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Social isolation and loneliness in the context of migration: A cross-sectional study of refugees, migrants, and the native population in Germany

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Lea-Maria Löbel, Hannes Kröger, Ana Nanette Tibubos

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**Social isolation and loneliness in the context of migration: a cross-sectional study of refugees,
migrants, and the native population in Germany**

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Abstract

The study of loneliness and social isolation has provided a lot of evidence for differences in the prevalence of the two, depending on the context of individuals. Given different social, legal, and economic differences for migrants and refugees, it has been documented that these groups show elevated levels of both social isolation and loneliness compared to the respective host population. Differences in association between social isolation and loneliness have received less emphasize. We test five competing hypotheses about the different sizes of association between social isolation and loneliness in the groups of migrants, refugees, and the host population in Germany. The hypotheses are informed by the differences in social, legal, and economic circumstances between the groups and their socioeconomic and psychological consequences. Using survey data from a large stratified random sample of the population, including migrants and refugees, we test our five hypotheses using a Bayesian Evaluation of Informative Hypotheses. We find highest relative support for the hypothesis about increased need for social networks and support among refugees, which would be indicated by a higher association of social isolation and loneliness for refugees than for the host and migrant population. However, further investigation of the results show all theory derived hypotheses perform poorly in explaining the major pattern in the data: The association of social isolation and loneliness is lowest for migrants (about 0.25 SD), with similar larger associations for refugees and the host population (about 0.5 SD). We discuss this contradiction of theory and evidence, proposing avenues for future research.

Introduction

Even before loneliness was made an omnipresent topic due to worldwide lockdown measures during the Covid-19 pandemic in 2020/21, it has been called a pandemic of modern times (J. T. Cacioppo & Cacioppo, 2018; Holt-Lunstad, 2017). In 2018, Great Britain even commissioned a ministry with the task of tackling loneliness (UK Government, 2018). Several societal trends have been proposed as explanation for the increase in loneliness in recent decades. Among these are social media usage (Primack et al., 2017), non-standard forms of employment such as the rise of the gig economy (Tran & Sokas, 2017), and the increase in global migration (de Jong Gierveld, Van Der Pas, & Keating, 2015; Djundeva & Ellwardt, 2019; C. R. Victor et al., 2012; Wu & Penning, 2015). Loneliness constitutes a severe problem for modern societies since it has been associated with an increased risk of developing physical and mental health problems (Jessen, Pallesen, Kriegbaum, & Kristiansen, 2018; Lee et al., 2019; Rutledge et al., 2008; Thurston & Kubzansky, 2009) and can exacerbate existing vulnerabilities (Tsur, Stein, Levin, Siegel, & Solomon, 2019). Awareness for these problems has grown with improved health communication, particularly via social media (McClellan, Ali, Mutter, Kroutil, & Landwehr, 2017).

Loneliness is commonly defined as the subjective feeling of disconnection from social interactions in everyday life (de Jong Gierveld, van Tilburg, & Dykstra, 2006). It is the cognitive evaluation and emotional consequences of the objective absence of social networks and support. The objective aspect of the definition of loneliness, the absence of links to a social network and support, is often referred to as social isolation (C. Victor, Scambler, Bond, & Bowling, 2000). Though social isolation and loneliness are often used interchangeably (Malcolm, Frost, & Cowie, 2019), the two definitions show that though they are interrelated, they are not identical and it is worthwhile disentangling both concepts (Beller & Wagner, 2018; Beutel et al., 2017). While social isolation does not per se invoke feelings of loneliness (C. Victor et al., 2000), it is an important predictor of loneliness throughout the entire life span (Berkman, Glass, Brissette, & Seeman, 2000; Luhmann & Hawkley, 2016a; Soest, Luhmann, Hansen, & Gerstorf, 2020). The aforementioned major societal trends bring with them the potential to disrupt social networks. It is therefore important to know under which conditions social isolation works as a strong predictor for loneliness and in

which cases the association is less pronounced. Our research contributes an investigation into the question how much context matters for the relation between social isolation and loneliness using the case of different migration experiences as an example.

With about 272 million migrants worldwide on the move, there is a considerable number of individuals who willingly leave their home country and social network behind to build lives elsewhere (United Nations Population Division, 2019). Forced migration stands out as a type of migration that warrants special consideration, given that it is involuntary in nature, not always premeditated and linked to many social and health risks. The years since the start of the Arab Spring 2011 have seen a stark increase in the numbers of forcibly displaced people, with 25.9 million refugees, 41 million internally displaced individuals and another 3.5 million asylum seekers (UNHCR, 2019).¹ Regular or forced cross-border mobility can take a heavy toll on social networks as well as support and can hence lead to social isolation in the country of destination.

It is uncontested that there are differences in the prevalence of social isolation and loneliness between migrants, refugees, and host populations. Migrants are more often subject to social isolation than host populations, as their networks in the new environment need to be (re-) established (Koelet & de Valk, 2016; Ten Kate, Bilecen, Steverink, & Castle, 2020). Additionally, they are also prone to experiencing higher rates of loneliness due to cultural differences and language barriers (de Jong Gierveld et al., 2015; Lim, Eres, & Vasan, 2020). The same result has been found for refugees (de Jong Gierveld et al., 2015). Nonetheless, there is also evidence that migrants' level of loneliness diminishes with time spent in the country of destination, approaching loneliness levels of the host population (Dolberg, Shiovitz-Ezra, & Ayalon, 2016). Whether comparable trends exist for refugees has yet to be established in longitudinal studies. Moving beyond the investigation of the prevalence in social isolation and loneliness, we focus on the association of the two constructs in our study. The economic, legal, and social differences in context motivate our

¹ We define refugees in Germany as those having applied for asylum, regardless of the outcome of their application. In most instances, the sample population in this study has some form of residence status by the year 2017.

investigation into the question whether there are relevant differences in the way social isolation is associated with loneliness among regular migrants, refugees, and the host population.

We develop five competing hypotheses about the association of social isolation and loneliness when comparing host, migrant, and refugee populations. These hypotheses imply that the three groups might differ in their evaluation of social networks and support given their different economic, legal, and social circumstances (Table 1). To test the hypotheses, we use one of the few available data sets which includes comparable and harmonized data for refugees, migrants, and the host population, the German Socio-Economic Panel Study (SOEP, v.35) (N=25,171). We use a Bayesian Evaluation of Informative Hypotheses (BEIH) framework to evaluate the hypotheses (Klugkist & Mulder, 2008; van de Schoot, Verhoeven, & Hoijtink, 2013), testing the robustness of our results in a multiverse framework (Simonsohn, Simmons, & Nelson, 2019; Steegen, Tuerlinckx, Gelman, & Vanpaemel, 2016).

Competing hypotheses

H₁: *The contextual relevance hypothesis* – From an evolutionary perspective, feeling lonely is a warning sign of the human body. It indicates the deviation from a norm of socializing and hence the presence of a potential hazard in being unprotected without social support of other humans (J. T. Cacioppo & Patrick, 2008). Research suggests that this mechanism has been established relatively early in human history and has coined the structure of the human brain to be sensitive to feelings of loneliness (J. T. Cacioppo & Patrick, 2008; S. Cacioppo et al., 2016; Hawkey & Capitanio, 2015). Hence, from a perspective of evolution we would expect susceptibility to loneliness in all human cultures and conditions. Further, a stronger version of this hypothesis – given a non-clinical, non-institutionalized context - would expect social isolation to predict loneliness to a similar degree, regardless of the context, and in consequence also regardless of migration background. This focus on commonalities between migration groups could be dubbed the *evolutionary dominance* hypothesis. Given that social circumstances and exposure to prior (possibly critical or traumatic) experiences vary greatly between migrants, refugees, and host population, we propose the competing *contextual relevance* hypothesis. Thus, stressing the differences between the groups, we expect

differences in the association of social isolation and loneliness between host, migrant and refugee population to be of substantive size. In detail, we expect the maximum difference between the associations to be above a threshold of 0.2 standard deviations (for a more detailed discussion of the choice of this value, see SM 4 in the supplemental material).

Expanding on the contextual relevance hypothesis, we propose four hypotheses that make competing predictions the differences in the association between social isolation and loneliness.

H_{2a}: *The increased need hypothesis* – The post-migration phase requires new skills and knowledge to fully participate in society. Social networks are an important structure, and have the potential to aid integration of migrants (Gërxhani & Kosyakova, 2020) and refugees (S. Y. Cheung & Phillimore, 2013; Månsson & Delander, 2017). Given the peculiarity of the flight experience, refugees tend to suffer even stronger resource losses, including income and property loss, expenses of the flight, physical and mental strain during migration as well as loss of social contact and trust in neighbors, colleagues, and family (Porter & Haslam, 2005; Ryan, Dooley, & Benson, 2008; Schweitzer, Melville, Steel, & Lacherez, 2006; Steel, Silove, Phan, & Bauman, 2002). Given the higher demand for social inclusion and support among refugees due to resource loss, the consequences of objective social isolation should weigh more strongly in perception on refugees. We hence expect the association of social isolation with loneliness to be strongest among refugees, and weaker for other migrants. It is supposedly weakest for the host population who on average have the lowest need to substitute resources.

H_{2b}: *The flight exceptionalism hypothesis* – Alternatively to **H_{2a}** but in a similar line of argument, it can be hypothesized that the differences between the three groups is not gradual in nature, but categorical. Refugees face a more difficult situation in the host country regarding social, cultural, and legal integration. The involuntary disruption of social networks is fundamentally different from that of other migrants and the host population. This unnatural break from social resources sets refugees apart with respect to their vulnerability and hence a need to receive support. Violence of the past remains visible in the aftermath of refugee migration, for instance manifesting in post-traumatic stress disorder (Schweitzer et al., 2006; Silove,

Sinnerbrink, Field, Manicavasgar, & Steel, 1997). Moreover, refugees experience involuntary family separations, entailing fear of family members remaining in danger (Choummavong, Poole, & Cooper, 2014; Hutchinson & Dorsett, 2012; Löbel, 2020; Nickerson, Bryant, Steel, Silove, & Brooks, 2010; Savic, Chur-Hansen, Mahmood, & Moore, 2013). Finally, refugee housing further isolates the newcomers from the host population and other migrants, with an effect on refugee mental health (Walther et al., 2020). A functioning social network, in quantity but also in quality support, is valuable in this context specific strain (Berkman et al., 2000; Thoits, 2011). The lack of social resources under these excluding circumstances might lead to an increased emotional response to the externally induced social isolation. Hence, we expect the association between social isolation and loneliness to be strongest for refugees, with no systematic differences between host and migrant population.

H_{2c}: *The numbing hypothesis* – This hypothesis makes the opposite prediction to **H_{2b}**. It is based on the insight that refugees have a higher risk of suffering from Post-Traumatic Stress Disorder (PTSD) and depression due to the extreme circumstances amid their resettlement (Fazel, Wheeler, & Danesh, 2005). Psychological responses to trauma can include a series of bodily reactions such as depersonalization and derealization symptoms (Sierra & David, 2011). One of them, involuntary in nature, is emotional numbing (Fazel et al., 2005; Spahic-Mihajlovic, Crayton, & Neafsey, 2005). Numbing is a diminished affective responsiveness towards any kind of feelings one might have in an emotional situation, also connected to emotion suppression (Tibubos et al., 2018). We hypothesize that numbing also affects the reaction of refugees towards experiences of social isolation. In the refugee situation, numbing means the dampening of their perception of loneliness. We therefore expect a lesser association between social isolation and loneliness among refugees compared to the host and migrant population.

H_{2d}: *The anticipation hypothesis* – No matter whether consulting economic theory (Aksoy & Poutvaara, 2019; Borjas, Bronars, & Trejo, 1992; Borjas, Kauppinen, & Poutvaara, 2019; McKenzie & Rapoport, 2006), health research (Rubalcava, Teruel, Thomas, & Goldman, 2008; Silventoinen et al., 2007), or insights on social networks (Batista, McIndoe-Calder, & Vicente, 2017; Blumenstock, Chi, & Tan, 2019; Boyd,

1989; McKenzie & Rapoport, 2006), it appears that migrants and refugees moving to another country systematically differ from those they leave behind. Though not fully conclusive, previous studies show that migrants are healthier and more socially connected than the average person in their country of origin – an indicator for self-selection. They actively consider the opportunities and opportunity costs. For refugees, the trade-off is even stronger due to the nature of the migration process. Both groups might more readily come to terms with insufficient networks for the time being. Based on these assumptions about anticipation of reduced social connections in the post-migration phase, the last hypothesis postulates that migrants show a lower association between social isolation and loneliness than the host population. We expect refugees to show the weakest association of the three groups.

Table 1: Hypotheses to be tested

Hypothesis			Proposal
$H_1 - \text{contextual relevance}$	$\max(\beta_h - \beta_m , \beta_h - \beta_r , \beta_r - \beta_m) > t$		Substantive differences between the way social isolation correlates with loneliness across host, migrants and refugee population
	$t = 0.2 SD$		
	Ranking	Prior Probability*	
H _{2a} – increased need	$\beta_h < \beta_m < \beta_r$	$\frac{1}{6}$	Host population is hypothesized to experience the least correlation between social isolation and loneliness
H _{2b} – flight exceptionalism	$\{\beta_h, \beta_m\} < \beta_r$	$\frac{2}{6}$	Association between social isolation and loneliness to be strongest for refugees with no systematic differences between host and migrant population
H _{2c} – numbing	$\{\beta_h, \beta_m\} > \beta_r$	$\frac{2}{6}$	Lesser association between social isolation and loneliness experienced by refugees as compared to the host and migrant population
H _{2d} - anticipation	$\beta_h > \beta_m > \beta_r$	$\frac{1}{6}$	Refugees hypothesized to experience the least correlation between social isolation and loneliness.
H ₃ – No systematic ordering	$\{\beta_h, \beta_m, \beta_r\}$	1	All orderings are equally likely ²

Note: β indicates the association between social isolation and loneliness. Population groups are defined in the index: h = host, m = migrant, r = refugee. *See methods section and supplemental material for a derivation of the prior probabilities

² Also referred to as: ‘no systematic difference’ in contrast to conventional hypothesis terminology in frequentists statistics. We believe that the association will never be exactly equal. Therefore, we also establish hypothesis H₃ instead of H₀.

Methods

Data

We use 2016 and 2017 data of the SOEP v.35 (Goebel et al., 2019; Liebig et al., 2019)³. The survey is a stratified random sample of the German population with recent booster samples for migrants and refugees. Notably, the IAB-BAMF-SOEP refugee-survey is harmonized with other samples and allows for analysis of a large number of cases of recently arrived refugees to Germany between 2013 and 2016 (Jacobsen, Krieger, Schikora, & Schupp, 2021). The SOEP draws the refugee samples from the Central Registry of Foreigners. Hence, the refugee survey is a sample from a clearly defined population. This is a clear advantage as most refugee surveys are based on highly targeted, clinical, or convenience samples (Kroh, Kühne, Jacobsen, Siegert, & Siegers, 2017; Kühne, Jacobsen, & Kroh, 2019).

Measures

Migrant status – We group individuals into (1) Germans without a direct migration background and German second generation migrants⁴ - labelled host population (**H**), (2) those with direct migration background – migrants (**M**) and (3) those with refugee or similar protected status who arrived since 2013 as part of the IAB-BAMF-SOEP Survey – refugees (**R**).

Loneliness – We use the three-item version of the UCLA loneliness scale (Hughes, Waite, Hawkley, & Cacioppo, 2004) as our measure for subjective loneliness. Items are rated on 5 point scales (0=„never“, 1=„rarely“, 2=„sometimes“, 3=„often“, 4=„very often“). Based on this scale, we test two different outcome measures of loneliness: (1) a simple summary score and (2) the factor score from a confirmatory factor analysis of the three items. Migrants and host population were surveyed on the three items in 2017, refugees in 2016, leading us to transmit the 2016 information to 2017. Measurement invariance tests across groups can be found in Table S1-2 and Figure S1-2.

³ DOI: 10.5684/soep-core.v35

⁴ We define the group of German host population as those born in the Federal Republic of Germany as of 1949, including second generation migrants.

Social isolation – We base the construction of social isolation on the seminal work on the need to belong by Baumeister & Leary (1995). The authors set out two principles for the sense of belonging that guide our definition of social isolation. First, the principle of *satiation* refers to the need for a minimum level of social connectedness to be present. This means that individuals evaluate themselves as lonely primarily if a certain degree of social connectedness is not present. It implies a threshold effect of social connectedness on loneliness. From this principle we derive relevance of analyzing social isolation, as a categorical concept, instead of degrees of social connectedness. Second, the *substitution* principle refers to the idea that certain social connections can replace others, hence shielding from isolation to a certain extend. This is reflected in the composition of this variable.

Social connections can cover different dimensions of social life, for example family and household, social activities, or social support (Cornwell & Waite, 2009). If an individual lacks these social linkages within a certain dimension, we will define the individual as being *deprived* in this particular social dimension in contrast to being *integrated*. If individuals are deprived in several dimensions, thereby not satisfying the *satiation* criterion, we will consider them to be overall socially isolated.

Concretely, we measure social isolation across three domains consisting of several indicators (Cornwell & Waite, 2009):

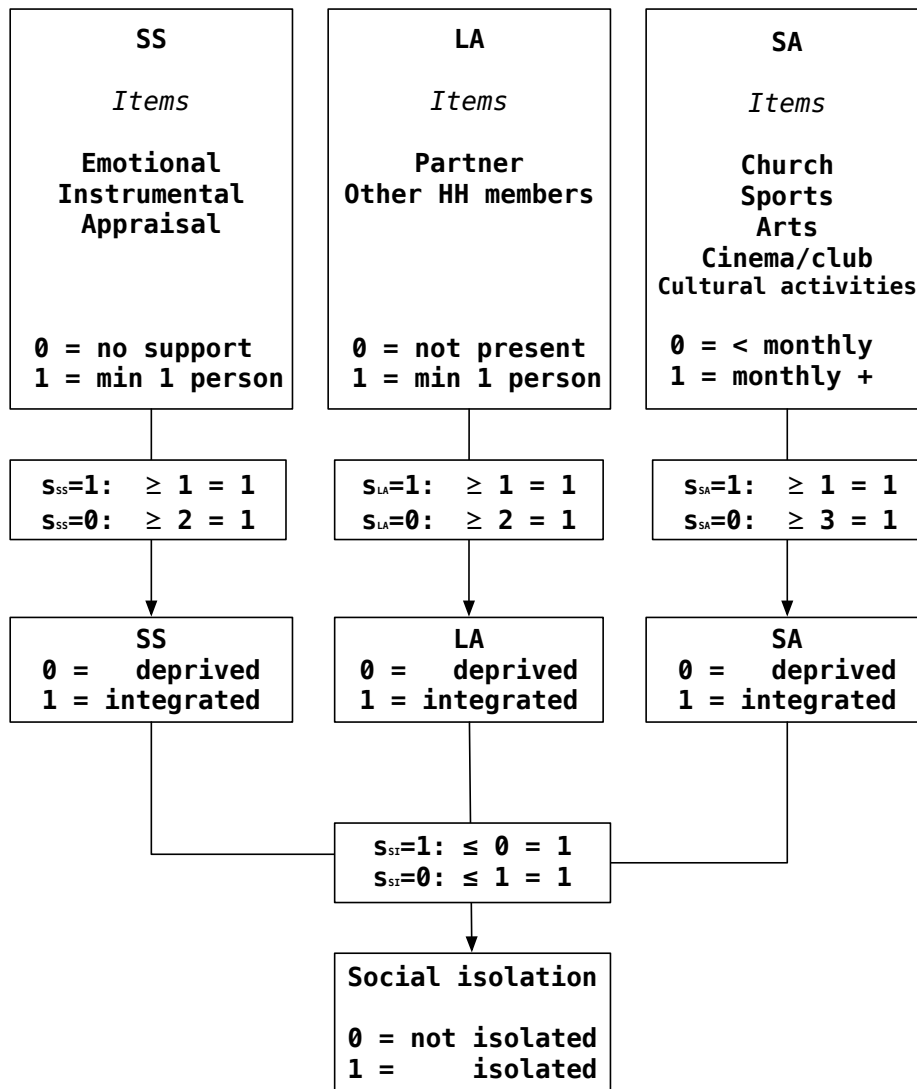
1. the size of the support network (SS) as surveyed by means of the number of individuals named in a name generator on social support in three categories. The SOEP contains the social support items (SS) for refugees in 2017 and for the host population and other migrants in 2016. Hence, we transmit the 2016 information for SOEP participants to 2017.
2. living and partnership arrangements (LA) a) having a spouse and b) presence of other household members.
3. frequency of attending social activities (SA) a) church, b) cultural activities, c) cinema/disco, d) sports, e) arts.

As there are different reasonable thresholds, which can be used to define social isolation across the different social domains, we create different variants of our indicator. These cut offs vary across the degree of substitution that can be integrated within a dimension. For instance, we identify a deprivation in the dimension of social support networks first, when someone has named no one as social support provider. In a second variation, we consider someone as deprived who only names 1 person per dimension. Variation one allows full substitutability, the other one partial substitutability. Moreover, we assume the absence of substitution theoretical implausible as it would lead to empirical extremely high levels of social isolation.

For each indicator and domain as well as the final addition of domains we test two alternative cut offs: one that allows for more and another allowing for less substitution. Overall, we derive 16 different social isolation indicators based on both principles (Figure 1, for a formal definition of the coding, see SM 3 in the supplemental material).

Controls - We control for age groups and gender. We further vary our models across specification in our multiverse analysis to allow for different combinations of controls variables including education, residence in rural and urban areas and East/ West Germany. For an overview of the coding of control variables, consult Appendix Table S3.

Figure 1 – Coding scheme for social isolation



Note: The numbers 0 and 1 in the summary stages of indicators refer to s = 1: full substitutability. s = 0: partial substitutability. They are also part of Figure 2 below to signal the combinations of partial and full substitution. SS= social support, LA= living and partnership arrangements, SA= social activities, HH= household.

A multiverse framework – reporting different data and model specifications

Recent research proposes that studies based on secondary data analysis report all plausible specifications of their data coding and sample definitions (Simonsohn et al., 2019; Steegen et al., 2016). It reduces the probability of reporting findings, specific to certain idiosyncratic decisions in the process of the data analysis (Orben, Dienlin, & Przybylski, 2019; Rohrer, Egloff, & Schmukle, 2017). Based on the definition of social isolation and the different cut offs presented additionally to alterations in sample definition and coding, we report all plausible specifications in a multiverse framework (specifications are listed in Figure S6). See SM 5 and SM 6 in the supplemental material for detailed description of the approach and supplemental material part 2 for the documentation of all central parameter estimates across all 1887 specifications.

Definition of the statistical model

This paper comprises five competing hypotheses, postulating different associations between the groups of host (H), migrant (M) and refugee (R) population living in Germany in terms of their objective social isolation and loneliness. The central parameters that represent the quantities of interest from our hypotheses are the regression coefficients β . They estimate the association of social isolation (SI) and loneliness (LONE) for the host population, migrants, and refugees separately, conditional on a set of control variables (X).

$$LONE_{gsdi} = \beta_{gsd} SI_{gsdi} + \gamma_{gs} X_{gsdi} + u_{gsd} + \epsilon_{gsdi}, \quad (3)$$

$$g \in \{H, M, R\}, s \in \{S\}, d \in \{D\}, u_{gsd} \sim N(0, \delta_{u_{gs}}), \epsilon_{gsdi} \sim N(0, \delta_{\epsilon_{gs}}), \beta_{gsd} \sim N(\beta_{gs}, \delta_{\beta_{gs}})$$

The index g stands for the three groups with different migrant status while the index s stands for the different specifications that are chosen with $S = \{s_1, s_2, \dots, s_k\}$ being the set of all $k = 1887$ converged specifications reported in our study (for a graphical representation of all results per group, consult Appendix Figures S4-6). Index i stands for the individual. SI_{gsd} is the social isolation indicator. β_{gsd} is the parameter

of interest that we will compare across the three groups to evaluate the five hypotheses. X_{gsd} is a matrix of control variables, and γ_{gsd} is the corresponding vector of coefficients.

One index needs to be mentioned separately: d indexes age and gender specific groups. The model is therefore a multilevel model. Individuals nest within 24 gender specific age groups and u_d is the random effect for each group with standard deviation $\delta_{u_{gs}}$. ϵ_{gsdi} is the individual specific error-term with standard deviation δ_ϵ . We therefore allow the association of social isolation with loneliness to vary across gender specific age groups. This is important as in a second step the estimates of the migrant and refugee group are post-stratified and averaged, with the same distribution across gender specific age groups as the host population. The post-stratification procedure accounts for the possibility that differences in the association found in the data could be attributed to the strong differences in age and gender composition of the three samples. Therefore, the hypotheses are evaluated based on these post-stratified parameters from the aforementioned multilevel regression models:

$$\bar{\beta}_{gs} = \frac{\sum_{d=1}^{24} \beta_{gsd} w_{dH}}{w_{dH}} \quad (4)$$

w_d is the number of observations in each of the gender-specific age groups in the host population.

Evaluation framework: Bayesian Evaluation of Informative Hypotheses (BEIH)

The BEIH framework is designed for a comparative evaluation of competing hypotheses. It is based on a Bayesian approach to statistical modeling and differs in certain respects from the common frequentist approach (Fennessey, 1977; Gelman, Carlin, Stern, & Rubin, 2014). The general estimation procedure for the posterior distribution of the parameters we use is the Integrated Nested Laplace Approximation (INLA) (Martins, Simpson, Lindgren, & Rue, 2013; Rue, Martino, & Chopin, 2009) implemented as a package for R (www.r-inla.org).

Our hypotheses imply a ranking of the association strength of the central parameters $\bar{\beta}_{gs}$. In a Bayesian framework we can estimate the probability that such a ranking - and by extension the proposed hypothesis

- is supported by model and data. We therefore get $p(H_t|s(Y))$ where s indexes the specification of the data Y and the model as noted above.

The key feature of the BEIH method is to compare the *observed* support $p(H_t|s(Y))$ for the hypothesis from the estimated posterior distribution of the coefficients to the *expected* support $p(H_t)$ for the hypothesis (prior probability). The prior probability is calculated assuming random ordering of the coefficients (Hoijsink, Klugkist, & Boelen, 2008; van de Schoot et al., 2013). From the relation of the two probabilities, we get the Bayes factor:

$$BF_{ts} = \frac{p(H_{th}|s(Y))}{p(H_t)} \quad (5)$$

If the Bayes factor is larger than 1, the hypothesis formulated has more predictive power than given by chance. Otherwise, if the Bayes factor is smaller than 1, the hypothesis is less probable than by chance.

As we test more than two hypotheses against one another, we additionally calculate posterior model probabilities (PMP):

$$PMP(H_t) = \frac{BF_t}{\sum_{t=1}^{2d} BF_t}; t \in 2a, 2b, 2c, 2d \quad (6)$$

The PMP states how much support one hypothesis receives compared to the overall support that all hypotheses under investigation receive. The range of the PMP is from 0 to 100%. The higher the value, the stronger the support for the hypothesis in question compared to the competing hypotheses (van de Schoot et al., 2013).

Results

The working sample for analysis consists of $N=16,658$ members of the host population, $N=3,790$ migrants of the first generation as well as $N=4,723$ refugees in Germany.

Descriptive statistics

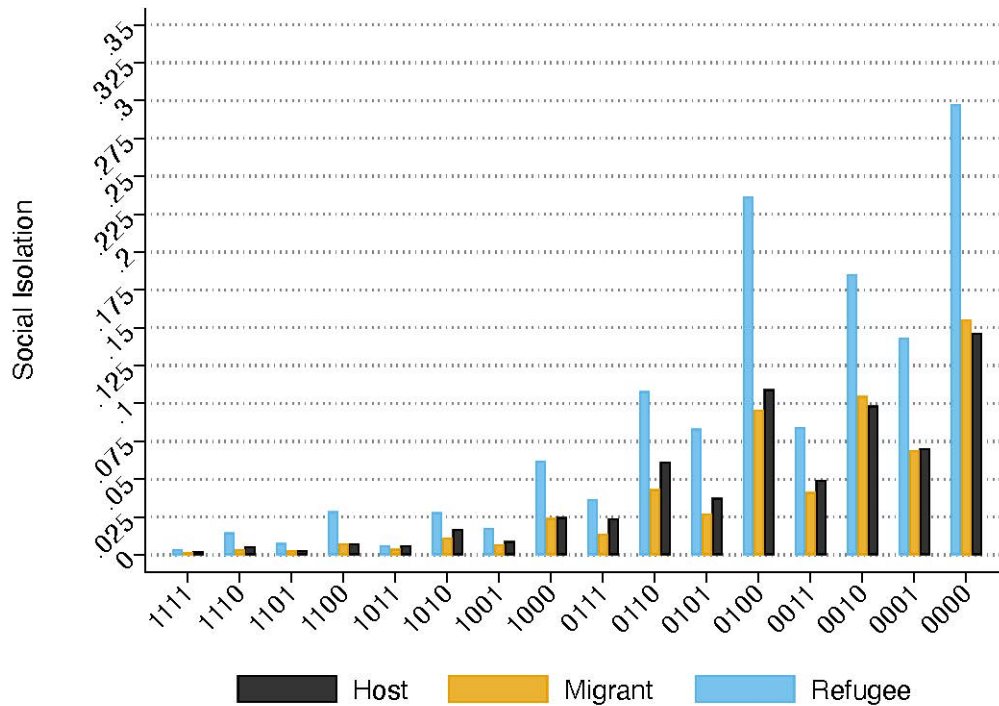
In the following, we describe the three groups of interest in terms of loneliness (Table 2). The factor score of loneliness is smallest for the host population (mean=-0.17, SD =0.85), and larger for migrants (mean=-0.03, SD=0.97) and refugees (mean=0.55, SD=1.24). The magnitude of the differences is even more intuitive when observing the summary score between the groups, ranging from a mean=2.89 (SD=2.22) in the host population to a mean of 4.81 (SD=3.23). Not only does the host population show lower mean levels of loneliness, but the dispersion is larger in the refugee population compared to host population and migrants. Appendix Table S7 lays out further descriptive statistics.

Table 2: Descriptive statistics of the two dependent variables of interest, a factor score of loneliness and the sum score – by subgroup

	Hosts				Migrants				Refugees			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
Factor score	-0.17	0.85	-1.28	3.33	0.04	0.97	-1.28	3.33	0.57	1.24	-1.28	3.33
Summary score	2.88	2.22	0.00	12.00	3.42	2.53	0.00	12.00	4.81	3.23	0.00	12.00

Figure 2 describes the prevalence for social isolation depending on the coding across groups. Notably, the prevalence of social isolation depends on the choice of cut offs. The less we allow for substitution, the more people count as socially isolated. Under full substitution within all and across all domains (coding 1111), less than 1% of the sample are categorized as socially isolated. When only partial substitution is allowed within all and across all domains (coding 0000), social isolation becomes as high as 30% among the group of refugees, 15% for host population and migrants. Disallowing full substitutability in the social activities' domain increases the prevalence of social isolation the most. Figure 2 also shows that refugees are more socially isolated than migrants and the host population. Hosts and migrants do not differ that much in their prevalence, with level differences declining the stricter the cut off.

Figure 2: Prevalence of social isolation by migration status over different coding specifications of social isolation.



Note: 4 numbers per isolation on the X-axis describe the degree of substitution (s) allowed in each step of the generation of the indicator for social isolation (see equation 1 and 2). The first digit represents the coding for the degree of substitution across dimensions (s_{SI}). The second digit indicates substitutability within the social support (s_{SS}) dimension. The third digit indicates substitutability within the living and partnership arrangements (s_{LA}) dimension. The fourth digit indicates substitutability within the social activities (s_{SA}) dimension. A $s=1$ stands for full substitutability, a $s=0$ for partial substitutability.

Testing the hypotheses

Estimates based on Equation 3 are presented in y-standardized coefficients. This means that they represent a difference in terms of standard deviations (SD) in loneliness (across all three groups) between those who are classified as socially isolated compared to those who are not socially isolated. Figure 3 contains two sets of results over the 16 specifications of social isolation on the Y-axis. On left, the mean and 95%-credible interval of the regression coefficients⁵ of social isolation are plotted. On the right, the table reports the Bayes

⁵ Averaged across the specifications. For a detailed explanation on the averaging, consult Appendix Figures S7-8. In Bayesian regression the mean of the posterior is substantively equivalent to a point estimate and the 95%-credible interval is equivalent to the 95%-Confidence interval in frequentist statistics.

factors (BF) and Posterior Model Probabilities (PMP - the darker the box, the higher the PMP) for the hypotheses corresponding to the coding of social isolation. We also would like to point to the lowest absolute number of observations who are counted as socially isolated. They naturally lead to a smaller number of cases per cell in the analysis, in some cases with less than 50 observations per cell, marked in grey. The credible intervals in the first seven rows of Figure 3 show the large uncertainty for the results with more substitution taking place. We consider specifications with fewer than 50 cases as unreliable for interpretation and focus on the results from the lower rows.

Regardless of the coding of social isolation, we see a substantial association of social isolation with loneliness in all three groups. The posterior mean of the migrant population is persistently lower than that of the host population and that of refugees, mostly below 0.25 SD. The posterior means of hosts and refugees are larger and similar in size, along an effect size of 0.50 SD. This means being socially isolated is associated with about a 0.25 standard deviations higher loneliness score for migrants and about a 0.50 SD higher score of loneliness for the host population and refugees in Germany. These comparisons are always made with respect to those individuals who are not socially isolated within their respective group.

The first column from the left of the table in Figure 3 reflects the evaluation of hypothesis H_1 . It reports the probability that the maximum difference between the three groups in effect size is above the threshold of 0.20 SD (Luhmann & Hawkey, 2016a). We can see that with sufficient numbers of observations for social isolation, the probability that the absolute differences are substantial, is high. It is above 70% in all specifications and in many specifications above 90%. Our data and model therefore yield strong support for the contextual relevance hypothesis H_1 .

Figure 3 also shows the Bayes factors from the evaluation of the competing hypotheses H_{2a-d} . The PMP is reflected in the strength of the green color associated with the Bayes factors. The PMP for hypothesis H_{2b} (flight exceptionalism) is largest compared to the other four hypotheses. The BF, however, remains below 1 in three of the specifications of interest. Hence, despite being favored relative to other hypotheses, it gets

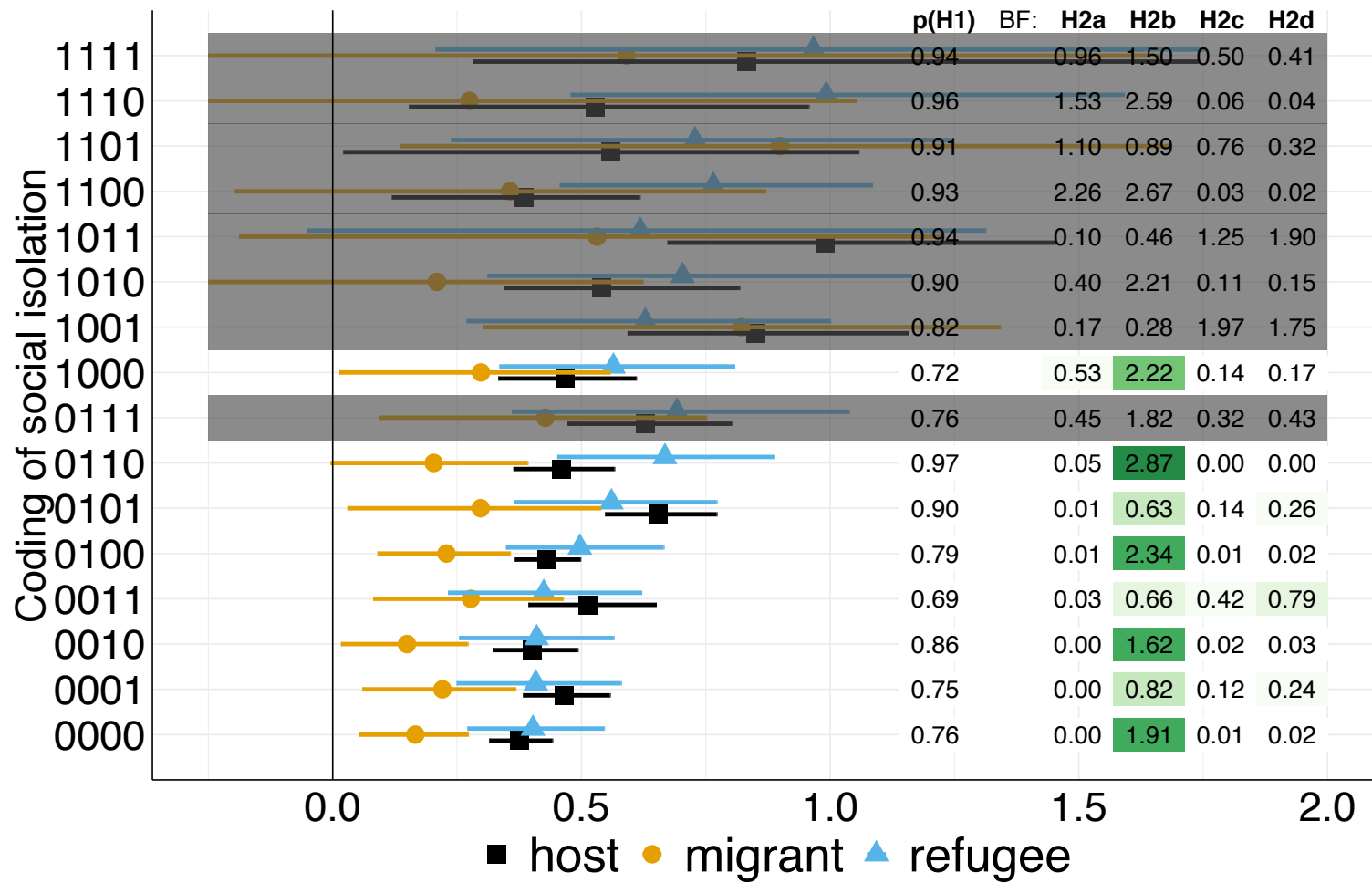
less support in our data than would be expected by chance alone in these instances, which is quite a poor absolute performance.

In the other cases, H_{2b} receives 1.73 times to 2.89 times more support than expected by chance. Hence, we find most support for the hypothesis that refugees' association between social isolation and loneliness is larger in size than that of the host population and migrants of the first generation.

Given all initial hypotheses, H_{2b} , the increased need hypothesis, was the one coming closest to what is identified in the data.

This result of the evaluation is at odds with the observations of posterior mean and the group level credible intervals, also reported in Figure 3. Focusing on this output, the association between social isolation and loneliness is lower for migrants and about equal for refugees and the host population across different social isolation specifications. This phenomenon is an indication that we yet have not correctly identified the most suitable hypothesis given the data.

Figure 3: Regression results and relative support for the hypotheses.



Note: The X-axis refers to effect sizes while the Y-axis describes different choices of specification of social isolation. 4 numbers per isolation indicator describe the degree of substitution (s) allowed in each step of the generation of the indicator for social isolation. The first digit represents the coding for the degree of substitution across dimensions (s_{SI}). The second digit indicates substitutability within the social support (s_{SS}) dimension. The third digit indicates substitutability within the living and partnership arrangements (s_{LA}) dimension. The fourth digit indicates substitutability within the social activities (s_{SA}) dimension. A $s=1$ stands for full substitutability, a $s=0$ for partial substitutability. Results which are underlined in grey are based on cell sizes for social isolation of less than 50. Bayes Factors are provided by the numbers in the table on the right. The strength of the Posterior Model probability is indicated by underlying green color in the table. The darker the green, the stronger relative support for specific hypotheses.

Discussion

We investigated the association between social isolation and loneliness under different circumstances of cross border migration. For analysis, we make use of the SOEP in Germany, comprising a random sample of the host- migrant- and refugee population. Initially, we provide competing hypotheses derived from theory on migrant needs, refugee vulnerability, coping and self-selection. Using a BEIH framework allows for the comparison of these hypotheses jointly.

The incidence of social isolation and loneliness across the three groups is little surprising. Refugees show higher levels of social isolation and loneliness than migrants. The host population, in this case German nationals, fair the best. These level differences in both, independent and dependent variable of interest, line up with other studies that have mainly analyzed differences in loneliness between migrants and host populations (de Jong Gierveld et al., 2015; Kearns, Whitley, Tannahill, & Ellaway, 2015; Koelet & de Valk, 2016; Rich Madsen et al., 2016; Ten Kate et al., 2020; C. R. Victor et al., 2012). This analysis highlights the even larger vulnerability of refugees in this regard. Importantly, the incidence of social isolation depends largely on how it is measured. It decreases for all groups but particularly for refugees as we partially allow for substitution within and between social isolation dimensions.

The analysis shows that no matter how social isolation is technically defined, the association with loneliness is smaller for migrants than it is for refugees and the host population. Among the set of hypotheses we tested, we saw that the “flight exceptionalism” hypothesis received most support relative to the other hypotheses. This hypothesis (H_{2b}) ranks the size of association between social isolation and loneliness highest for refugees and lowest for the host population, given the exceptional circumstances under which refugees socially integrate (Schweitzer et al., 2006; Silove et al., 1997).

The informal, but distinct finding that the association is weaker for migrants than for the host and refugee groups is in conflict with the result of the formal hypotheses testing procedure conducted. This difference indicates that the set of hypotheses did not include the most relevant proposition about the relative strength of the association of social isolation and loneliness. Testing the new hypothesis that migrants do indeed

show a lesser vulnerability to social isolation with respect to loneliness should be tested in future studies on independent samples and potentially with other operationalizations of social isolation to ensure the robustness of our findings.

Looking for an explanation, we turn to the composition of the migrant group in our sample and to the alternative hypotheses we equally postulated. The lesser association of migrants between social isolation and loneliness can still be attributed to positive self-selection and anticipation (H_{2d}). Migrants might more readily accept the social circumstances as they have actively chosen the country of destination based on social network considerations (Borjas et al., 1992; Boyd, 1989; Gërxhani & Kosyakova, 2020; Haug, 2008; Munshi, 2003). Meanwhile, refugees have less choice of destination. Their self-selection to migrate is less linked to a well-functioning diaspora but to a need to survive. Possibly, migrants in the sample are more often focused on a temporary stay in Germany. They might therefore be less vulnerable to social isolation as it is seen as a temporary state and therefore inflict the feeling of loneliness to a lesser degree (Increased Need Hypothesis H_{2a}). Indeed, the proportion of those who state they plan to stay temporarily is highest among migrants (13.7% compared to 4.1% among refugees). Still, the majority of migrants wants to stay permanently, rendering this a weaker explanation.

A puzzle presents the equal strength in association between social isolation and loneliness of refugees and the host population. One possible solution for this riddle are different mechanisms at play, leading to the same association in both groups. Statistical test of measurement equivalence (Supplementary Material Table S1-3 and Figure S1-2), support measurement invariance between the three migration groups (gender, and age, showing similar performance as other mental health related scales (Tibubos & Kröger, 2020)). Nevertheless, in terms of qualitative invariance, deviations from social norms are perhaps more awkward for individuals from the host population, who compare themselves to other members of the host community and hence to people who should be alike (J. T. Cacioppo & Patrick, 2008). As an example, a young working age German without family and a large friendship network might evaluate isolation more strongly, given that other peers in that age group are outgoing and connected. Meanwhile, a migrant in the same age group

is aware of the situation and evaluates it in a positive light. In the end, it is all about the frame through which individuals evaluate their social connections. This sensitivity for a social deviation from the norm in the host population would then be equal in strength to the refugee population.

Regarding limitations to the analysis, our data did not allow testing the underlying mechanisms directly. This also makes it difficult to assess why the data showed a clear, but unexpected result with migrants being less vulnerable to social isolation in terms of loneliness. Further research needs to look at the proposed mechanisms separately. Despite the large data set used, a systematic differentiation within the migrant and refugee group was not possible. It is possible that country of origin, reason for migration, or duration of stay explain how social isolation is linked to loneliness in varying degrees. Samples drawn from more specific population would be necessary to get reliable results. Last, we argued that social isolation can be seen as deprivation in social contacts across several domains. While our data cover three domains and has several indicators, there are aspects we do not measure: For example, closeness of the social network (Lubben et al., 2006) or integration into transnational networks (Bilecen & Cardona, 2018; Herz, 2015). Separate data collection would be necessary which cannot be done in a common purpose survey like the SOEP.

As has been established in previous research, particularly loneliness represents a link to mental health languishing and hence a cost that should be avoided where possible (Beutel et al., 2017; Hawkey & Capitanio, 2015; Holt-Lunstad, 2017). Our study suggests that intervening in loneliness to prevent risk of mental ill-health can start with the prevention of social isolation. Particularly experimental evidence with the elderly show promising result applying group-based activities and testing support opportunities (see for instance Gardiner et al., 2018) but also digital interventions (Shah, Nogueras, Van Woerden, & Kiparoglou, 2019). The groups at stake might be best stimulated in different ways, next to creating supportive structures for refugees also providing more inclusive activities for the host population. Yet, the present analysis cannot infer direct policy guidance. Particularly interesting would be a closer look on whether a substitution effect among different social activities exists. This is just another way forward studying the strength of association between social isolation and loneliness in the context of migration.

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Supplementary Material

(online appendix)

**Social isolation and loneliness in the context of migration: a cross-sectional study of refugees, migrants
and the native population in Germany**

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Table of content

SM 1 - Loneliness – Measurement Invariance.....	42
Table S1a - Loneliness overall model fit by migration status.....	42
Table S1b - Loneliness factor loadings by migration status	43
Table S1c - LONE item intercepts by migration status	43
Table S2 - Test for measurement invariance of the loneliness across sex and migration status.....	43
Figure S1 – Loneliness (LONE) questionnaires used in the SOEP	45
Figure S2 - Factor structure for Loneliness (LONE). Refer to Figure S1 for item formulation in the survey and to Table S2 for summary statistics of the items.....	46
SM 2 - Coding decisions – general overview	47
Table S3 - Variable Coding Scheme and Survey Years	47
Table S4: Overview of years of measurement for social isolation and loneliness.....	50
Table S5: Sample restrictions.....	50
Table S6: Country of origin by migration status.....	50
Figure S3 – Year of immigration – proportion by migration group	52
Table S7: Descriptive statistics - control variables	54
SM 3 - Social isolation index cut off choices	56
Figure S4 –Distribution of loneliness score by migration status	58
Figure S5 – Distribution of loneliness score by migration status	59
SM 4 – Choice of effect size threshold for contextual relevance hypothesis	60
SM 5 - Multiverse analysis and discussion	62
Figure S7: Overview of specifications	63
SM 6 – Specification curve analysis and Bayesian model averaging.....	64
Figure S8: Bayesian model averaging over specifications for the estimates of standardized posterior mean and credible interval of the association between social isolation and loneliness – an illustrative example	66
SM 7 - Bayesian Evaluation of Informative Hypotheses.....	67
Bibliography.....	69

SM 1 - Loneliness – Measurement Invariance

We ran measurement invariance analyses over the three groups of analyses in our study. Overall model fit is very good (based on CFI > 0.85 and RMSEA below < 0.1 criterion) in all three groups (table S1a, for measurement quality adjusted cut-offs, see (McNeish, An, & Hancock, 2018)). The model used is represented in figure S1. Comparing different models based on subsequently stronger restrictions, we can see that scalar measurement invariance holds across sex, age, and migration status (based on the ΔCFI and $\Delta RMSEA < 0.01$ criterion (G. W. Cheung & Rensvold, 2002; Putnick & Bornstein, 2016)). This means that both the association of social isolation and loneliness as well as the levels of loneliness can be meaningfully compared across the three migration groups. The difference we find are therefore unlikely to derive from substantial differences in the way the three-item loneliness scale works in the three groups.

Table S1a - Loneliness overall model fit by migration status

	χ^2	<i>df</i>	<i>p</i>	<i>CFI</i>	<i>RMSEA</i>	<i>RMSEA-LB</i>	<i>RMSEA-UB</i>	<i>SRMR</i>
Loneliness								
<i>Overall</i>	60.643	1.000	0.000	0.998	0.049	0.039	0.059	0.014
<i>Migration status</i>								
Host population	153.237	1.000	0.000	0.990	0.096	0.083	0.109	0.026
Migrant	29.033	1.000	0.000	0.992	0.086	0.061	0.114	0.024
Refugee	19.439	1.000	0.000	0.995	0.062	0.040	0.088	0.017

Table S1b - Loneliness factor loadings by migration status

	<i>LONE-1</i>	<i>LONE-2</i>	<i>LONE-3</i>
<i>Overall</i>	0.647	0.822	0.796
<i>Migration status</i>			
Host population	0.633	0.796	0.791
Migrant	0.640	0.825	0.787
Refugee	0.584	0.822	0.792

Table S1c - LONE item intercepts by migration status

	<i>LONE-1</i>	<i>LONE-2</i>	<i>LONE-3</i>
<i>Overall</i>	1.373	1.120	0.744
<i>Migration status</i>			
Host population	1.288	1.006	0.591
Migrant	1.457	1.142	0.821
Refugee	2.002	1.475	1.332

Table S2 - Test for measurement invariance of the loneliness across sex and migration status

Loneliness												
	χ^2	<i>df</i>	<i>p</i>	<i>CFI</i>	<i>RMSEA</i>	Sex <i>RMSEA-LB</i>	<i>RMSEA-UB</i>	<i>SRMR</i>	$\Delta\chi^2$	Δdf	ΔCFI	$\Delta RMSEA$
<i>configural</i>	58.834	2.000	0.000	0.998	0.047	0.036	0.060	0.013	NA	NA	NA	NA
<i>metric</i>	62.894	3.000	0.000	0.998	0.040	0.030	0.050	0.015	4.060	1.000	0.000	-0.008
<i>scalar</i>	97.942	4.000	0.000	0.996	0.043	0.035	0.051	0.018	35.049	1.000	0.001	0.003
<i>strict</i>	111.969	5.000	0.000	0.996	0.041	0.034	0.048	0.018	14.027	1.000	0.001	-0.002

Migration status												
<i>configural</i>	201.708	3.000	0.000	0.991	0.089	0.078	0.100	0.024	NA	NA	NA	NA
<i>metric</i>	301.836	5.000	0.000	0.987	0.084	0.075	0.093	0.038	100.128	2.000	0.004	-0.005
<i>scalar</i>	484.551	7.000	0.000	0.979	0.090	0.083	0.097	0.045	182.715	2.000	0.008	0.006
<i>strict</i>	925.451	9.000	0.000	0.959	0.110	0.104	0.116	0.051	440.901	2.000	0.020	0.020
Age categories												
<i>configural</i>	137.446	12.000	0.000	0.995	0.069	0.058	0.082	0.015	NA	NA	NA	NA
<i>metric</i>	244.748	23.000	0.000	0.991	0.067	0.058	0.076	0.034	107.302	11.000	0.004	-0.003
<i>scalar</i>	298.632	34.000	0.000	0.989	0.060	0.053	0.067	0.037	53.884	11.000	0.002	-0.007
<i>strict</i>	382.531	45.000	0.000	0.986	0.059	0.053	0.065	0.039	83.899	11.000	0.003	-0.001

Note: *df* = degrees of freedom; *CFI* = comparative fit index; *RMSEA* = root mean square error of approximation; *LB* = lower bound; *UB* = upper bound. BRCS= Brief Resilience Coping Scale. n/a = not applicable.

Figure S1 – Loneliness (LONE) questionnaires used in the SOEP

321 How often do you feel that you miss the company of others?

Very often	1
Often	2
Sometimes	3
Occasionally	4
Never	5
No details	99

LONE-1

321:pgef11 bgp bgpr321 Company of Others is missing
 321:pgef11 bgp_refugees bgpr321 Company of Others is missing
 321:pgef11 pl plj0587 Company of Others is missing

322 How often do you feel like an outsider?

Very often	1
Often	2
Sometimes	3
Occasionally	4
Never	5
No details	99

LONE-2

322:pgef12 bgp bgpr322 Feeling Left Out
 322:pgef12 bgp_refugees bgpr322 Feeling Left Out
 322:pgef12 pl plj0588 Feeling Left Out

323 How often do you feel socially isolated?

Very often	1
Often	2
Sometimes	3
Occasionally	4
Never	5
No details	99

LONE-3

323:pgef13 bgp bgpr323 Feeling Socially Isolated
 323:pgef13 bgp_refugees bgpr323 Feeling Socially Isolated
 323:pgef13 pl plj0589 Feeling Socially Isolated

Note: The questionnaires of SOEP are not copyrighted and free of charge (Siedler, Schupp, Spiess, & Wagner, 2009). Presented are the English translations of the German original questionnaires. Source: (SOEP Group, 2019)

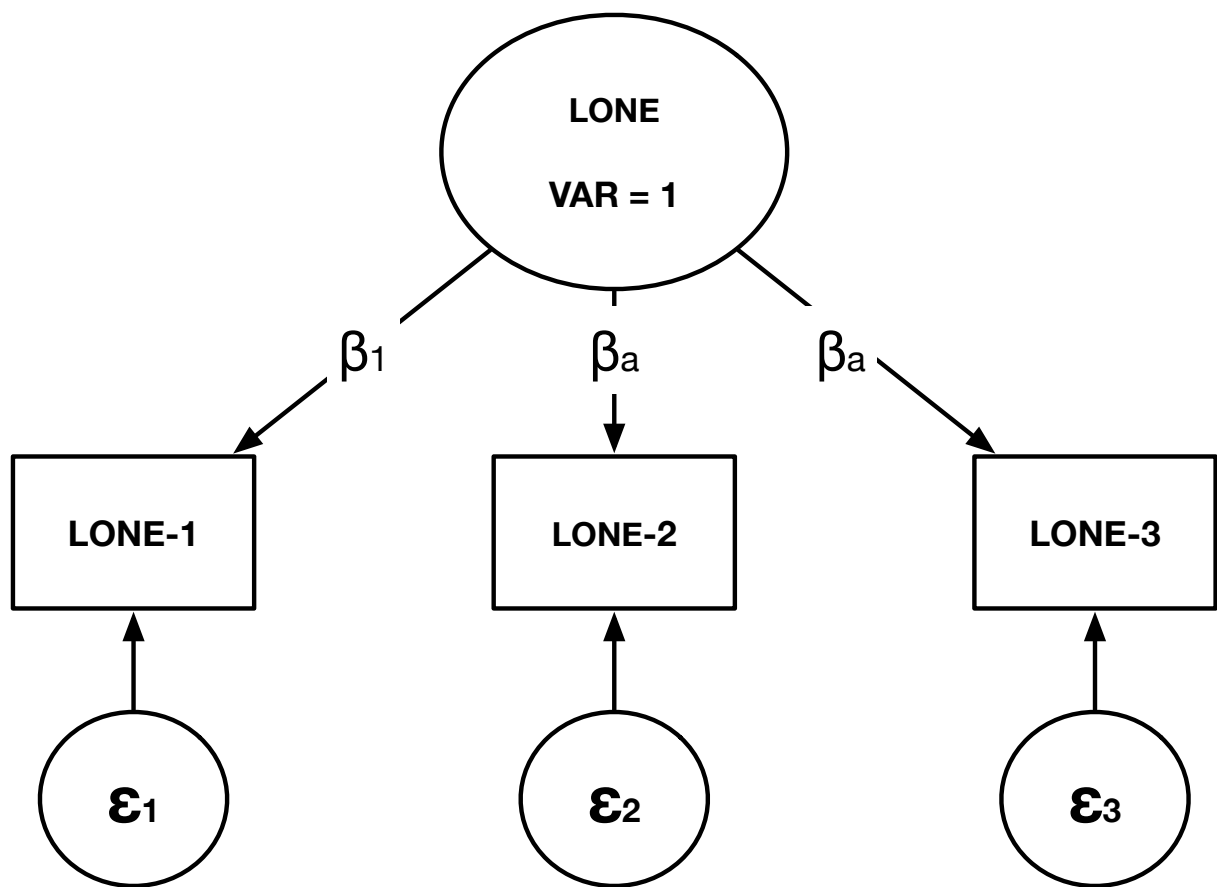


Figure S2 - Factor structure for Loneliness (LONE). Refer to Figure S1 for item formulation in the survey and to Table S2 for summary statistics of the items

SM 2 - Coding decisions – general overview

In the following, we present the coding of all variables used in the analysis, adding to the replication of this study.

Table S3 - Variable Coding Scheme and Survey Years

Variable	Coding Information	Survey Year
Independent Variables		
Network size – for emotional support	<p>Count of the number of people with whom to discuss thoughts; Missing values in refugee population counted as 0 (not having a person).</p> <p>This variable consists of five individual variables asking for the role relation providing emotional support. Each variable is re-coded as dummy – indicating whether a role relation was named.</p> <p>Afterwards, the information is consolidated to one variable, indicating whether any emotional support is subjectively granted.</p> <p>0 = no support 1 = support</p>	2016 for host and migration population / 2017 for refugees of the IAB-BAMF-SOEP Survey of Refugees
Network size – informational support	<p>Count of the number of people with whom to discuss educational and work-related matters; Missing values in refugee population counted as 0.</p> <p>This variable consists of five individual variables asking for the role relation providing informational support. Each variable is re-coded as dummy – indicating whether a role relation was named.</p> <p>Afterwards, the information is consolidated to one variable, indicating whether any informational support is subjectively granted.</p> <p>0 = no support 1 = support</p>	2016 for host and migration population / 2017 for refugees of the IAB-BAMF-SOEP Survey of Refugees
Network size – unpleasant truths	<p>Count of the number of people with whom to discuss unpleasant truths; Missing values in refugee population counted as 0.</p> <p>This variable consists of five individual variables asking for the role relation providing appraisal support. Each variable is re-coded as dummy – indicating whether a role relation was named.</p>	2016 for host and migration population / 2017 for refugees of the IAB-BAMF-SOEP Survey of Refugees

Afterwards, the information is consolidated to one variable, indicating whether any appraisal support is subjectively granted.

0 = no support

1 = support

Spouse	0 = no spouse or partner 1 = spouse or partner	2017
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Living Alone	0 = living not alone 1 = living alone	2017
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Social Participation	Five dummy variables indicating the regular participation in social activities: 0 = not active 1 = active	2017
----------------------	---	------

Activities include: church, cultural activities, cinema/disco, sports, arts

Dependent Variable

Loneliness 1	Summary score of three items UCSL loneliness scale, coded 1 = never / 5 = very often: Company of others is missing, Feeling left alone, Feeling socially isolated	2017/ 2016 for those first surveyed in the IAB-BAMF-SOEP Survey of Refugees in 2016 <i>plj0587</i> <i>plj0588</i> <i>plj0589</i>
Loneliness 2	Weighted sum score of three items UCSL loneliness scale (subtraction of score from mean and divided by standard deviation) (Hughes et al., 2004)	2017/ 2016 for those first surveyed in the IAB-BAMF-SOEP Survey of Refugees in 2016 <i>plj0587</i> <i>plj0588</i> <i>plj0589</i>

Controls

Age-Categories	Survey year – birthyear Categorization: 1 = 18 - 24 years 2 = 25 - 29 years 3 = 30 - 34 years 4 = 35 – 39 years 5 = 40 – 44 years 6 = 45 – 49 years 7 = 50 – 54 years 8 = 55 – 59 years 9 = 60 – 64 years	2017
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	10 = 65 – 69 years 11 = 70 – 74 years 12 = 75+ years	
Gender	0 = male 1 = female	2017
Education	CASMIN 1 = Inadequately Completed 2 = General Elementary School 3 = Basic Vocational Qualification 4 = Intermediate General Qualification 5 = Intermediate Vocational 6 = General Maturity Certificate 7 = Vocational Maturity Certificate 8 = Lower Tertiary Education 9 = Higher Tertiary Education	2017
Rural/ Urban divide (Population density)	Number of inhabitants - retrieved from BGSR classification of counties in Germany 1 = > 2000 2 = 2000 - 5000 3 = 5000 - 20000 4 = 20000 - 50000 5 = 50000 - 100000 6 = 100000 - 500000 7 = 500000 +	2017
Migration status	Individuals identified and categorised based on the generated SOEP variable <i>migback</i> and by means of the refugee sample indicators ⁶ 1 = Native Germans – individuals with German nationality or residence status, who were born in Germany and whose parents were no migrants either (DESTATIS, 2020) ⁷ 2 = Migrants – in this case those with a direct migration background, meaning they were born outside of the German borders after 1949. 3 = Refugee status – individuals who applied for asylum between 2013 and 2016 (selection via sample M3, M4 and M5 of the IAB-BAMF-SOEP Survey of Refugees)	2017

⁶ For one sample specification, we do not select refugees via the IAB BAMF SOEP Survey (Refugees who applied for asylum in Germany between 2013 and 2016) but also those who applied earlier. Those individuals can be identified using the generated *arefbac* variable in the SOEP.

⁷ For one specification of the model, we include second-generation migrants to the group of native Germans.

Table S4: Overview of years of measurement for social isolation and loneliness

Group	Loneliness	Social isolation
Host	2017	2016
Migrant	2017	2016
Refugee	2016/2017	2017

Table S5: Sample restrictions

Restriction	Individuals
1 Full sample	69,766
2 Exclude non-refugees, pre-2013 refugees, and German born refugees in refugee sample	67,996
3 Exclude new 2017-sample (PIAAC-L) without support variables	62,331
4 Exclude non-probability observations	45,398
5 Exclude individuals below 18	30,628
6 Exclude individuals with missing information on covariates	28,569
7 Exclude individuals with missing information on loneliness	25,171

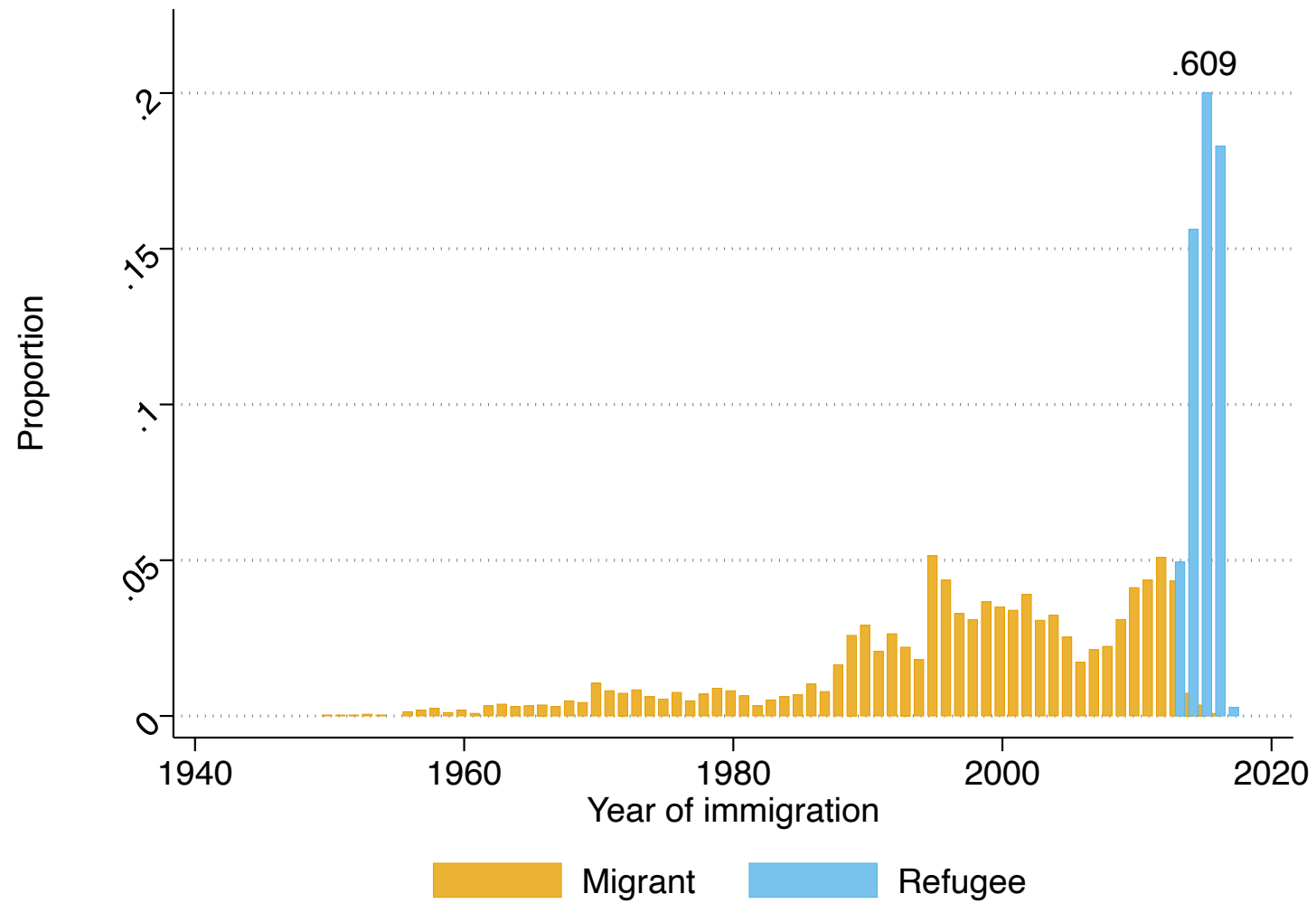
Country of origin and year of immigration among refugees and migrants

Table S6: Country of origin by migration status

Country of origin	Host	Migrant	Refugee
Germany	16,658	0	0
Turkey	0	311	6
Poland	0	441	0
Syria	0	288	0
Romania	0	54	2,569
Syria	0	435	70
Russia	0	21	569
Afghanistan	0	58	633

Iraque	0	226	33
Ex-Yugoslavia	0	464	48
Southern Europe	0	386	11
Eastern Europe	0	484	43
CIS	0	93	116
Arabic	0	62	1
Latin America	0	243	3
Western Europe & Northern America	0	63	371
Asia	0	150	249
Rest of the world	0	11	1
Total	16658	3790	4723

Figure S3 – Distribution of the year of immigration within migrant and refugee group



Note: Value of year 2015 for refugees (0.609) is cut off at 0.2 for illustrative purposes. It means that 60.9% of all refugees in the analytic sample arrived in Germany in 2015.

Table S7: Descriptive statistics - control variables

Migration status	Host				Migrant				Refugee			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max
Loneliness score (weighted)	-0.17	0.85	-1.28	3.33	0.04	0.97	-1.28	3.33	0.57	1.24	-1.28	3.33
Loneliness score (unweighted)	2.88	2.22	0.00	12.00	3.42	2.53	0.00	12.00	4.81	3.23	0.00	12.00
Gender (proportion of men)	0.46	0.50	0.00	1.00	0.45	0.50	0.00	1.00	0.61	0.49	0.00	1.00
Age	51.18	17.47	18.00	101.00	44.35	13.91	18.00	98.00	33.40	10.99	18.00	97.00
Social Isolation by coding												
1111	0.00	0.05	0.00	1.00	0.00	0.04	0.00	1.00	0.00	0.06	0.00	1.00
0111	0.02	0.15	0.00	1.00	0.01	0.12	0.00	1.00	0.04	0.19	0.00	1.00
1110	0.01	0.07	0.00	1.00	0.00	0.06	0.00	1.00	0.01	0.12	0.00	1.00
0110	0.06	0.24	0.00	1.00	0.04	0.20	0.00	1.00	0.11	0.31	0.00	1.00
1101	0.00	0.06	0.00	1.00	0.00	0.05	0.00	1.00	0.01	0.09	0.00	1.00
0101	0.04	0.19	0.00	1.00	0.03	0.16	0.00	1.00	0.08	0.28	0.00	1.00
1100	0.01	0.09	0.00	1.00	0.01	0.09	0.00	1.00	0.03	0.17	0.00	1.00
0100	0.11	0.31	0.00	1.00	0.10	0.29	0.00	1.00	0.24	0.42	0.00	1.00
1011	0.01	0.08	0.00	1.00	0.00	0.06	0.00	1.00	0.01	0.08	0.00	1.00
0011	0.05	0.22	0.00	1.00	0.04	0.20	0.00	1.00	0.08	0.28	0.00	1.00
1010	0.02	0.13	0.00	1.00	0.01	0.11	0.00	1.00	0.03	0.16	0.00	1.00
0010	0.10	0.30	0.00	1.00	0.10	0.31	0.00	1.00	0.19	0.39	0.00	1.00
1001	0.01	0.09	0.00	1.00	0.01	0.08	0.00	1.00	0.02	0.13	0.00	1.00
0001	0.07	0.26	0.00	1.00	0.07	0.25	0.00	1.00	0.14	0.35	0.00	1.00
1000	0.02	0.16	0.00	1.00	0.02	0.15	0.00	1.00	0.06	0.24	0.00	1.00
0000	0.15	0.35	0.00	1.00	0.16	0.36	0.00	1.00	0.30	0.46	0.00	1.00
Education												

Inadequately Completed	0.01	0.10	0.00	1.00	0.06	0.24	0.00	1.00	0.41	0.49	0.00	1.00
General Elementary School	0.06	0.24	0.00	1.00	0.15	0.36	0.00	1.00	0.21	0.40	0.00	1.00
Basic Vocational Qualification	0.22	0.41	0.00	1.00	0.20	0.40	0.00	1.00	0.02	0.13	0.00	1.00
Intermediate General Qualification	0.03	0.17	0.00	1.00	0.01	0.11	0.00	1.00	0.00	0.05	0.00	1.00
Intermediate Vocational	0.27	0.45	0.00	1.00	0.06	0.23	0.00	1.00	0.00	0.01	0.00	1.00
General Maturity Certificate	0.04	0.20	0.00	1.00	0.08	0.28	0.00	1.00	0.15	0.36	0.00	1.00
Vocational Maturity Certificate	0.09	0.29	0.00	1.00	0.16	0.37	0.00	1.00	0.03	0.16	0.00	1.00
Lower Tertiary Education	0.09	0.29	0.00	1.00	0.02	0.15	0.00	1.00	0.00	0.00	0.00	0.00
Higher Tertiary Education	0.16	0.37	0.00	1.00	0.24	0.43	0.00	1.00	0.18	0.39	0.00	1.00
West vs. East Germany	0.75	0.43	0.00	1.00	0.92	0.27	0.00	1.00	0.87	0.34	0.00	1.00
Population density												
GKK > 2.000	0.06	0.24	0.00	1.00	0.02	0.15	0.00	1.00	0.02	0.12	0.00	1.00
GKK 2000 - 5000.	0.10	0.30	0.00	1.00	0.05	0.22	0.00	1.00	0.06	0.23	0.00	1.00
GKK 5000 - 20000	0.29	0.45	0.00	1.00	0.24	0.43	0.00	1.00	0.23	0.42	0.00	1.00
GKK 20000 - 50000	0.18	0.38	0.00	1.00	0.21	0.41	0.00	1.00	0.22	0.42	0.00	1.00
GKK 50000 - 100000	0.09	0.28	0.00	1.00	0.09	0.29	0.00	1.00	0.12	0.33	0.00	1.00
GKK 100000 - 500000	0.13	0.34	0.00	1.00	0.17	0.37	0.00	1.00	0.20	0.40	0.00	1.00
GKK 500000 +	0.15	0.36	0.00	1.00	0.22	0.41	0.00	1.00	0.15	0.36	0.00	1.00
Observations	16658				3790				4723			

SM 3 - Social isolation index cut off choices

Since an index takes considerable researchers' degrees of freedom in coding and deciding on valuable cut off points, we opt to present a multiverse analysis in which we lay out all alternative decisions which can take place in the process of data generation and hence also in the analysis.

In the following, we describe the coding of the loneliness index and the decisions taken at different stages of the coding process. The loneliness index consists of three domains (based on Cornwell & Waite, 2009) made up of several indicators as provided in the SOEP (see Figure 1). Domain 1 reflects the social support individuals receive in their social networks in three different areas: receiving emotional support, informational support and appraisal support. Network function serves as signal that potential supportive partners and resources are available (Berkman et al., 2000; Thoits, 2011). Domain 2 contains information on the household composition, namely living alone, and the presence of a partner or spouse in the life of the individual. Living arrangements are indicative of daily affirmations, emotional support and safety (Holt-Lunstad, Smith, & Layton, 2010; Kandler, Meisinger, Baumert, & Löwel, 2007; Yan, Huang, Huang, Wu, & Qin, 2011). Domain 3 consists of five indicators that capture different areas of activities, individuals are active in on a regular basis. Regular social activities are equally based on the exchange of resources, even if only intangible in nature (Rozanova, Dosman, & de Jong-Gierveld, 2008; Väänänen, Buunk, Kivimäki, Pentti, & Vahtera, 2005).

On the level of indicators, both the substitution assumptions and satiation assumption are applied within the three domains (Figure 1). In the domain of social networks and social support, we build a sum score across all support items and in a substitution fashion. A person counts as deprived when not having support in all areas. Meanwhile, using the satiation case, the cut off is set already when being deprived in two support areas, as we do not assume substitution effects being at play. The two indicators in the living arrangement domain are both dummy variables. A person is socially isolated using the substitution

assumption when living alone and having no partner. In comparison, a person counts as deprived in the satiation framework in case already one indicator shows deprivation, postulating either the absence of a housemate or a spouse. Last, in the social activities domain, individuals are deprived in the substitution framework when they do not regularly take part in all five activities. Using the satiation assumption, we flag individuals as deprived when they do not take part in at least three activities.

Once indicators are built flagging out within-domain social isolation, the same cut offs are introduced on the second level, namely between domains. In the substitution tradition, individuals count as deprived across all domains when being deprived in all three domains. In the satiation assumption framework, two domain deprivations are sufficient to count an individually as socially isolated.

Overall, the different coding strategies across all domains and indicators leaves us with 16 alternative social isolation variables.

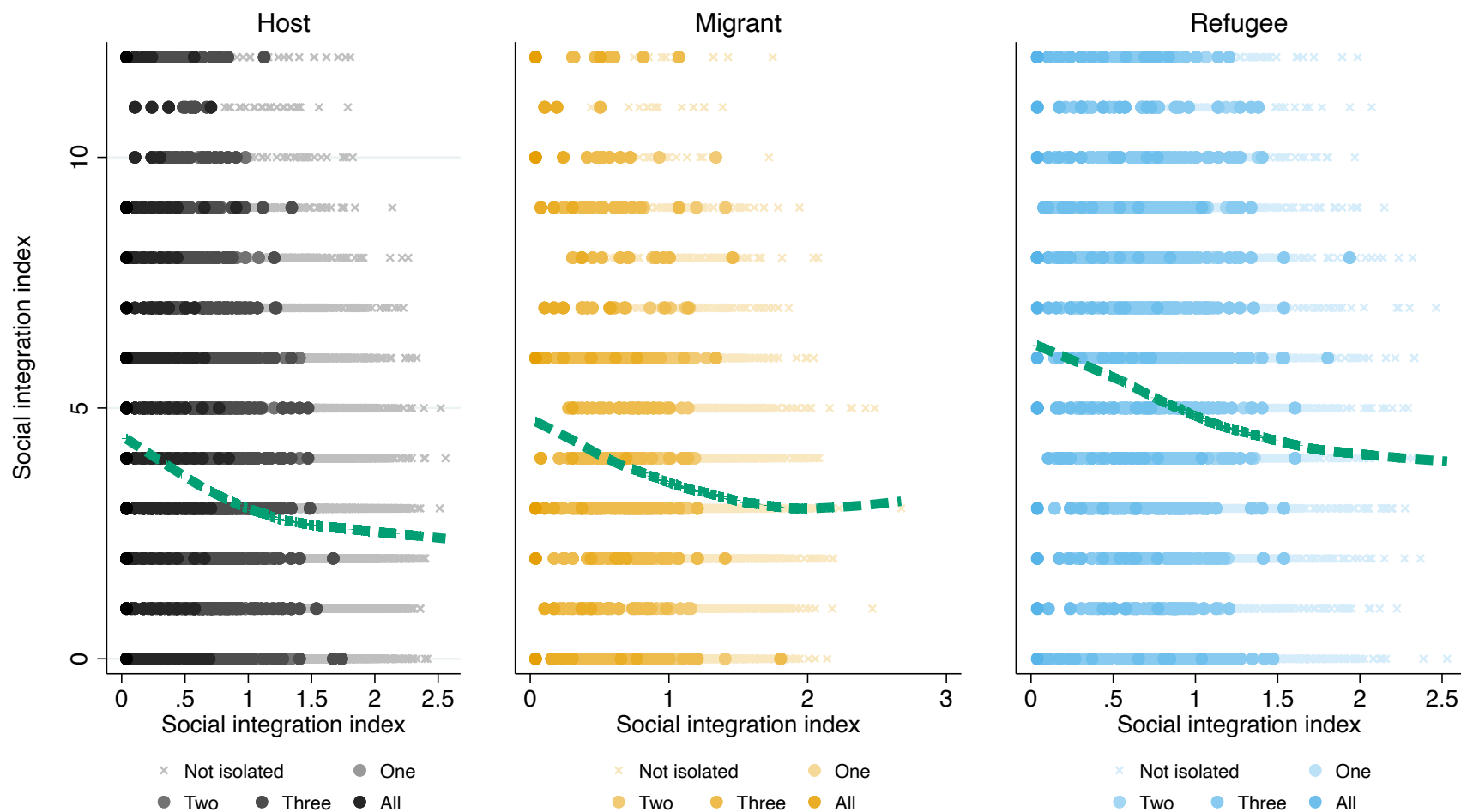
$$I_{js_j} = D[0,1], D = 1 \mid \sum_{k_j=1}^{k_j} C_{k_j} \geq t_{s_j}, j \in \{SS, LA, SA\}, s_j \in \{1,0\} \quad (1)$$

D_{js} indicates the state of integration (1) versus deprivation (0) in dimension j applying threshold t_{s_j} which either allows for fully substitutability ($s_j = 1$) or only partial substitutability $s_j = 0$. k_j indicates the number of indicators C_{k_j} used to measure social connections in each dimension. Based on this coding of integration per dimension, social isolation is then defined as:

$$SI_{s_j} = D[0,1], D = 1 \mid \sum_{m=1}^3 I_{js_j} \leq t_{s_{SI}}, j \in \{SS, LA, SA\}, s_{SI} \in \{1,0\} \quad (2)$$

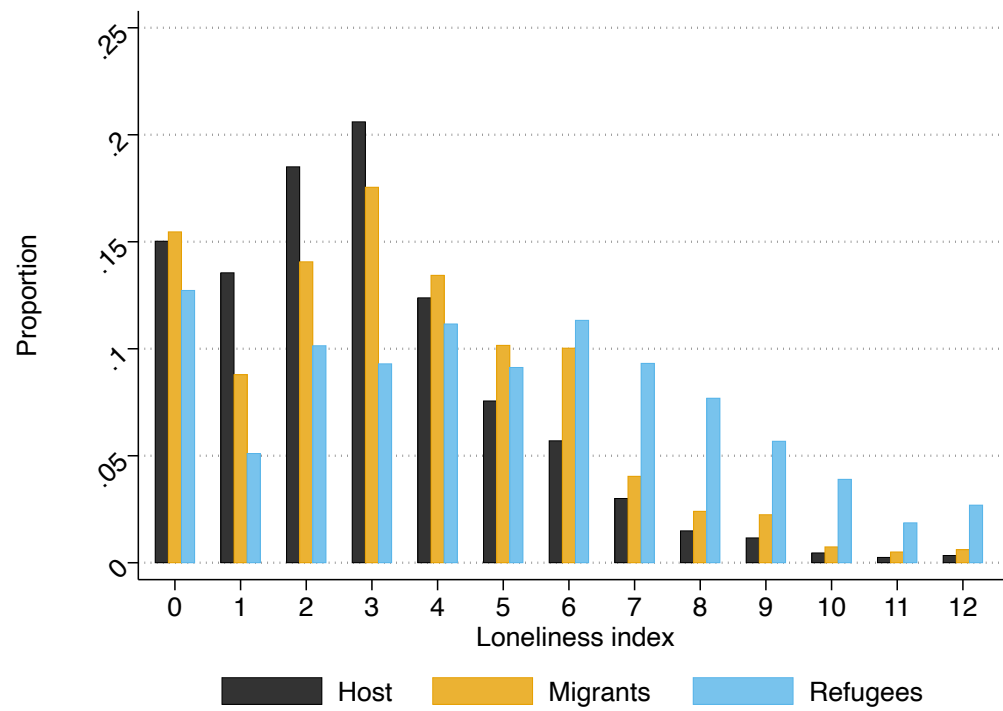
This means that an individual is defined as being social isolated if the number of dimensions it is integrated into is equal or lower than a certain threshold $t_{s_{SI}}$.

Figure S4 –Distribution of loneliness score by migration status



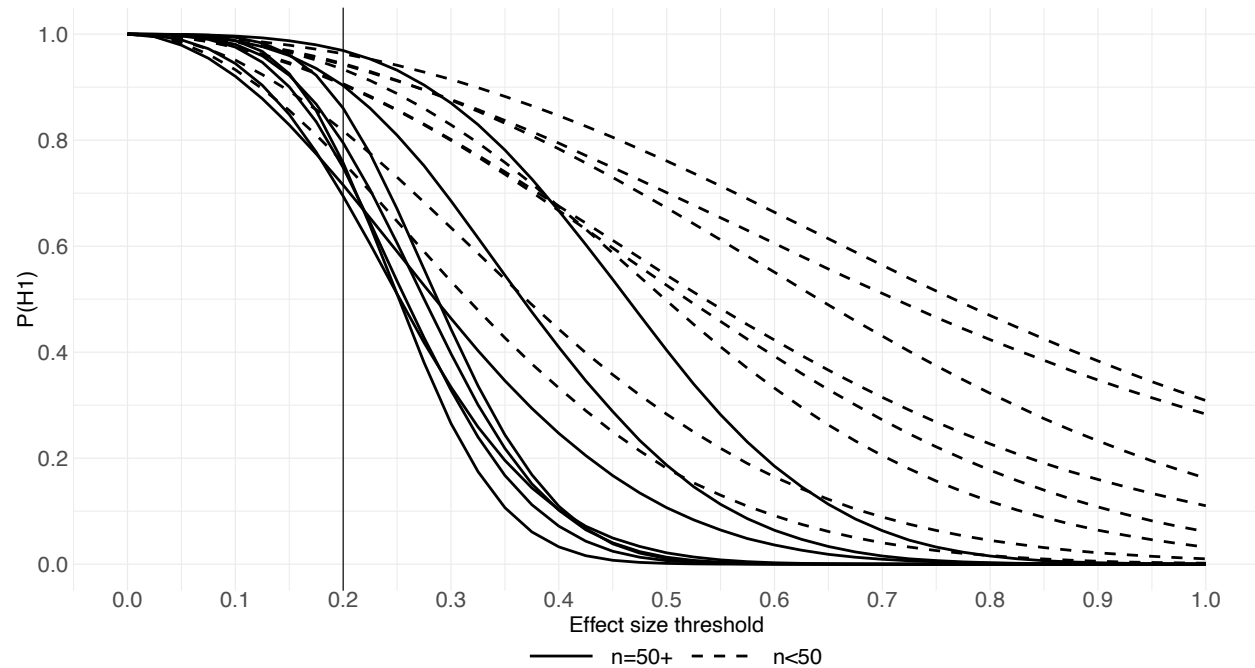
Note: Observed data points are plotted over the loneliness index and an index of social integration. The different shadings indicate under which coding the observation is considered to be socially isolated. Listed are the number of dimensions in which full substitution is allowed. As noted in the manuscript, the more substitution is allowed, the fewer observations are isolated. The dashed line shows the functional relationship between social integration and loneliness estimated by non-parametric LOESS regression.

Figure S5 – Distribution of loneliness score by migration status



SM 4 – Choice of effect size threshold for contextual relevance hypothesis

Figure S6 – Relationship between support for H1 and effect size threshold



Note: The figure shows the relationship between choice of the effect size threshold and support for *contextual relevance* hypothesis H_1 . for all 16 codings (divided into those with sufficient and those with non-sufficient minimum number of observations in the social isolation category).

With respect to the effect size threshold chosen in H_1 , one could of course consider other values for this cut-off. Figure S6 shows the relationship between this choice and the degree of support H_1 would get using our data and model.

The higher the threshold is chosen (meaning only very large differences in effect size are considered to be consequential), the less support H_1 gets. We chose a reference cut-off of 0.2 SD, because this value about the size of the maximum difference in loneliness that is found between different age groups (age range 20 to 80) in a previous study using German data (Luhmann & Hawkley, 2016b). It is therefore a cut-off that considers only substantial differences (approximately as large or larger than strongest differences found across all age) as evidence in favor of H_1 . Consequently, the strong support we find for H1 corroborates

the visual impression of figure 3 in the manuscript that the differences between the migrant group and the host and refugee group are indeed substantial in size and meaningful.

SM 5 - Multiverse analysis and discussion

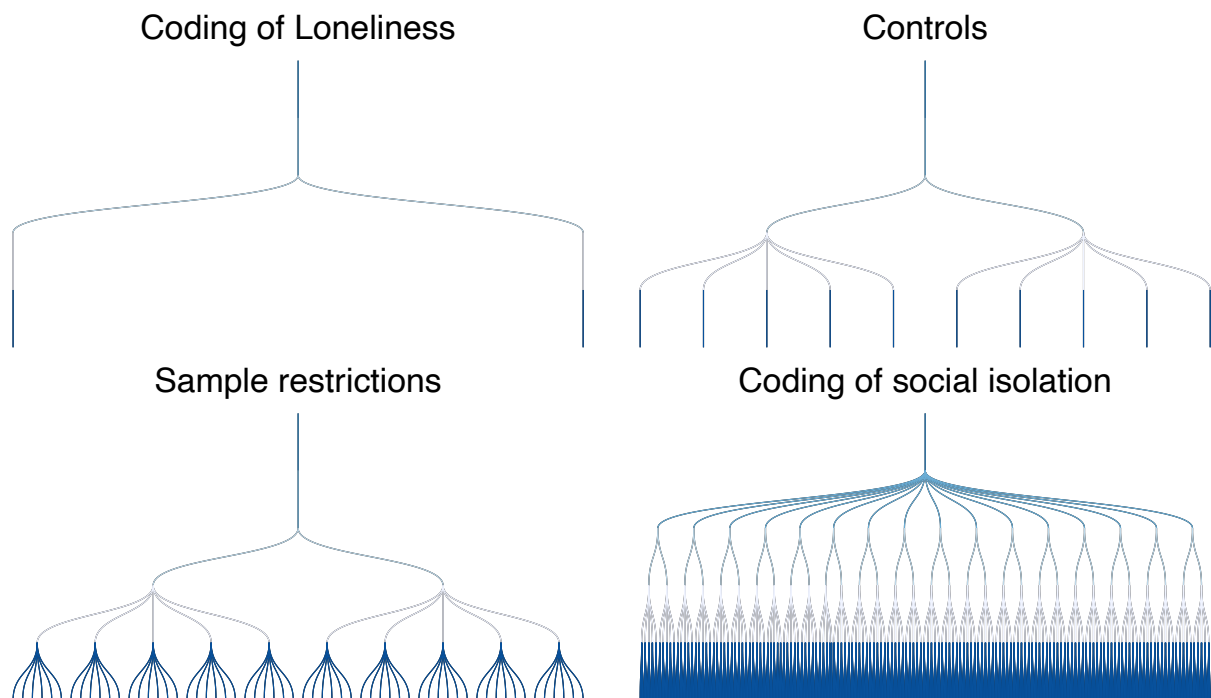
As the section on the social isolation index indicates, researchers not only take decisions on how to construct different measures of a concept. Through these decisions, they are able to have influence on the results presented.

In our analyses, we take several major coding decisions. In the following, we explain these different decisions. After that, we present the analyses with all the varying decisions taken to show how our results vary by specification. This method showing the volatility or robustness of results is called a multiverse analysis, as prominently features amongst others in the work by Rohrer et al. (2017).

Figure S7 shows four different areas in which this article sets out different specifications, leaving us with a theoretical set of 1920 sample specifications to test in the analysis.

- 1) We present two different coding schemes for the UCLA Loneliness Scale.
- 2) We test 5 different specifications regarding control variables: besides always controlling for gender and age, we test for (a) east/west differences, (b) leaving out any covariates, (c) size of population in the area, (d) education levels, and (e) all indicators combined.
- 3) We test 5 different sample restrictions: (a) leaving out individuals who applied for asylum before 2013, (b) leaving out second generation migrants, (c) including all individuals from the 2017 SOEP survey, (d) leaving out individuals age < 54 , (e) leaving out individuals age < 65
- 4) Due to the different possible cut offs, 16 different social isolation indicators are derived in preparation of the analysis.

Figure S7: Overview of specifications



SM 6 – Specification curve analysis and Bayesian model averaging

The derived posterior means and credible intervals in the manuscript are not the indicators we are most interested about in our analysis. Aim of this study is to retrieve Bayes factors and Posterior Model probabilities that allow for a comparison of hypotheses. Unfortunately, it is difficult to derive these estimates with 1887 converged results per group of interest. 33 of the total 1920 models did not converge.

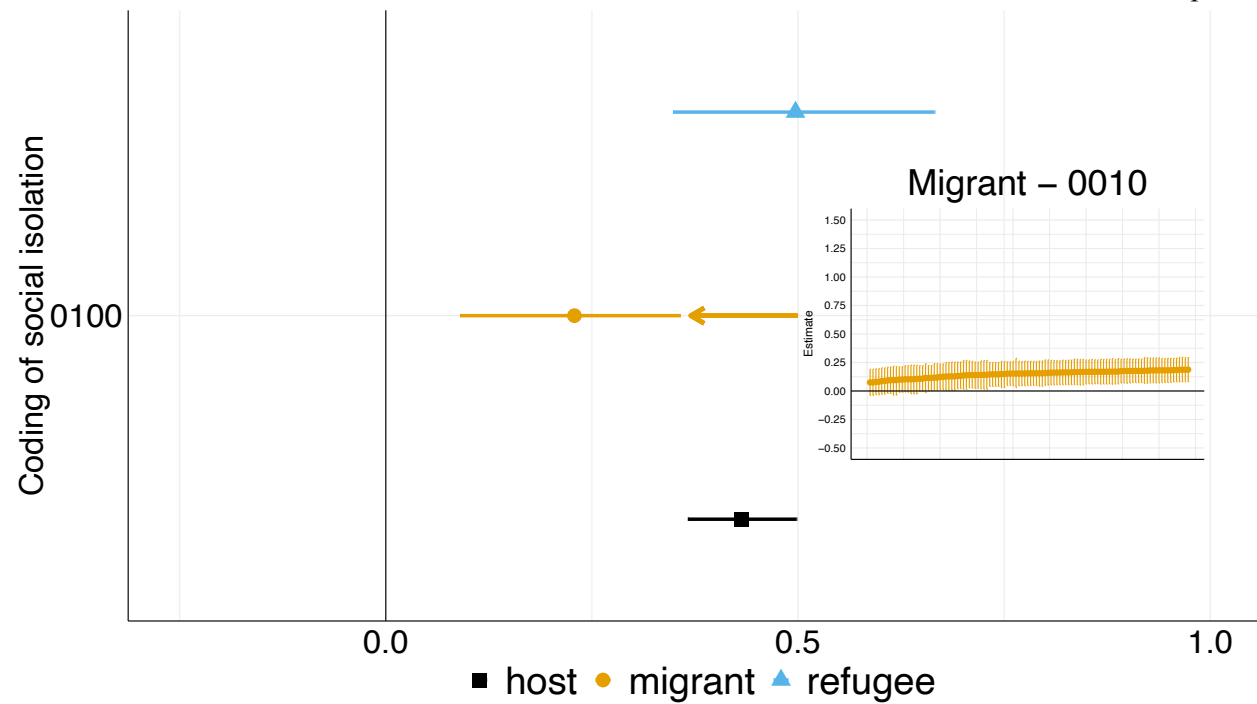
Hence, we have summarized the results from the multiverse framework further, along the lines of the 16 social isolation indicators.

Figure 4 of the manuscript shows the standardized effect sizes of the association between social isolation and loneliness on the X-axis. Meanwhile, the Y-axis provides us with the 16 different alternative social isolation indicators used. Per indicator, we present one posterior mean and credible interval per group.

How does one arrive at only three outcomes when in fact we started out with results from 1887 model specifications? Figure S7 shows how we created an overall mean from the posterior mean and the credible interval of all specifications for the social isolation indicator included in the model. The method allows discussing the differences in association depending on the specification of the social isolation index without going too much into detail about the possible other specifications.

In this example below, the graph shows the size of the association for a model specification where social isolation is coded with a soft cut of in the social network domain, a hard cut off in the living arrangement domain, a soft cut off in the social activities domain and a soft cut off for the summary of the overall domains.

Figure S8: Bayesian model averaging over specifications for the estimates of standardized posterior mean and credible interval of the association between social isolation and loneliness – an illustrative example



SM 7 - Bayesian Evaluation of Informative Hypotheses

To illustrate the Bayesian Evaluation of Informative Hypotheses (BEIH) and the ranking of the different hypotheses, we use the *increased need hypothesis* (H_{2a}) as an example.

$$\beta_h < \beta_m < \beta_r$$

The hypothesis proposes a ranking of the strength of association between social isolation and loneliness. β_h represents the parameter for the host population, β_m the parameter for migrants of the first generation and β_r the parameter for refugees. In this case, the hypothesis does not propose equal strength of association but a ranking. This is indicated by the equality sign between parameters. Derived from an increased need to have social contacts, the hypothesis postulates the largest association between social isolation and loneliness for the group of refugees, with decreasing association parameters for migrants and refugees.

Applying BEIH we first specify alternative hypotheses with the different rankings proposed between parameters (see Table 1).

Next, every hypothesis possesses a defined prior that is the probability of finding the hypothesis in the data by chance. The more restrictions or inequalities we place between parameters in one hypothesis, the less support we will find in the data by chance. For example, H_3 represents the hypothesis without any rankings between parameters. It accepts all possible inequalities between the coefficients. Consequently, the *contextual relevance* hypothesis receives a prior of one, while the four hypotheses belong to the set of context moderation hypothesis have priors based on the number of constraints between parameters. The *flight exceptionalism hypothesis* (H_{2b}) is much more elaborate than H_3 , with one restriction in relation to how the association found in the refugee population should be compared against the host- and migrant population. Most restrictions are placed between the hypothesis including two signs of order, such as the

increased need hypothesis (H_{2a}). The likelihood to find these hypotheses by chance further decreases. Hence, their prior probabilities are smaller as well.

Applying our regression models on the data using INLA, we retrieve a posterior distribution. From this distribution, it is possible to draw random samples. From a sample of e.g. 100 000 draws we can now ask the question: How often does e.g. hypothesis H_{2a} hold true in our sample from the posterior distribution? We calculate the marginal likelihood of observing one hypothesis and compare it to the expected likelihood given by chance (our prior distribution). Given the observed support for the posterior distribution and the expected support from the prior of the hypotheses, we can calculate the so-called Bayes factor for each hypothesis (BF) (Klugkist, 2008), a comparison between the actual outcome and expectation by chance. The proportion $\frac{1}{d_t}$ denotes the grade of support from the posterior distribution, t standing for the hypothesis under consideration. After that we compare the hypothesis to the alternative, for instance that there is no ordering (H_1). $\frac{1}{c_t}$ is defined as the proportion of the prior distribution (expectation) that is in agreement with the hypothesis t . The formula to derive the Bayes Factor is:

$$BF_t = \frac{\frac{1}{d_t}}{\frac{1}{c_t}} = \frac{c_t}{d_t}$$

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