g., documenting athletic activities) and weight control (e.g., counting calorie intake). Although quantification-related behavior regarding money and prices was less strongly related to the *NfQ scale*, activities such as noting and comparing prices of food items or creating lists about the own finances were substantially related to the *NfQ scale*. The same was true for the preference of feedback in the form of grades (rather than qualitative feedback) and behavior unrelated to performance, such as counting "sheep" when not falling asleep. Altogether, these correlational relationships show that the *NfQ scale* covers the need for quantification-related behavior rather generally than just specific behaviors in the realm of self-measurement.

Regarding the influence of gender, men showed a more pronounced need for quantification. Since most quantification-related behavior relies on technology use (such as fitness apps, excel charts, or other tables and figures for checking the bank account), this result might match the stronger affinity for technology among men (Karrer, Glaser, Clemens, & Bruder, 2009). However, the subjects' age did not correlate significantly with the need for quantification.

The positive correlations with the need for cognitive closure and external control beliefs facilitated a better understanding of the need for quantification. People with a high need for cognitive closure perceive ambiguities and ambivalences as aversive. Consequently, they develop a greater need for quantification. Quantifying behavior can thus be interpreted as a technique that reduces such ambiguities. The need for quantification is stronger among individuals challenged by uncertainties, ambivalences, and ambiguous information. For them, numbers and the corresponding quantification of information might help reduce these ambiguities.

It was also shown empirically that the social external control conviction correlated significantly and positively with the need for quantification. The more people assume that they are powerless and depend on other powers or people, the stronger their need for quantification. This finding indicates that the need for quantification reflects a compensation strategy. This interpretation supports Selke's (2016a) hypothesis, according to which self-measurement corresponds with the fear of losing control in modern societies. The need for quantification and the resulting self-measurement practices serve to compensate for deficient control beliefs.

The empirical results also showed that the need for quantification correlated significantly with self-efficacy. The lower the self-efficacy, the greater the need for quantification. Although causal conclusions are again difficult, it is reasonable to assume that the need for quantification is a response to low self-efficacy to improve self-efficacy through self-measurement. Proceeding from this idea, the need for quantification develops as part of a reactive coping strategy.

Finally, the assumption that achievement motivation correlates positively with the need for quantification found moderate support in this study. The correlation with the need for quantification was significant when calculated according to Pearson but not to Spearman. Therefore, the interpretation that achievement-motivated people develop a stronger need for quantification should be made cautiously.

To further validate the *NfQ scale*, it would be important to differentiate the construct from technological affinity and compulsiveness as well as to examine its relationship to the Need for Cognition (Petty et al., 2009). The extent to which the need for quantification correlates with quantifying behaviors (criterion validity) should also be examined.

Finally, the *NfQ scale* might also be used in decision making processes. Constructs such as trust, certainty, or the need for cognitive closure are of great importance in this area (Henss & Pinquart, 2023). In decision making tasks, individuals leveling high in the *NfQ* could potentially be more prone to make data informed decisions, compared to those with low scores. This idea so far is only modestly supported by a moderate correlation of .398 of the NfQ with the single item "Numbers help you make decisions with a clear conscience".

Another area which should be investigated in relation to the *NfQ* is spanned by self-concepts on science and mathematics. Probably, subjects with a high *NfQ* might be more likely to appreciate scientific research than those with low *NfQ* scores (Engelmann et al., 2022).

In the next steps, it would be important to examine how the need for quantification is related to numerical abilities and to objectively measured quantification-related behavior as it can be assessed by mobile sensing and/or ambulant assessments.

Finally, it would be interesting to investigate the extent to which different groups of people develop the need for quantifications based on different motives and in response to what experiences. It is conclusive that the need for quantification can be understood as part of both self-optimization (e.g. achievement motivation) and self-regulation (e.g. need for cognitive closure). However, further research would have to differentiate these relationships in more detail.

Limitations

Some limitations of the present studies need to be mentioned. One is the rather small sample size in Study 2. The sample was large enough for the factor analysis but for stable correlations N > 250 is recommended (Schönbrodt & Perugini, 2013). With only 216 people, we did not meet this recommendation. Even more important is the fact that all our results rely on self-report data.

Another limitation is given by correlations between the NfQ and specific quantification-related single items in Study 1. Although Bergkvist and Rossiter (2007) did not find an evidence of bias when comparing multiple-item measures with single-item measures measuring the same construct, the debate around the use of single item measures is still ongoing (Allen et al., 2022). In particular, and this is a weakness of this study, single-item measures are more vulnerable to measurement error than multiple item measures (Jovanović & Lazić, 2020) and thus, the correlations in Study 1 have to be interpreted with care.

Conclusion

In sum, the NfQ scale is a psychometrically sound survey instrument to economically determine the need for quantification. It promises good application possibilities in education, health intervention, sports training, and medical or psychotherapeutic interventions.

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Appendix

Instruktion: Beim Beantworten der folgenden Fragen gibt es keine guten oder schlechten bzw. richtigen oder falschen Antworten. Es geht darum, wie Sie sich selbst einschätzen. Beantworten Sie die Fragen möglichst so, dass die Antworten Ihr Erleben zutreffend beschreiben. Wenn keine Antwortoption passt, wählen Sie diejenige aus, die am ehesten passt.

	stimmt nicht	stimmt wenig	stimmt mittelmäßig	stimmt ziemlich	stimmt sehr
1. Das Sammeln und Analysieren von Daten bereitet mir Freude.					
2. Daten über mich und meine Leistungen in verschiedenen Lebensbereichen (Sport, Arbeit, etc.) in Zahlen zu erfassen, verschafft mir ein Gefühl von Sicherheit.					
3. Ich habe es gerne, wenn ich Eigenschaften von mir in konkreten Zahlen erfassen kann.					
4. Ich leide häufig unter innerer Unruhe, wenn ich vergessen habe, meine Ergebnisse zu dokumentieren.					
5. Ich beobachte gerne, über mehrere Wochen (oder Monate) gemessene Daten über mich, wie zum Beispiel mein Gewicht, und vergleiche sie miteinander.					
6. Wenn ich könnte, würde ich gerne alles was ich tun muss, messen und in Zahlen ausdrücken.					
7. Es verunsichert mich, wenn ich einen Monat lang keine Daten über mich erfassen kann.					