

## Cognition and Neurosciences

### Latent class analysis of indicators of intolerance of uncertainty

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Intolerance of Uncertainty (IU) is a transdiagnostic vulnerability factor involved in depression and anxiety symptoms and disorders. IU encompasses Prospective IU (“Unforeseen events upset me greatly”) and Inhibitory IU (“The smallest doubt can stop me from acting”). Research has yet to explore whether subgroups or classes of people exist characterized by different profiles of IU. This study used latent class analysis to identify such subgroups and examined if different classes of IU were distinct in terms of several cognitive vulnerabilities and psychological symptoms. Data were obtained from 519 students completing a 12-item measure of IU. Four subgroups were identified, characterized by low IU, predominantly Prospective IU, predominantly Inhibitory IU, and high IU, respectively. People in the high IU class reported cognitive vulnerabilities and depression and anxiety more than people in the low IU class. Inhibitory IU was more strongly associated with poor outcomes than was Prospective IU.

**Key words:** Intolerance of uncertainty, latent class analysis, depression, anxiety.

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#### INTRODUCTION

Since the mid-1990s there is growing evidence supporting the importance of Intolerance of Uncertainty (IU) in human functioning (Carleton, 2016a). People with increased IU are intolerant of the possibility that negative events may occur and that no precise means exist to predict and avoid such events, and perceive uncertainty as something that reflects negatively on a person (cf. Koerner & Dugas, 2008). More recently, Carleton (2016b, p. 5) proposed the following operational definition: “IU is an individual’s dispositional incapacity to endure the aversive response triggered by the perceived absence of salient, key, or sufficient information, and sustained by the associated perception of uncertainty.” IU has been conceptualized as a multidimensional concept, encompassing Prospective IU and Inhibitory IU (e.g., Carleton, Norton & Asmundson, 2007). Prospective IU refers to cognitive perceptions of threat pertaining to future uncertainty (tapped with items such as “Unforeseen events upset me greatly”). Inhibitory IU refers to inhibition of action or experiences as a result of apprehension of uncertainty (e.g., “The smallest doubt can stop me from acting”). There is growing evidence that IU is a transdiagnostic vulnerability factor involved in depression (Carleton, Mulvogue, Thibodeau, McCabe, Antony & Asmundson, 2012; Van der Heiden, Melchoir, Muris, Bouwmeester, Bos & van der Molen, 2010) and anxiety symptoms and disorders, including panic disorder, obsessive compulsive disorder, social anxiety, posttraumatic stress, and health anxiety (see Carleton, 2016b; Carleton, Mulvogue *et al.*, 2012). This stresses the importance of further scrutinizing the nature, manifestation, and correlates of IU.

In light of the emerging interest of IU as a concept with broad importance (Carleton, 2016b), different psychometric evaluations of tools for its measurement have been reported in the literature. For instance, Carleton, Weeks, Howell, Asmundson, Antony and

McCabe (2012) used taxometric analyses to examine the latent structure of IU in anxiety disorder outpatients. Their findings indicated that IU has a continuous, rather than a categorical latent structure. Addressing the methodological shortcomings of taxometrics, Oglesby, Allan, Short, Raines, and Schmidt (2017) further explored the latent structure of IU, using factor mixture modelling. Different from Carleton, Weeks *et al.* (2012), they found evidence that IU was best conceptualized as having a categorical latent structure. The current study used latent class analysis (LCA)—a person-centred method that identifies classes or subgroups of persons sharing common characteristics (Collins & Lanza, 2010)—to explore whether subgroups of people exist characterized by different IU profiles. Our study builds on prior taxometric work (Carleton, Weeks *et al.*, 2012) that allows no more than two classes, to explore the possibility of more than two classes of IU emerging in our study sample. Theoretically, it was possible that subgroups of people exist, characterized by different scores on all IU indicators or different levels of Prospective IU and Inhibitory IU (e.g., high Prospective/low Inhibitory or low Prospective/high Inhibitory IU). Identifying such subgroups may provide valuable information for research and clinical practice. For instance, delineating patterns of IU across potentially emerging subgroups could provide an additional basis with which to further clarify underlying mechanisms of IU or its role as reflecting a fundamental fear (Carleton, 2016b). Moreover, if subgroups of people based on IU profiles could be distinguished, this could underscore the importance of administering tailored interventions to groups with the most problematic profiles.

Accordingly, the current study was a preliminary attempt to identify subgroups of people characterized by different IU profiles. In so doing, we relied on data from a large student sample. The 12-item Intolerance of Uncertainty Scale (IUS-12) was used to assess IU. The IUS-12 a validated instrument tapping

Prospective IU and Inhibitory IU (e.g., Carleton *et al.*, 2007). Our first aim was to examine whether subgroups of people could be identified based on their endorsement of IUS-12 items using LCA (Collins & Lanza, 2010). To our knowledge, there are no prior studies using LCA to study IU. Based on LCA research in other areas, including psychiatric disorders such as post-traumatic stress (e.g., Djelantik, Smid, Kleber & Boelen, 2017; Hebenstreit, Madden & Maguen, 2014) at least two possible outcomes were anticipated. A first possible outcome was that different subgroups would emerge characterized by low, intermediate, and high scores across all IU items. A second possible outcome was that subgroups would emerge with distinct IU profiles (e.g., high Prospective/low Inhibitory or low Prospective/high Inhibitory IU). The former finding would indicate that people can be distinguished in terms of gradually increasing likelihoods of endorsing different manifestations of IU; the latter outcome would suggest that people differ in terms of their propensity to endorse some but not other manifestations of IU.

The second aim of the current study was to examine if people included in different classes of IU were distinct in terms of several cognitive vulnerabilities and psychological symptoms. With respect to cognitive vulnerabilities, we focused on: (i) worry (repetitive thought about negative future events; Borkovec, Ray & Stober, 1998); (ii) rumination (repetitive thinking about causes and consequences of past negative events and emotions; Treynor, Gonzalez & Nolen-Hoeksema, 2003); (iii) experiential acceptance (the ability to be present with, rather than attempting to control, unwanted thoughts, and feelings; Hayes, Wilson, Gifford, Follette & Strosahl, 1996); and (iv) mindfulness (the ability to attend to present events and experiences; Brown & Ryan, 2003). With respect to symptoms, we investigated: (i) depressive symptoms; (ii) general anxiety; (iii) obsessive compulsiveness; (iv) social anxiety; and (v) separation anxiety. We examined associations of different IU profiles with these cognitive vulnerabilities and symptoms for several reasons. First, exploring the distinctiveness of emerging subgroups in terms of these variables was considered to enhance theoretical knowledge about IU—specifically, about the issue of whether inclusion in different IU classes confers differential risks for maladaptive cognitive processes and psychological problems. Second, exploring differences in cognitive vulnerabilities and symptoms between IU-classes was considered clinically useful. For instance, if we would be able to identify IU-classes characterized by different cognitive vulnerabilities and symptoms, that could help in determining which aspects or features of IU should be targeted in the treatment of these difficulties. Given the scarcity of research on latent classes of IU, we were hesitant to formulate specific hypotheses with respect to our second study goal. However, there is emerging evidence that IU is a key cognitive vulnerability that is significantly associated with different other cognitive vulnerabilities (e.g., ruminative thinking; Hong & Cheung, 2015). In addition, IU has been found to robustly predict anxiety and depressive symptoms and disorders (Carleton, 2016a; Oglesby *et al.*, 2017). Accordingly, assuming that the LCA would identify at least two subgroups of IU characterized by relatively low and high IU, we expected individuals in the more pervasive IU class to report increased cognitive vulnerabilities and depression and anxiety symptoms.

## METHOD

### *Participants and procedure*

Data were obtained from students of a Dutch University participating in an internet-based survey-study addressing (among other things) the severity and correlates of depression and anxiety symptoms. (For another study drawing from this survey, see Boelen & Lenferink, 2018.) Participants were recruited via announcements in university buildings and websites and participated in return for course credits. All participants provided informed consent. In total, data from 519 students were included in this study. Participants had a mean age of  $M = 21.6$  ( $SD = 2.4$ , range 18–44, median = 21.0) years. There were 460 (88.6%) women.

### *Measures*

*Intolerance of Uncertainty.* The Intolerance of Uncertainty Scale Short Form (IUS-12; Carleton *et al.*, 2007) is a 12-item measure of IU. It has two factors, tapping Prospective IU (7 items, e.g., “I can’t stand being taken by surprise”) and Inhibitory IU (5 items, e.g., “When it’s time to act, uncertainty paralyzes me”), respectively. Items are scored on a five-point scale (1 = *not at all characteristic of me*, 5 = *entirely characteristic of me*). The IUS-12 has yielded excellent psychometric properties in clinical and non-clinical samples (e.g., Carleton *et al.*, 2007; Dutch version Helsen, Van den Bussche, Vlaeyen & Goubert, 2013; for further evidence of its utility and psychometric properties see, e.g., Gentes & Ruscio, 2011; Hong & Lee, 2015). In the present sample, the  $\alpha$  of the total scale was 0.87, of the Prospective IU items was 0.85, and of the Inhibitory IU items was 0.80.

*Cognitive vulnerabilities.* The Penn State Worry Questionnaire-Abbreviated (PSWQ-A; Hopko, Reas, Beck *et al.*, 2003) is a measure of worry. Respondents are asked to indicate to what extent 8 items (e.g., “I am always worrying about something”) are typical of them on 5-point scales (1 = *not at all typical of me*, to 5 = *very typical of me*); items are summed such that higher total scores index stronger worry. Research has supported psychometrics of the measure (Hopko *et al.*, 2003). In this sample, the  $\alpha$  was 0.92.

The Ruminative Response Scales (RRS) Brooding Scale (Treynor *et al.*, 2003) was used to assess rumination. This scale includes five items tapping unconstructive pondering (e.g., “I think ‘Why do I always react this way?’”) in response to a sad/depressed mood. Items are rated on 4-point scales (1 = *almost never*, to 4 = *almost always*); the summed items reflect stronger brooding. English (Treynor *et al.*, 2003) and Dutch studies (Schoofs, Hermans & Raes, 2010) have shown that the RRS, including its brooding scale, has good psychometric properties. In this sample, the  $\alpha$  was 0.75.

The Acceptance and Action Questionnaire-9 (AAQ-9; Hayes, Strosahl, Wilson *et al.*, 2004) is a nine-item questionnaire measuring the tendency to accept negative psychological experiences (e.g., “When I feel depressed or anxious, I am unable to take care of my responsibilities”). Items are scored on 7-point scales (1 = *never true*, to 7 = *always true*) and summed (after reversing some of the item-scores) such that higher scores represent stronger “experiential acceptance”. English (Hayes *et al.*, 2004) and Dutch versions (Boelen & Reijntjes, 2008) have yielded adequate psychometric properties. The internal consistency ( $\alpha$ ) in the current sample was 0.65.

The Mindful Attention Awareness Scale (MAAS; Brown & Ryan, 2003) is a 15-item questionnaire tapping a person’s awareness and attention to present events and experiences (e.g., “I find it difficult to say focused on what is happening in the present” (reverse scored). Items are scored on 6-point scales (1 = *almost always*, to 6 = *almost never*). Higher total scores indicate greater trait-mindfulness. The English (Brown & Ryan, 2003) and Dutch (Schroevens, Nyklicek & Topman, 2008) versions have sound psychometric properties. In this sample, the  $\alpha$  was 0.88.

*Depression and anxiety symptoms.* The Beck Depression Inventory (BDI) is a commonly used measure, including 21 groups of four statements representing depressive symptoms at increasing levels of severity (e.g., “I

do not feel sad/I feel sad/I am sad all the time and I can't snap out of it/I am so sad and unhappy that I can't stand it"). Participants choose the statement that best describes their current state. English (Beck, Steer & Brown, 1996) and Dutch versions (Van der Does, 2002) have adequate psychometric properties. The  $\alpha$  in this sample was 0.90.

The Beck Anxiety Inventory (BAI) is a measure of (mostly somatic) symptoms of general anxiety. Participants rate the occurrence of symptoms (e.g., numbness and tingling, fear of the worst happening) during the preceding week on four-point scales (0 = *not at all*, to 3 = *severely*). English (Beck, Epstein, Brown & Steer, 1988) and Dutch versions (e.g., Muntingh, van der Feltz-Comelis, van Marwijk, Spinhoven, Penninx & van Balkom, 2011) have good psychometric properties. In the current sample, the  $\alpha$  was 0.89.

The Obsessive Compulsive Inventory revised version (OCI-R) is an 18-item measure developed by Foa, Huppert, Leiberg *et al.* (2002) tapping obsessive compulsive symptoms (e.g., "I repeatedly check doors, windows, drawers, etc."). Respondents rate the presence of symptoms on 5-point scales (0 = *not at all*, to 4 = *extremely*). The total score (used in this study) offers an index of overall obsessive compulsiveness. English (Foa *et al.*, 2002) and Dutch versions (Boelen & Reijntjes, 2009) have yielded adequate psychometric properties. Cronbach's alpha was 0.87.

The Social Phobia Inventory (SPIN) is a 17-item questionnaire constructed by Connor, Davidson, Churchill, Sherwood, Foa, and Weisler (2000) for the assessment of social anxiety symptoms (e.g., "Parties and social events scare me"). Respondents rate the presence of symptoms in the preceding week, on 5-point scales (0 = *not at all*, to 4 = *extremely*). Items are summed to form an overall social anxiety severity score. The psychometric properties of the SPIN have been found to be adequate in several studies (e.g., Antony, Coons, McCabe, Ashbaugh & Swinson, 2006; Carleton, Collimore, Asmundson, McCabe, Rowa & Antony, 2010; for information on the Dutch version, see Boelen & Reijntjes, 2009). In the present sample, the  $\alpha$  was 0.91.

The Adult Separation Anxiety Symptom Questionnaire (ASA-27) developed by Manicavasagar, Silove, Wagner, and Drobny (2003) is a 27-item measure of symptoms of adult separation anxiety. The items (e.g., "Have you been worrying a lot about people you care about leaving you?") are rated on 4-point scales (0 = *this never happens*, to 3 = *this happens all the time*). The English (Manicavasagar *et al.*, 2003) and Dutch (Boelen, 2013) versions have yielded adequate psychometric properties. The  $\alpha$  in the present sample was 0.91.

### Statistical analyses

IUS-12 items were subjected to a LCA, using Latent Gold version 5.0 (Vermunt, 2010) to examine how many different classes could be identified based on similarly endorsed patterns of IU indicators. To enable LCA, all item scores were dichotomized. In so doing, we derived dichotomous indicators reflecting low vs. high presence of IU indicators. Specifically, presence of an IU indicator was considered low if rated as 1 = *not at all characteristic of me* or 2 = *a little characteristic of me*, and was considered high if rated as 3 = *somewhat characteristic of me*, 4 = *very characteristic of me*, or 5 = *entirely characteristic of me*.

To determine the optimal number of latent classes, we first fitted the one class model, followed by models with increasing numbers of classes.

Following recommendations of Nylund, Asparouhov, and Muthén (2007), we selected the most optimal model based on statistical criteria, class size (s), and consistency with theory and previous research. With respect to statistical criteria we considered: (1) the Log-likelihood, sample-size adjusted Bayesian information criterion (SA-BIC), and Akaike's information criterion (AIC; frequently used to compare the fit of models with different number of classes) with lower values indicating better fit; (2) the bootstrap likelihood ratio test (BLRT), with  $p$ -values < 0.05 pointing at a significant improvement of the fit of the solution relative to a solution with one less class (Nylund *et al.*, 2007); (3) entropy  $R^2$  values (i.e., indication of latent class separation) with values closer to one indicating better fit and class-separation (Carragher, Adamson, Bunting & McCann, 2009). Less than 1% of the data was missing per item and missing data were handled using maximum likelihood estimation. With respect to non-statistical criteria, parsimony and interpretability of the latent classes were considered. That is, solutions including classes with larger sample sizes reflecting theoretically meaningful IU patterns were preferred over solutions that included classes with small samples and that reflected patterns adequately captured by solutions with lower numbers of classes. After selection of the most optimal class solution, participants were assigned to the classes using a proportional assignment procedure with probability estimates being estimated for each participant for each class (Vermunt, 2010).

Next, we examined whether class-membership was associated with differences in Prospective IU scores, Inhibitory IU scores, and total IUS-12 scores. To this end, these three scores were subsequently regressed on class-membership. In so doing, we used the 3-step procedure implemented in Latent Gold (Vermunt, 2010); in this procedure, the classification error resulting from assigning participants to classes is taking into account yielding a weighted analysis of variance (ANOVA), using the method of Bolck, Croon, and Hageaars (2004) as recommended by Bakker and Vermunt (2016). The same procedures were used in two further rounds of analyses in which we investigated associations of class-membership with cognitive vulnerabilities and with depression and anxiety symptoms, respectively. Differences between groups were deemed statistically significant at a  $p$ -value of < 0.05.

## RESULTS

### LCA: model selection

Table 1 shows fit indices of the one to five class solutions. The five-class model had the lowest LL, SA-BIC, and AIC values. The entropy  $R^2$  value was the highest in the two-class model. However, the significant  $p$ -value of the BLRT of the four-class model indicated that this model yielded a better fit compared with the three-class model. Non-statistical criteria accorded with the four-class model as the optimal solution; that is, as described in more detail in the next section, the four classes that emerged could fairly straightforwardly be interpreted as reflecting classes of people with Low IU, predominantly Prospective IU, predominantly Inhibitory IU, and High IU, respectively. Upon

Table 1. Goodness-of-fit statistics for one- to four-class models ( $N = 519$ )

| Model       | LL       | SA-BIC  | AIC     | BLRT $p =$ | Entropy $R^2$ | Smallest Class size |
|-------------|----------|---------|---------|------------|---------------|---------------------|
| One class   | -3849.68 | 7736.30 | 7723.36 |            |               |                     |
| Two class   | -3421.15 | 6919.23 | 6892.29 | <0.001     | 0.80          | 224                 |
| Three class | -3350.74 | 6818.43 | 6777.48 | 0.004      | 0.73          | 120                 |
| Four class  | -3299.30 | 6755.56 | 6700.59 | 0.038      | 0.73          | 72                  |
| Five class  | -3272.11 | 6741.20 | 6672.22 | 0.110      | 0.71          | 46                  |

Notes: LL = Log-likelihood; SA-BIC = Sample-Size Adjusted Bayesian Information Criterion; AIC = Akaike's Information Criterion; BLRT = bootstrap likelihood ratio test.

inspection, the general pattern of the five-class solution seemed to be adequately captured by the profile of the four-class solution.

*Description of four classes of IU*

Table 2 shows the probabilities that IU indicators were endorsed in each of the four classes (i.e., conditional probability estimates). Conditional probability estimates are also graphically displayed in Fig. 1. In keeping with prior LCA-studies (Djelantik *et al.*, 2017; Hebenstreit *et al.*, 2014) probabilities of item endorsement of < 0.30 were considered “very low”, between 0.30 and 0.50 as “low/moderate”, and > 0.50 as “high”. The first class (*n* = 193, 37.2%) was the largest class and characterized by very low probabilities for nine IU indicators, low/moderate probabilities for two IU indicators, and high probability for one IU indicator. This

class was therefore labeled as “Low IU Class”. The second class (*n* = 149, 28.7%) was characterized by high probabilities for five of seven Prospective IU indicators, low/moderate probabilities for two of seven Prospective IU indicators, and by low/moderate probability for one of five and very low probabilities for four of five and Inhibitory IU indicators. This class was labeled as “Prospective IU Class”. The third class (*n* = 72, 13.9%) was the smallest class and was characterized by high probabilities for three of seven, low/moderate probabilities for two of seven, and low probabilities for two of seven Prospective IU items, and by high probabilities for three of five, and low/moderate probabilities for two of five Inhibitory IU indicators. This class was labeled as “Inhibitory IU Class”. The fourth class (*n* = 105, 13.9%) was characterized by high probabilities for all 12 IU-indicators and was labeled as “High IU Class”.

Table 2. Intolerance of uncertainty probability estimates for the four-class model (N = 519)

| Label    | Item   | Overall item frequency |      | Low IU (n = 193; 37.2%) |      | Prospective IU (n = 149; 28.7%) |      | Inhibitory IU (n = 72; 13.9%) |      | High IU (n = 105; 20.2%) |      |
|----------|--|------------------------|------|-------------------------|------|---------------------------------|------|-------------------------------|------|--------------------------|------|
|          |  | N                      | %    | Prob.                   | SE   | Prob.                           | SE   | Prob.                         | SE   | Prob.                    | SE   |
| Prosp. 1 | Unforeseen events upset me greatly.  | 330                    | 63.6 | 0.33                    | 0.04 | 0.71                            | 0.07 | 0.80                          | 0.07 | 0.98                     | 0.02 |
| Prosp. 2 | It frustrates me not having all the information I need.                        | 439                    | 84.9 | 0.66                    | 0.04 | 0.95                            | 0.03 | 0.94                          | 0.04 | 0.98                     | 0.02 |
| Prosp. 3 | One should always look ahead so as to avoid surprises.                         | 298                    | 57.4 | 0.22                    | 0.05 | 0.78                            | 0.05 | 0.59                          | 0.08 | 0.93                     | 0.03 |
| Prosp. 4 | A small unforeseen event can spoil everything, even with the best of planning. | 180                    | 34.7 | 0.14                    | 0.03 | 0.37                            | 0.07 | 0.14                          | 0.07 | 0.86                     | 0.05 |
| Prosp. 5 | I always want to know what the future has in store for me.                     | 310                    | 59.7 | 0.24                    | 0.05 | 0.87                            | 0.05 | 0.48                          | 0.11 | 0.96                     | 0.02 |
| Prosp. 6 | I can't stand being taken by surprise.   | 184                    | 35.5 | 0.07                    | 0.03 | 0.46                            | 0.07 | 0.21                          | 0.08 | 0.85                     | 0.05 |
| Prosp. 7 | I should be able to organize everything in advance.                            | 241                    | 46.6 | 0.11                    | 0.03 | 0.66                            | 0.08 | 0.34                          | 0.08 | 0.94                     | 0.03 |
| Inhib. 1 | Uncertainty keeps me from living a full life.                                  | 213                    | 41.1 | 0.20                    | 0.04 | 0.29                            | 0.06 | 0.73                          | 0.09 | 0.74                     | 0.07 |
| Inhib. 2 | When it's time to act, uncertainty paralyzes me.                               | 119                    | 23.0 | 0.03                    | 0.02 | 0.03                            | 0.05 | 0.64                          | 0.11 | 0.58                     | 0.09 |
| Inhib. 3 | When I am uncertain I can't function very well.                                | 319                    | 61.6 | 0.48                    | 0.04 | 0.45                            | 0.08 | 0.91                          | 0.05 | 0.89                     | 0.05 |
| Inhib. 4 | The smallest doubt can stop me from acting.                                    | 119                    | 23.0 | 0.06                    | 0.02 | 0.07                            | 0.06 | 0.44                          | 0.08 | 0.64                     | 0.08 |
| Inhib. 5 | I must get away from all uncertain situations.                                 | 140                    | 27.0 | 0.03                    | 0.01 | 0.24                            | 0.06 | 0.31                          | 0.07 | 0.74                     | 0.06 |

Note: Prob. = probability estimate; SE = standard error; Prosp = Prospective; Inhib = Inhibitory; IU = intolerance of uncertainty.

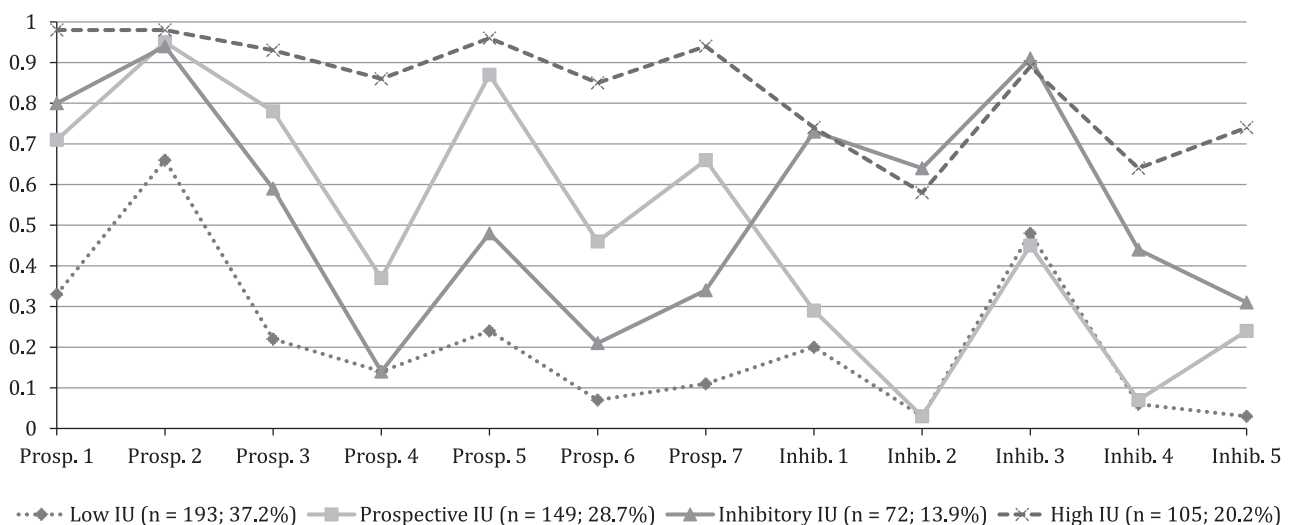


Fig. 1. Conditional probability estimates for IU indicators in the four class solution. Prosp. = Prospective; Inhib. = Inhibitory; IU = intolerance of uncertainty.



### Associations of IU class-membership with Prospective IU, Inhibitory IU, and total IU scores

Table 3 shows mean scores (plus standard errors, SEs) of the summed 12 items of the IUS-12 scale, the summed Prospective IU items, and the summed Inhibitory IU items for all four classes. ANOVAs and pairwise comparisons showed that IUS-12 total scores differed significantly between all four classes and were ordered such that Low IU < Prospective IU < Inhibitory IU < High IU. Prospective IU scores also differed significantly between the four classes; this score was highest in the High IU Class and—as expectable—significantly higher in the Prospective IU Class, compared to the Low IU Class and Inhibitory IU Class. Inhibitory IU scores also differed significantly between classes, except between the Inhibitory IU Class and High IU Class. Specifically, Inhibitory IU scores were higher in the Prospective IU Class compared to the Low IU Class and higher in the Inhibitory IU Class and High IU Class, compared to the Low IU Class and Prospective IU Class. Detailed outcomes regarding these comparisons are shown in Appendix 1.

### Associations of IU class-membership with cognitive vulnerabilities

Table 3 also shows mean scores (plus SEs) on indices of cognitive vulnerabilities for all four classes. Worry differed straightforwardly between the classes, with scores ordered Low IU < Prospective IU < Inhibitory IU < High IU. Mean scores of rumination and experiential acceptance differed significantly between the Low IU Class, Prospective IU Class, and Inhibitory IU Class, but not between the Inhibitory IU Class and High IU Class. Rumination scores were ordered such that: Low IU < Prospective IU < Inhibitory IU = High IU. Experiential acceptance scores were ordered such that Low IU > Prospective IU > Inhibitory IU = High IU. Mindfulness scores were similar between the Low IU Class and Prospective IU Class and between the Inhibitory IU Class and High IU Class, but differed such that Low IU = Prospective IU > Inhibitory IU = High IU.

### Associations of IU class-membership with depression and anxiety symptoms

Table 3 also shows mean scores (plus SEs) on indices of depressive and anxiety symptoms for all four classes. Mean depression scores and mean social anxiety scores were similar between the Low IU Class and Prospective IU Class, and between the Inhibitory IU Class and High IU Class, but differed such that Low IU = Prospective IU < Inhibitory IU = High IU. General anxiety scores were similar between the Low and Prospective IU Classes, were significantly higher in the Inhibitory IU Class compared to these classes, and were even higher in the High IU Class (i.e., Low IU = Prospective IU < Inhibitory IU < High IU). With respect to both obsessive compulsiveness and separation anxiety, participants in the Low IU Class had significantly lower scores compared to the other three classes. Participants in the Prospective IU Class and Inhibitory IU Class had lower scores compared to the High IU class, but did not differ in terms of these symptoms (i.e., Low IU < Prospective IU = Inhibitory IU < High IU).

### DISCUSSION

The current study aimed to further knowledge about IU, a cognitive bias conveying risk for anxiety and depressive symptoms and syndromes (Carleton, 2016a). Our first aim was to examine latent classes of individuals distinguished by differences in the likelihood of endorsing different aspects of IU. Based on the LCA, four classes were distinguished. The first was a Low IU Class (37.2%), characterized by low probabilities of endorsement of nine of 12 IU indicators. The second was coined the Prospective IU Class (28.7%). This class included individuals with high probabilities of endorsing most Prospective IU items and low probabilities to endorse items tapping Inhibitory IU. The third was the Inhibitory IU Class (13.9%). Compared to the second class, people in this class evidenced lower probabilities of endorsing Prospective IU items and higher probabilities of endorsing Inhibitory IU items. The fourth class included 20.2% of

Table 3. Parameter estimates for cognitive vulnerabilities and psychological symptoms regressed on class-membership

| Dependent variable                         | Low IU Class<br>Mean (SE) | Prospective IU Class<br>Mean (SE) | Inhibitory IU Class<br>Mean (SE) | High IU Class<br>Mean (SE) | Pairwise comparisons    |
|--|---------------------------|-----------------------------------|----------------------------------|----------------------------|-------------------------|
| <b>Intolerance of Uncertainty</b>          |                           |                                   |                                  |                            |                         |
| Prospective IU ( <i>N</i> = 519)           | 13.39 (0.23)              | 21.82 (0.29)                      | 17.96 (0.40)                     | 26.87 (0.39)               | 1 < 2 < 4; 1 < 3; 3 < 4 |
| Inhibitory IU ( <i>N</i> = 519)            | 8.53 (0.20)               | 9.25 (0.23)                       | 15.43 (0.35)                     | 15.90 (0.31)               | 1 < 2 < 3 = 4           |
| Total IU ( <i>N</i> = 519)                 | 21.92 (0.35)              | 31.07 (0.39)                      | 33.39 (0.55)                     | 42.77 (0.58)               | 1 < 2 < 3 < 4           |
| <b>Cognitive vulnerabilities</b>           |                           |                                   |                                  |                            |                         |
| Worry ( <i>N</i> = 519)                    | 18.74 (0.51)              | 23.09 (0.64)                      | 27.64 (0.86)                     | 30.87 (0.69)               | 1 < 2 < 3 < 4           |
| Rumination ( <i>N</i> = 518)               | 8.14 (0.19)               | 9.04 (0.28)                       | 11.05 (0.39)                     | 11.61 (0.38)               | 1 < 2 < 3 = 4           |
| Experiential acceptance ( <i>N</i> = 518)  | 43.60 (0.38)              | 41.79 (0.52)                      | 35.89 (0.80)                     | 34.98 (0.59)               | 1 > 2 > 3 = 4           |
| Mindfulness ( <i>N</i> = 518)              | 63.98 (0.90)              | 62.11 (1.01)                      | 57.74 (1.70)                     | 55.33 (1.24)               | 1 = 2 > 3 = 4           |
| <b>Psychological symptoms</b>              |                           |                                   |                                  |                            |                         |
| Depressive symptoms ( <i>N</i> = 518)      | 4.71 (0.40)               | 5.51 (0.59)                       | 11.97 (0.99)                     | 12.92 (0.92)               | 1 = 2 < 3 = 4           |
| General anxiety ( <i>n</i> = 515)          | 6.57 (0.45)               | 7.16 (0.65)                       | 10.78 (0.97)                     | 14.78 (1.09)               | 1 = 2 < 3 < 4           |
| Obsessive compulsiveness ( <i>n</i> = 518) | 4.38 (0.46)               | 6.10 (0.56)                       | 8.05 (0.93)                      | 13.68 (1.09)               | 1 < 2 = 3 < 4           |
| Social anxiety ( <i>n</i> = 517)           | 23.38 (0.44)              | 24.82 (0.69)                      | 35.28 (1.54)                     | 37.87 (1.36)               | 1 = 2 < 3 = 4           |
| Separation anxiety ( <i>n</i> = 517)       | 36.43 (0.56)              | 39.70 (0.94)                      | 42.37 (1.33)                     | 48.03 (1.42)               | 1 < 2 = 3 < 4           |

Note: IU = intolerance of uncertainty; SE = standard error.

the sample evidencing high probabilities to endorse all 12 IU indicators.

Prior studies using “variable-centred” approaches (e.g., confirmatory factor analysis) have pointed at the distinctiveness of Prospective IU and Inhibitory IU (Carleton *et al.*, 2007; Helsen *et al.*, 2013). The current study complements these findings by using a “person-centered” approach, pointing out that a distinction can be made between two subgroups, including people with elevated probabilities of endorsing indicators of Prospective IU and Inhibitory IU, respectively. These findings are important given that some researchers have questioned the viability of treating Prospective IU and Inhibitory IU as distinct factors (e.g., Hale, Richmond, Bennett *et al.*, 2015), despite earlier evidence supporting the differential discriminative validity of both factors (McEvoy & Mahoney, 2011). Interestingly, Oglesby *et al.* (2017) recently found evidence that Prospective and Inhibitory IU are distinguishable at moderate but not high or low overall levels of IU. Our findings that people in the Prospective IU and in the Inhibitory IU classes had overall IU scores that were *higher* than scores of people in the Low IU Class but *lower* than people in the High IU Class accords with these prior findings and, more broadly, indicate that Prospective IU and Inhibitory IU are distinguishable and meaningful constructs.

The outcomes of our LCA provide some potentially meaningful information about the performance of different IUS-12 items as indicators of IU. For instance, the probability that participants endorsed IU item 2 (“It frustrates me not having all the information I need”) was high (> 0.50) in all classes, suggesting that this is a relatively poor indicator of IU. Notable too was that Prospective IU items 4 and 6 had lower item probabilities compared to Prospective IU items 1–3 and 5, indicating that the latter items are better indicators of Prospective IU than the former ones. Notable too, in the Inhibitory IU Class, Inhibitory IU items 1–3 had higher probabilities to be endorsed than Inhibitory IU items 4 and 5, suggesting that the former items were better indicators of Inhibitory IU. It may be relevant for future studies to further explore the psychometric performance of individual IU indicators, in order to optimize tools tapping the construct.

The second aim of our study was to examine relations between the derived latent classes and indices of cognitive vulnerabilities and symptoms of depression and anxiety. We found significant and meaningful differences between the High IU Class and the Low IU Class in terms of all cognitive vulnerabilities we examined; specifically, participants evidencing high IU reported stronger tendencies to engage in worry and rumination, and weaker tendencies toward experiential acceptance and mindfulness. These results are consistent with prior findings that elevated IU is associated with cognitive vulnerabilities, including rumination and worry (cf. Boswell, Thompson-Hollands, Farchione & Barlow, 2013; Hong & Cheung, 2015; Hong & Lee, 2015). Our findings add to prior work by showing that increased IU is also associated with lower tendencies towards applying adaptive regulatory strategies such as mindfulness and experiential acceptance.

More in-depth examination of the differences in cognitive vulnerabilities between groups revealed several interesting things. For instance, worry scores were significantly different between all four groups (such that: Low IU < Prospective IU < Inhibitory

IU < High IU). This indicates that, apart from High IU coinciding with stronger worry than Low IU, people with elevated Prospective IU or elevated Inhibitory IU already have a greater chance to engage in worry than people with low IU. Notable too was that for all cognitive vulnerabilities we examined, participants in the Inhibitory IU Class had significantly worse scores than participants in the Prospective IU Class. This finding accords with prior research evidence that Inhibitory IU is the more debilitating component of IU (e.g., Hong & Lee, 2015). However, outcomes of pairwise comparisons were somewhat ambiguous given that scores for rumination and experiential acceptance did not differ between the Inhibitory IU and High IU classes, whereas mindfulness scores did not differ between the Low IU and Prospective IU classes and between the Inhibitory IU and High IU classes. This suggests that in the associations with some variables, Prospective IU converges with low IU and Inhibitory IU with high IU.

In the comparison of depression and anxiety scores between classes, we found that, compared to participants in the Low IU Class, participants in the High IU Class evidenced significantly more severe depression, general anxiety, obsessive compulsiveness, social anxiety, and separation anxiety. These findings corroborate prior evidence that IU is a transdiagnostic risk factor for various mood and anxiety symptoms (Carleton *et al.*, 2012). To the extent that participants in the Prospective IU and Inhibitory IU classes differed, participants in the latter class evidenced stronger emotional distress. Specifically, we found that, compared to people in the Prospective IU class, people in the Inhibitory IU Class reported significantly higher levels of general anxiety, and—consistent with prior research (McEvoy & Mahoney, 2011)—more severe depression and social anxiety. The Prospective IU and Inhibitory IU classes did not differ in terms of obsessive compulsiveness and separation anxiety. That obsessive compulsiveness was equal between these classes is at odds with findings of Prospective IU being critical to obsessive-compulsive disorder (McEvoy & Mahoney, 2011). Altogether, it is relevant for future studies to further explore the differential association of Prospective IU and Inhibitory IU with different anxiety and depressive symptoms and syndromes, preferable across clinical and non-clinical samples. Although our findings reflect prior evidence that Inhibitory IU is the more toxic component of IU (Hong & Lee, 2015) there is some inconsistency between our and prior findings (e.g., concerning obsessive compulsiveness) and more work is needed to explore how differential findings can be reconciled.

Several other limitations should be taken into account when considering the current study. First, this study relied on a relatively homogenous group of students, which were mostly young, woman, highly educated, and experiencing low to moderate emotional distress. Caution should therefore be applied in generalizing the current findings to other, including clinical, samples. Future research could attempt to replicate and extend the current findings to these and other samples. Second, our reliance on self-report measures did not allow us to examine differences in rates of clinical diagnoses of depressive and anxiety disorders between classes. It would be informative for future studies in this area to include interview-based assessments. Third, because we only used cross-sectional data, the degree to which IU classes are

stable over time and the degree to which inclusion in particular IU classes are associated with the onset or maintenance of psychological symptoms are issues that still need to be studied in future longitudinal research.

Notwithstanding these considerations, being the first to use LCA to study IU, the current study provides valuable information about IU. We found that subgroups were distinguishable with relatively low, moderate, and high levels of IU—with people with moderate levels of IU being distinguishable into one group with elevated probabilities to endorse Prospective (relative to Inhibitory IU) items and another group with elevated probabilities to endorse Inhibitory (relative to Prospective IU) indicators. We also found that, compared with people with Low IU, people with High IU tended to engage in maladaptive cognitive strategies more often and to experience more severe depression and anxiety-related symptoms. Importantly, our findings add to the ever-growing body of evidence showing that IU is critical in predicting psychopathology (Carleton, Mulvogue *et al.*, 2012; McEvoy & Mahoney, 2011), mediates symptom change in anxiety treatment (McEvoy & Mahoney, 2013), accounts for substantial variance in other cognitive vulnerabilities (Hong & Cheung, 2015), and, as a manifestation of fear of the unknown, may reflect a fundamental fear (Carleton, 2016b). In addition, we found that Inhibitory IU seems to be a stronger risk factor for poor outcomes, relative to Prospective IU. Although this finding accord with some prior evidence (Hong & Lee, 2015) it should be further explored in future research, taken into account inconclusive findings about the discriminant validity of these IU factors (cf. Hale *et al.*, 2015). If future studies confirm that subgroups can be distinguished with different IU profiles this could point at the usefulness of using transdiagnostic interventions to target IU. The unified protocol for the transdiagnostic treatment of emotional disorders (Barlow, Ellard, Fairholme *et al.*, 2011) has been advised as a treatment for IU (Boswell *et al.*, 2013). Interventions to target IU may include psychoeducation about the inevitability of uncertainties and unknowns, cognitive restructuring targeting probability assessment, and practicing mindfulness skills to enhance tolerance of negative feelings associated with uncertainties and unknowns. Future research may explore the usefulness of identifying subgroups with elevated IU, and the effects of mitigating IU using this or other transdiagnostic treatment to treat or prevent psychopathology.

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APPENDIX 1

Table A1. Confidence intervals for the parameter estimates for the dependent variables regressed on class-membership

| Dependent variable                 | Low vs. Prosp. IU |              | Low vs. Inhib. IU |               | Low vs. High IU |               | Prosp. vs. Inhib. IU |              | Prosp. vs. High IU |               | Inhib. vs. High IU |             |
|------------------------------------|-------------------|--------------|-------------------|---------------|-----------------|---------------|----------------------|--------------|--------------------|---------------|--------------------|-------------|
|                                    | B                 | 95% CI       | B                 | 95% CI        | B               | 95% CI        | B                    | 95% CI       | B                  | 95% CI        | B                  | 95% CI      |
| <b>IU mean scores</b>              |                   |              |                   |               |                 |               |                      |              |                    |               |                    |             |
| Prospective IU (N = 519)           | 8.43              | 7.61, 9.25   | 4.57              | 3.63, 5.51    | 13.48           | 12.60, 14.36  | -3.86                | -4.88, -2.84 | 5.05               | 4.01, 6.09    | 8.91               | 7.71, 10.11 |
| Inhibitory IU (N = 519)            | 0.72              | 0.09, 1.35   | 6.90              | 6.06, 7.74    | 7.36            | 6.65, 8.07    | 6.18                 | 5.30, 7.06   | 6.64               | 5.80, 7.48    | 0.47               | -0.47, 1.41 |
| Total IU (N = 519)                 | 9.15              | 8.01, 10.29  | 11.46             | 10.07, 12.85  | 20.85           | 19.56, 22.14  | 2.32                 | 0.95, 3.69   | 11.70              | 10.17, 13.23  | 9.39               | 7.72, 11.06 |
| <b>Cognitive vulnerabilities</b>   |                   |              |                   |               |                 |               |                      |              |                    |               |                    |             |
| Worry (N = 519)                    | 4.35              | 2.64, 6.06   | 8.90              | 6.86, 10.94   | 12.13           | 10.62, 13.64  | 4.55                 | 2.33, 6.76   | 7.78               | 5.96, 9.60    | 3.24               | 1.12, 5.36  |
| Rumination (N = 518)               | 0.90              | 0.19, 1.61   | 2.90              | 2.02, 3.78    | 3.47            | 2.63, 4.31    | 2.00                 | 1.00, 3.00   | 2.57               | 1.59, 3.55    | 0.57               | -0.53, 1.67 |
| Experiential acceptance (N = 518)  | -1.81             | -3.14, -0.48 | -7.71             | -9.51, -5.91  | -8.62           | -9.99, -7.25  | -5.90                | -7.88, -3.92 | -6.81              | -8.46, -5.16  | -0.91              | -2.91, 1.09 |
| Mindfulness (N = 518)              | -1.86             | -4.64, 0.92  | -6.24             | -10.14, -2.34 | -8.65           | -11.63, -5.67 | -4.37                | -8.41, -0.33 | -6.78              | -10.11, -3.45 | -2.41              | -6.68, 1.86 |
| <b>Psychological symptoms</b>      |                   |              |                   |               |                 |               |                      |              |                    |               |                    |             |
| Depressive symptoms (N = 518)      | 0.81              | -0.66, 2.28  | 7.26              | 5.08, 9.43    | 8.21            | 6.25, 10.17   | 6.46                 | 4.15, 8.77   | 7.41               | 5.16, 9.66    | 0.95               | -1.77, 3.67 |
| General anxiety (n = 515)          | 0.59              | -1.06, 2.24  | 4.21              | 2.03, 6.38    | 8.20            | 5.91, 10.49   | 3.62                 | 1.27, 5.97   | 7.61               | 4.98, 10.24   | 3.99               | 1.03, 6.95  |
| Obsessive compulsiveness (n = 518) | 1.72              | 0.19, 3.25   | 3.67              | 1.57, 5.77    | 9.30            | 7.01, 11.59   | 1.95                 | -0.22, 4.12  | 7.58               | 5.05, 10.11   | 5.63               | 2.71, 8.55  |
| Social anxiety (n = 517)           | 1.43              | -0.24, 3.10  | 11.89             | 8.64, 15.14   | 14.49           | 11.73, 17.25  | 10.46                | 6.97, 13.95  | 13.06              | 9.85, 16.27   | 2.60               | -1.54, 6.74 |
| Separation anxiety (n = 517)       | 3.27              | 0.98, 5.56   | 5.94              | 3.04, 8.84    | 11.60           | 8.64, 14.56   | 2.67                 | -0.68, 6.02  | 8.33               | 4.78, 11.88   | 5.66               | 1.80, 9.52  |

Note: IU = intolerance of uncertainty; CI = confidence interval.