Mental illnesses are highly prevalent in society (e.g., National Institute of Mental Health, 2015). For example, depression affects 14.9% to 19% of all people during their lifetime (Bijl, Ravelli, & van Zessen, 1998; Bromet et al., 2011; Kessler et al., 2011) and is a substantial public health problem, causing tremendous human suffering and major costs to society (T. R. Insel, 2008). There is a large heterogeneity among mental illnesses and their severity. They can be short and relatively insignificant, they could have a large and long impact on people’s day-to-day life, or something in between. Moreover, some people do not at all suffer from mental problems. Besides the negative connotation of mental symptoms, advantageous effects of mental symptoms are not uncommon and some mental symptoms might actually surface as strengths and give people an edge (van der Krieke, Jeronimus, et al., 2016). For example, people who ‘suffer’ from a Diagnostic and Statistical Manual of Mental Disorders (DSM) Autism Spectrum Disorder can outperform ‘healthy’ individuals in certain tasks (Mottron, 2011).

Besides these differences between persons, individuals also show great intraindividual variation of mental health problems over time. As such, the between per-
son variability and correlations might not at all be indicative for differences on the level of the individual, and vice versa (Brose, Voelkle, Lövdén, Lindenberger, & Schmiedek, 2015; Hamaker, Nesselroade, & Molenaar, 2007). The importance of intra-individual research, next to interindividual research has been stated in previous studies, and considering an individual as a possibly unique dynamic system might bring back the attention for variation over time (Hamaker, 2012; Molenaar, 2004).

This heterogeneity between and within people is one of the main viewpoints underlying the two national mental health studies described in this chapter: HowNutsAreTheDutch and Leefplezier (Blaauw, van der Krieke, de Jonge, & Aiello, 2014; Jeronimus et al., 2017; van der Krieke, Jeronimus, et al., 2016). Both projects focus on the level of heterogeneity amongst people and serve as a means to allow individuals to get an insight into their own psychological strengths and weaknesses. This chapter presents the objectives and methods of both the cross-sectional and longitudinal part of the HowNutsAreTheDutch (HND) and the Leefplezier study.

### 3.1 HowNutsAreTheDutch and Leefplezier

The research project HowNutsAreTheDutch (Dutch: HoeGekIsNL) is designed to allow for the investigation of mental health as a dimensional and dynamic phenomenon, characterized by both vulnerabilities and strengths. HowNutsAreTheDutch (HND) is a widely broadcast national crowdsourcing study in the Netherlands collecting self-report data on mental health in a general population sample. The project uses an Internet platform to recruit participants and invite them to assess themselves on multiple mental health dimensions. The combination of a cross-sectional and intensive longitudinal diary design allows for a data-driven empirical approach that may help us generate new ideas about how key variables interact in a multidimensional representation of individuals’ mental condition. The primary purpose of HND is to explore the associations and dynamic interactions between mental strengths and vulnerabilities, both between and within participants.

The Leefplezier project has similar goals and perspectives as HND. A large Dutch health care organization (Espria)\(^1\) has initiated the Leefplezier project to assess, improve, and enhance the well-being of the elderly population in the Netherlands, by researching various factors influencing well-being. The notion of well-being has been of interest in gerontology for a long time (Clarke, Marshall, Ryff, & Wheaton, 2001). Elderly people are a frail group with respect to well-being. For example, they report more longstanding illnesses (e.g., in the United Kingdom; Hughes & Church, 2010), they have to cope with the loss of freedom and mobility (e.g., the amount

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\(^1\)Website: http://espria.nl.
3.2 Crowdsourcing Procedure

For HND and Leefplezier we applied a crowdsourcing procedure, an important model for doing psychological research in which a task is outsourced to a group of people, often online, in an open call (Brabham, 2008; Howe, 2006). Previous health research studies have used crowdsourcing as a method to collect new information, and showed that it can be a useful method to obtain information that otherwise tends to be overlooked by researchers (e.g., Bevelander et al., 2014), or to collect big data sets on multiple outcomes that could not be realized without the participation of a large crowd (e.g., Revelle, Wilt, & Rosenthal, 2010). The crowdsourcing method enables the development of ‘citizen science’, in which the general public volunteers to assist scientists in their research activities and contribute with their intellectual effort, knowledge, or tools and resources to answer real-world questions (Hand, 2010). For HND in specific we hope that the crowdsourcing approach (i) engages Dutch inhabitants with the debate about psychiatric classification (Dehue, 2014) and (ii) results in a sizable sample of participants that allows researchers to perform data-driven analysis of the relations between mental symptoms and strengths both within and between individuals.

With HND, we launched an open call to inhabitants of the Netherlands to join
our research and invited them to visit our Dutch website\textsuperscript{2}, which has been online since December 19, 2013. The open call was announced on local and national radio broadcasts, television, during local podium discussions, in newspapers, and in magazines. The news about the HND research project was picked up and further disseminated via online blogs, twitter, and other social media. To join the project, participants had to register and create an account. Participants filled out their email address and a password on the HND website and received an email with a hyperlink to confirm their account. Before starting the actual research, participants were asked to provide information about their gender, birth year and month, their postal code area, and country of residence (the Netherlands / Belgium / Other). Although HND is targeted towards Dutch citizens, we added a question about country of residence after news about HND was picked up by the Belgian media and Dutch speaking participants from Belgium started to join the website.

For the Leefplezier project we applied a similar approach, albeit done using several phases of public exposure. In the first phase, the Leefplezier project was only accessible to a small sample of elderly people subscribed the Espria member panel. This first phase of the project started on June 1, 2014. At the time of the first release approximately 2000 people were subscribed to this panel. People were invited via electronic and printed newsletters to join the Leefplezier study. Subsequent to the study we asked the participants for feedback about the project, and we conducted several qualitative interviews. This feedback was used to improve the project where possible for the second phase. In the second phase, which was released on June 24, 2015, a larger group of elderly people (the Espria member association) was allowed access to the study, making the project accessible to more than 100,000 people. The same publicity methods as in the first phase were used. In the third and last phase we allowed access to the project for all people in the Netherlands\textsuperscript{3}. Leefplezier was publicly released on June 27, 2017. The release was announced using marketing campaigns on social media, articles on various news platforms, and radio interviews to invite people to participate in the study.

3.3 Shifting Perspectives: From the Population to the Individual

HND and Leefplezier both comprise a cross-sectional study and a longitudinal study with intensive repeated assessments in daily life, namely a diary study with EMAS.\footnote{Website: https://hoegekis.nl (also http://hownutsarethedutch.com).}

\footnote{The platform was accessible worldwide, but no marketing actions were performed to involve people from outside of the Netherlands.}
3.3. Shifting Perspectives: From the Population to the Individual

In HND, participants could complete either one of these studies, or both. In Leefplezier the cross-sectional part of the study was only available during the first and second phase. In the third phase, the Leefplezier cross-sectional study was discontinued and only the EMA study remained available.

3.3.1 Cross-sectional Study

The cross-sectional study of HND was launched together with the website. In this study, participants were invited to complete various questionnaire ‘modules’, that is, a questionnaire or a set of combined questionnaires covering a specific domain (see Table A.1 on page 199 for a list of all questionnaire modules in the cross-sectional study). The order in which these modules could be completed was partly fixed. All questionnaire modules were visible from the start, but initially only part of them was activated. The first mandatory module was the ‘Start’ module, assessing participants’ sociodemographic profile. Subsequently, participants got access to three key modules: (i) (an extensive assessment of one’s) living situation, (ii) affect / mood, and (iii) well-being, which could be completed in any order. After the affect / mood and well-being modules had been completed all other modules became available and could be completed in any order. These latter modules were not yet available at the launch of the HND website, but were added to the website one at a time over the years following the launch. Approximately every three months participants were informed about these additions via an email newsletter. All implemented modules are outlined in Table A.1 (page 199). Eligible participants were aged eighteen or older and consented to their data being used for research.

The cross-sectional study of Leefplezier had a procedure similar to that of the HND study. Access to the platform was provided via the Espria member portal. Participants were invited to sign up and fill out a series of five questionnaire modules. Contrary to HND, the ordering of these modules was determined beforehand. The modules assessed the following traits (in order): (i) feelings, (ii) personal life (sociodemography), (iii) emotional well-being, (iv) affect / mood, and (v) personality. The specifics for each questionnaire module are outlined in Table A.8 (page 210).

After completing a questionnaire module, participants in both the HND and the Leefplezier project received instant and automated feedback on the website. This feedback consisted of graphs showing their scores relative to the maximum possible score on a given questionnaire and graphs reflecting their personal scores relative to the average scores of the HND or Leefplezier participants. This feedback remained available after a participant would close the browser or complete a different module. Examples of the feedback of HND are presented in Figure A.1 (page 205).

In both HND and Leefplezier, digital questionnaires were used, most of which
had been programmed to be completed from top to bottom with no items to be left blank. As a result, the missing data within questionnaires is minimal. In the cross-sectional study many questionnaire modules were optional, so not all participants completed all modules. Table A.4 (page 207) shows how many participants in HND completed each module and Table A.10 (page 216) shows how many participants in Leefplezier completed each module.

3.3.2 Ecological Momentary Assessments

Besides a cross-sectional component, both projects included an EMA study. In the EMA study, participants were intensively monitored in their natural environments by means of electronic diaries, three times a day for thirty subsequent days, resulting in a maximum of 90 assessments per individual. Assessments were prompted at equidistant time points with a six-hour interval in between, with the exact time points depending on participants’ sleep–wake schedule.\textsuperscript{4}

The HND EMA study was launched on May 22, 2014. The implementation of the HND study was created on and offered via the existing HND web application.\textsuperscript{5} The participants that enrolled in the study received a text message on their mobile phone with a link to a questionnaire. They were asked to fill out the questionnaire immediately after the alert, or, if impossible, within one hour, after which the questionnaire could no longer be accessed. Participants were informed about the requirements and procedure of the EMA study by means of an information page and a short animated video on the HND website.\textsuperscript{6} Additionally, they could download an information booklet with details on the study procedure, EMA items, and their reward, being a digital report containing personalized feedback.\textsuperscript{7} The study requirements were: age eighteen or above, having a mobile phone with Internet connection, not engaged in shift work, not anticipating a major disruption of daily routines (e.g., a planned trip abroad, an anticipated surgical operation), being aware that participation would be useless in case too many assessments would be missed, and approving of one’s anonymous data being used for scientific research. Participants had to check a box for each of these requirements before they could proceed. Subsequently, they had to complete a baseline assessment consisting of the items of the Positive And Negative Affect Schedule (PANAS; Peeters, Ponds, & Vermeeren, 1996; Raes, Daems, Feldman, Johnson, & Van Gucht, 2010), the Quick Inventory of Depressive Symptoms (QIDS; A. Rush et al., 2003; A. J. Rush et al., 2006), and two extra items re-

\textsuperscript{4}Note that although the daytime measurements are equidistant, we neglected the measurement during the night for practical reasons.

\textsuperscript{5}Website (in Dutch): https://hoegekis.nl.

\textsuperscript{6}Video available (in Dutch) at https://github.com/frbl/thesis-supplement.

\textsuperscript{7}Website (in Dutch): https://hoegekis.nl/dagboekstudie/extra-informatie.
trieved from the Inventory of Depressive Symptomatology (IDS; A. J. Rush, Gullion, Basco, Jarrett, & Trivedi, 1996) to assess anxiety / panic symptoms. Finally, participants configured their personal settings for the daily assessments, that is, their telephone number, their preferred start date (within five days after completion of the baseline assessment), and the sampling schedule. Participants were instructed to pick a sampling schedule that fitted their daily rhythm, with the evening measurement preferably half an hour before their regular bedtime. After completion of their EMA study, participants were sent a short evaluation questionnaire. Participants who quit the study prematurely were asked for their reasons to quit by means of a short questionnaire.

The Leefplezier EMA study was released in the form of a smartphone application, available for both Apple’s iOS and Google’s Android; the Leefplezier App. Like the cross-sectional study, the EMA study was released in phases. The first version of the Leefplezier App was released on June 24, 2014, in the Espria Member association (the second phase of the Leefplezier project). After qualitative research in the form of evaluations and interviews this initial version was updated, resulting in a second version that was released on May 30, 2016. This last version is the version that was, apart from some minor modifications, also released to the general Dutch population on June 27, 2017, and is the version of the Leefplezier App discussed in this chapter. The procedure adhered to in the Leefplezier App was similar to the HND procedure. When someone opened the app, they could either select to participate or read some information about the project. This information explained why the Leefplezier project might be interesting and what the EMA study entailed. After opting in for participation, the person was introduced to Emma, a persona that guides the participant through the EMA procedure and provides extra information when needed. This information was presented in the form of various video clips starring Emma, and was accompanied with a text describing the same information. The next step in the registration procedure was to create an account or log in to an existing one. When registering for a new account the user was asked to provide an email address, password, birth year and month, gender, postal code (numbers), and to accept the requirements of the study. These requirements were: age eighteen or above, having read the information (or viewed the video) and understood the contents, being aware that the study takes thirty days and that at least 75% of the assessments (≥ 68 assessments) need to be completed in order to get the full results, and approving of one’s anonymous data being used for scientific research. Finally, participants configured their personal settings for the daily assessments, that is, general settings for the EMA questionnaire, their preferred start date (within three days), and the sampling schedule. Like in HND, participants were instructed to pick a sampling schedule that fitted their daily rhythm, with the evening measurement preferably
half an hour before their regular bedtime. Thirty days after the completion or cancellation of their EMA study, participants were sent a short evaluation questionnaire via email. A baseline assessment was not strictly included in the study, however, participants did have the option to fill out a general questionnaire at the start or during the study. Filling out this general questionnaire was voluntarily, although people could not access the results of their EMA study if this questionnaire had not been completed. During the study itself, the native Leefplezier App sent the participants a notification using the native system libraries. The Leefplezier App imposed the same rules on the questionnaires as HND, that is the questionnaires could be filled out up to one hour after the notification and all questions in one questionnaire were mandatory. A general impression of the Leefplezier App is provided in Figure 3.1. Note that the original Leefplezier App is in Dutch; these screenshots have been translated.

![Welcome screen.](image1)
![Subscription procedure.](image2)
![Results screen.](image3)

**Figure 3.1:** Screenshots of the Leefplezier App.

**Questionnaire items.**

The HND EMA questionnaire contained 43 items. It combined items from existing and validated questionnaires and a few newly created items. We assessed subjective well-being, sleep, mood, anxiety, depression, physical activity, physical discomfort, self-esteem, worrying, loneliness, mindfulness, context (location, social company,
3.3. Shifting Perspectives: From the Population to the Individual

activities), and the appraisal of this context, stressful events, time pressure, the feeling one makes a difference, laughing, and being outdoors. All questionnaire items and literature references are presented in Table A.2 (page 202). Additionally, participants could define a personal item that they felt relevant to their situation. This item could be chosen from a list of options or could be self-created during the configuration of personal settings. Examples of personal items were: ‘I worry a lot’ or ‘I smoked a lot since the last assessment’. All items except categorical ones were rated on a visual analogue scale (VAS) ranging from 0 to 100, with appropriate labels at the extremes and middle of the scale, and the middle as default positive. To answer a question, the slider had to be moved.

The EMA Leefplezier App allowed for a personalized configuration of the EMA questionnaires. Instead of serving the same set of questionnaire items to every participant, the Leefplezier App allowed the participant to select a number of ‘themes’ that they felt relevant to their situation. These themes were described by a keyword and an image (see Figure 3.1b). Eight themes were available: (i) sleep, (ii) activity, (iii) body, (iv) mind, (v) social, (vi) environment, (vii) mindfulness, and (viii) meaning / connectedness. The number of questions in each theme varied between four and nine questions. Participants were allowed to pick at most four themes. Besides these themes, the EMA questionnaire for each participant contained a default set of fifteen questionnaire items. All questionnaire items and references to the corresponding literature are presented in Table A.9 (page 210).

Automated feedback.

Automated and personalized feedback was an important aspect for both HND and Leefplezier. They served as a means to motivate people, to reward them for their efforts, and, moreover, to provide them with insights about their own well-being and mental health.

In HND, the personalized feedback was only available after completing the whole diary study. That is, after being enrolled in the study for thirty consecutive days while filling out enough measurements. This feedback was automatically generated and presented on the website. Participants who completed at least 65% (t ≥ 59) of the assessments received basic personalized feedback consisting of graphs and explanatory text (see Figure A.2 on page 205 for two examples). Participants who completed at least 75% (t ≥ 68) of the assessments also received personal network models showing the interrelationships (i.e., Granger causality) between variables assessed in the diary study (see Figure 2.2 on page 24 for an example of such network representation).

The feedback implementation for Leefplezier was slightly different. In the Leef-
plezier App participants received several rewards during their study. Firstly, participants received various general ‘trivia’ items (or *weetjes* in Dutch). Every day the participant was participating in the study, they unlocked one of these trivia items, each of which provided the participant with a short text containing interesting facts related to well-being or general psychology. The goal of these trivia was to engage people in using the Leefplezier App and to reward them for participating. Secondly, participants received personalized feedback throughout their studies. Prerequisites for receiving feedback where that (i) enough measurements were completed, and (ii) the general personality questionnaire was completed. After subscribing to the study they could, depending on whether they completed the general questionnaire, view a graph comparing their personality to the rest of the Leefplezier sample. On day three, participants received a graph presenting their well-being over time, on day seven they were presented with a graph showing their personal question over time, after fourteen days we showed them a graph with their levels of positive and negative affect during the day, on the twenty-first day we showed a graph presenting the amount of pleasure they received from performing various activities, and on the thirty-first day we presented them with several network models, presenting the relations between variables over time.

Network models.

The network models were of special interest, as they revealed the causal relations between the health variables assessed in the diary study measurements, and provided an example of an implementation of purely individualized feedback. Examples of such network models are provided in Figure 2.2 on page 24. The network models were estimated for each participant separately using vector autoregression (VAR) modeling (Brandt & Williams, 2007; Lütkepohl, 2006). To automate this procedure, we used Autovar, an open source R package that reads raw EMA data and automatically fits and evaluates VAR models (Blaauw, van der Krieke, Bos, et al., 2014; Emerencia et al., 2016; van der Krieke et al., 2015). The number of variables included in the network models was limited to six, for the sake of comprehension and in order to focus on the most informative results. These six variables were selected based on highest moment-to-moment variability, as indicated by the mean squared successive difference (MSSD), and lowest skewness. Both variables usually perceived as ‘positive’ (e.g., laughing, relaxation) and variables perceived as ‘negative’ (e.g., rumination, feeling down) were selected, as well as the participant’s personal item, unless variability was too low (MSSD < 50) or skewness too high (z-skewness > 4). Only VAR models with one time lag were estimated, to prevent overparameterization. Dummy variables for the part of the day (morning / afternoon / evening)
were included in all models. Trend variables denoting the assessment point (and the square of it) were included if necessary. Dummy variables for the days of the week were included and variables were log transformed if this improved model fit. Autovar only considered models that met the assumptions of stability, normality, homoscedasticity, and serial independence, and selected the best model based on the Akaike information criterion (AIC). As expected, many participants missed assessments in the diary studies. To present reliable network models, we only ran VAR analyses for participants who completed $\geq 75\%$ of the data ($\geq 68$ observations). Missing data of these participants were imputed using Amelia-II imputation (Honaker, King, & Blackwell, 2011). More on these network models and the analysis performed to generate them is presented in Chapter 6.

### 3.4 Discussion and Concluding Remarks

We presented the rationales and development of HND and Leefplezier as a means to perform psychopathology research on a national scale. HND was primarily a scientific endeavor to explore ways in which the traditional classification of psychiatric symptoms could be improved, via data-driven studies of how mental vulnerabilities and strengths are related and interact, and by zooming into dynamic interactions between health-related variables. Additionally, we aspired to contribute to the debate about mental health in the Netherlands, aiming to reduce the stigma associated with psychiatric diagnosis (Hinshaw & Stier, 2008).

With Leefplezier we shifted from a scientific perspective towards a practical implementation of an e-mental health self-help tool. For Leefplezier, data collection was not the primary goal. Instead, we focused on providing a mobile application that is intended to be useful for its users. Relaxing the constraints of scientific rigor allowed us to make the Leefplezier App even more personalized, for example by including themes and trivia, and by providing personalized feedback during the EMA study. Hopefully, now that the Leefplezier App has been released nationwide, the elderly in the Netherlands can fully benefit from it.