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RESEARCH PAPER

Development and Validation of Cognitive Errors Scale (CES)

[1]Nazia Noureen, [2]Dr. Samina Rashid* and [3] Rizwana Samreen

1. MS Scholar, Department of Psychology, University of Wah, Punjab, Pakistan
2. Assistant Professor, Department of Psychology, University of Wah Punjab, Pakistan
3. MS Scholar, Department of Psychology, University of Wah, Punjab, Pakistan

***Corresponding Author:** samina.rashid@uow.edu.pk

ABSTRACT

This study aimed to develop the cognitive error scale and assesses the psychometric properties of the newly developed scale. Cognitive errors are disturbed thoughts that negatively affect the individual's emotions and cause them to view reality inaccurately. The items were generated based on the interviews that were taken from the participants (N=45). The scale was administered on the sample (N=350) males and females (17-50 years) from Wah Cantt, Attock, and Rawalpindi, Pakistan using simple random sampling technique. Principle Component factor analysis was carried out for scale development. Items with factor loadings >.30 on the initial factors for the cognitive error scale were selected for the final version of the scale. To make sure the data were suitable, several tests were run before the factor analysis. Five factors were extracted based on promax rotation. The scale was finalized with 15 items comprising 5 factors. The study helps in determining other cognitive errors that were also defined by Beck and it needs to be confirmed by Confirmatory Factor analysis.

KEYWORDS Cognitive Error Scale, Exploratory Factor Analysis, Scale Development

Introduction

Beck's cognitive theory is one of the most influential contributions to psychotherapy (Beck et al., 2008). The cognitive theory places emphasis on the dependence of emotional and behavioral reactions of individuals on certain underlying cognitive structures such as beliefs and thought systems (Akkoyunlu & Turkcapar, 2013). Because one's emotional reactions to events are influenced by information processing mechanisms, maladaptive emotional and behavioral consequences of negatively biased cognitive processes can be anticipated (Dozois & Beck, 2008).

The good intentions and hard work of an honest investigator can be compromised by cognitive biases (MacLean et al., 2020). Bias is not random error, it is the systematic deviation from evidence-based objective judgment (Kahneman et al., 2021). Dror (2020) provides a taxonomy of eight sources of bias. It shows how sources of bias range from architecture and constraints of the human brain to contextual factors that are event specific and environmental. Inaccurate base-rates are the fourth source of bias presented in the sources of bias hierarchy. Base-rate knowledge is an understanding and expected probability of the event, that is, the rate of occurrence of some feature in a population. When drawing conclusions, a clear understanding of base-rates can be beneficial and instructive, but it may also distort perception by making individuals assume something is probable to have happened than is actually the case given their current situation (Wickens et al., 2009). Cognition is connected to abstract conceptions like mind and intellect in psychology. It is made up of mental processes and skills including learning, problem solving, memory, attention, and language reasoning (Sternberg & Sternberg, 2009). "Cognitive errors" result from faulty or inefficient information processing. (Beck, 1967). A person's thought patterns have an essential impact on their personality.

Cognitive theories of emotional disorders argue that an individual's emotional reactions to events are a function of how they receive information (Dozois & Beck, 2008). Furthermore, the emotional and behavioral consequences that follow when people receive information in a way that is negatively biased can be very maladaptive. According to the cognitive theory of depression, for instance, people are more likely to feel sadness in reaction to stressful experiences and may even continue to experience unpleasant emotions over time if they are able to process negative information properly. The several types of cognition that can have significant effects on an individual's emotions are frequently differentiated by cognitive theorists and clinicians. Biases in thought content, memory, and attention, for example, have been demonstrated to predict depression and are significantly linked to a range of unpleasant emotional states (Dozois & Beck, 2008). First, there are basic principles, which are thought to be established opinions on important aspects of life. For example, might be a fundamental belief about oneself.

Literature Review

According to Korteling and Toet (2022), cognitive biases are systematic, universal tendencies, inclinations, or dispositions in human decision-making that may leave it open to incorrect inadequate, or inaccurate outcomes. In the context of depression, researchers identified seven distortions commonly observed among individuals with depression, such as overgeneralization and selective abstraction (Beck et al., 1979). Burns (1980) further expanded this list by identifying ten thinking errors frequently seen in people experiencing depression. Assessment of errors across time has been done in a number of ways.

Lefebvre (1981), however, integrated some of the errors after recognizing that some of them considerably overlapped, creating the Cognitive Errors Questionnaire. (CEQ). The CEQ evaluates how many individuals tend to make four types of errors: catastrophizing, overgeneralization, personalization and selective abstraction. Similar to the CBQ the CEQ presents people, with scenarios followed by a " cognition". Asks them to rate how closely that cognition resembles their own thoughts in that situation. Cognitive errors are also linked to differentiation and dependence.

Individuals who exhibit levels of differentiation, in stressful scenarios tend to experience lower levels of stress and exhibit faster recovery compared to those with less differentiation (Gharibi et al., 2017). Aaron Beck argues that depression is a form of disorder and implementing a philosophy program for children and teenagers can enhance their thinking and reasoning abilities in the setting. Additionally, it can play a role, in addressing errors and facilitating their modification (Qin et al., 2020). The cognitive errors questionnaire typically measures specific conceptual content, as opposed to actual errors resulting in spontaneous thinking.

There were a few published research papers that have addressed the crucial necessity of studying thinking errors that contribute to negative emotional states. The possibility that some cognitive errors are more likely than others to cause negative emotional reactions is one of the main arguments for assessing particular cognitive errors. Cognitive-behavioral therapy and training for cognitive errors affect people’s beliefs and explanations for events, and cognitive errors also come from the way individuals think and reason. Studies indicate that cognitive-behavioral therapy, focused on thought patterns, emotions, and actions, can impact peoples' happiness and mental well-being (Kube et al., 2017). It would be beneficial for both researchers and practitioners to understand whether certain thought mistakes are more unhelpful than others. Furthermore, an individualized evaluation of a client's cognitive errors may help clinicians comprehend the full story (Kuyken et al., 2009) and develop the best treatment plan. This scale aims to understand patterns of thinking that can impact one's wellbeing. It examines common cognitive tendencies like generalizing from little information or focusing only on negative details. The goal is to evaluate these impartially for each person and situation.

This study wanted to measure whether participants perceived their reality inaccurately due to negative emotions. The overall aim was to develop and testing a Cognitive Error Scale. Cognitive errors play a key role in theories of emotional health challenges, no single tool had comprehensively addressed the five error types discussed by Beck. This study sought to fill this measurement gap.

Material and Methods

Generation of Item Pool

Item pool generation was based on the Inductive method. In which the target population's opinions are used to gain qualitative information on a construct for item development. e.g., interviews (Kapuscinski & Masters, 2010). Following steps were involved in this process:

Step 1: Interviews

In-depth interviews were conducted from the diverse group of participants (N=45) males and females from University of Wah, Wah Cantt and their ages ranged from 20-30 years. They were all studying at bachelor's level. This sample was chosen through a simple random sampling technique. Participants were given instructions to recall those situations when they faced cognitive errors. Then they were given various examples to explain how they recognized these errors, and the consequences of these errors on their thoughts and behaviors. For example, "Can you describe a situation where you made a decision or judgment, but later realized it was incorrect" and "Can you recall a time when you jumped to conclusions about a situation or person? What information or assumptions influenced your decision?". Data was gathered by using probing questions to explore the nuances of different cognitive errors.

Step 2: Item pool Generation

21 items were generated in the light of information obtained from the participants in the interviews. By using the information that were gain from the participants in the interviews, the list of the cognitive errors refined and expanded to ensure that the scale items were relevant and comprehensive. Statements were simple and short as possible, and language was easily understandable by the general population. Items were addressing the single issue, "double-barreled" statements were avoided.

Item Evaluation by Experts and Establishment of Face Validity

For the purpose of item evaluation, 2 professional clinical psychologists including 2 M. Phil Clinical Psychologists and 2 PhD from Institute of University of Wah were given the initial item statements for rating. Content Validity was measured by using ICV-I formula (Polit & Beck, 2006) in which experts panel evaluated the items of the scale and rated them on their relevance and representativeness to the cognitive errors. On the basis of their ratings few items were rephrased as per their suggestions and rated by them. Items with more than 0.78 values were retained in the scale while those items with 0.76 or less values were eliminated from the scale. 15 items were selected out of 21 items based on the 6 expert's evaluation. 5 point Likert scale was constructed ranging from 1 to 5 (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree).

Factor Analysis for final item selection

Sample

350 adults (161 males & 189 females) with age range of 17-50 from population from Rawalpindi, Wah Cantt and Attock, Pakistan through simple random sampling technique. Participants were included in this study if they completed their intermediate education. Also, participants were required to have a self-reported ability to read and understand English. Participants were excluded if they had been formally diagnosed with a reading or any other disability. Cognitive error scale was provided to the participants. A cover letter briefly explained the purpose of the survey and was attached with the scale which indicated that information should be confidential and will only be used for academic purpose. It was also briefed that they have the right to quit if they felt uneasy to give their information at any time. Along with consent form they were asked to fill in the demographic foam which included their age, gender, qualification, birth order, job status and Family status. After completing the demographic form, they were asked to rate every item on a 15 item scales with reference to its applicability on them. Data was collected, later they were thanked for their time and their cooperation.

Results and Discussion

Principle component factor analysis was carried out and psychometric characteristics of the scale were calculated using alpha reliability coefficients.

Exploratory Factor Analysis

A factor examination was led to decide the component structure and to test the dimensionality of the initial structure of the Cognitive Error Scale. Bartlett's test of sphericity and Kaiser-Meyer-Olkin measure was computed for verification of data suitability for factor examination. As indicated by these outcomes the Kaiser-Meyer-Olkin esteem was 0.82 for the Cognitive Error Scale and Bartlett's test of sphericity had a value of 615.19. Since these values were huge, the information was viewed as appropriate for component examination. Kaiser prescribes that a Kaiser-Meyer-Olkin value near 1 demonstrates that examples of connections are relatively concentrated, along these lines factor examination ought to create clear and dependable component comes about. Along these lines, exploratory factor examination was directed on the 15 items of the cognitive error scale.

The factor structure was examined using principal component analysis (PCA) which explains it. This statistical technique helps the researchers identify coherent subsets of the variables within single set, which showed which variables are relatively independent of each other (Tabachnick & Fidell, 2001). In this analysis, factor loadings above .6 are usually classified as high, and moderately high if they are above .3 (Kline, 2000). Hence, only variables that had factor loadings greater than .3 were included in this study. The results showed that items in the scale had high-quality metric on multiple factors. However, while striving to create simple structures that could be described by factor analysis, it becomes mandatory to isolate items with high loadings on one factor only (Tabachnick & Fidell, 2001). Thus, items which had high loadings on more than one factor were not included in the scale. Accordingly, when choosing these items, differences between loading values of the items in all factors and other factors were confined to only .20 at most.

Table 1

Factor Analysis and loadings for the Cognitive Error Scale

		Factor loadings				
		Factor 1	**Factor 2**	**Factor 3**	**Factor 4**	**Factor 5**
Sr. no	**Item no**	**Overgener-alization**	**Catastro-phizing**	**Mental filtering**	**Emotional reasoning**	**All-or-nothing**
1	7	**.42**	.07	.21	.01	.09
2	2	**.53**	.08	-.00	.04	.10
3	5	**.53**	.04	.32	-.04	-.15

4	6	**.61**	-.02	.09	.17	-.05
5	3	**.77**	-.20	-.17	-.14	.27
6	15	.00	**.58**	.04	.23	-.04
7	4	.26	**.62**	-.06	-.10	-.20
8	13	-.21	**.81**	.02	-.05	.19
9	12	-.00	-.19	**.60**	.38	-.05
10	9	.15	.11	**.61**	-.20	-.05
11	14	.07	.03	**.65**	-.11	.46
12	8	.18	.19	.04	**.42**	.05
13	10	-.02	-.02	-.09	**.85**	.08
14	11	.16	.17	-.18	.22	**.47**
15	1	.09	-.05	.13	.03	**.76**

Note: Factor loading >.30 have been reported in each factor.

Table 1 showed the dimensions of the factors; the content of the items with a factor loading greater than .30 have been examined in detail. It is revealed that those items which are having >.30 factor loading on each of these factors are showing a consistent pattern in their content and could be interpreted in terms of different dimensions of cognitive errors. For example, the items which have >.30 loadings on first factor are related to Overgeneralization thinking. The items on second factor are related to the Catastrophizing thinking. The items which loaded high on third are reflecting the Mental filtering. The items highly loaded on fourth factor are related to the Emotional reasoning while items highly loaded on fifth factor are related to the All or nothing thinking.

Based on the content of these highly loaded items, these five factors have been, therefore labelled as "Overgeneralization", "Catastrophizing", "Mental filtering", "Emotional reasoning" and "All or nothing". It may be noted that only those 15 items having >.30 factor loadings on the five factors have been selected to form the Cognitive Error Scale. These 15 items related to five dimensions may constitute the 5 subscales of the cognitive error scale, consisting of 5 items in first subscale (Overgeneralization), 3 items in second subscale (Catastrophizing), 3 items in third subscale (Mental filtering), 2 items in the fourth subscale (Emotional reasoning) and 2 items in the fifth subscale (All or nothing).

Scree Plot. Simple line segment plot shows the percentage of the total variance in the data that can be attributed to each component.

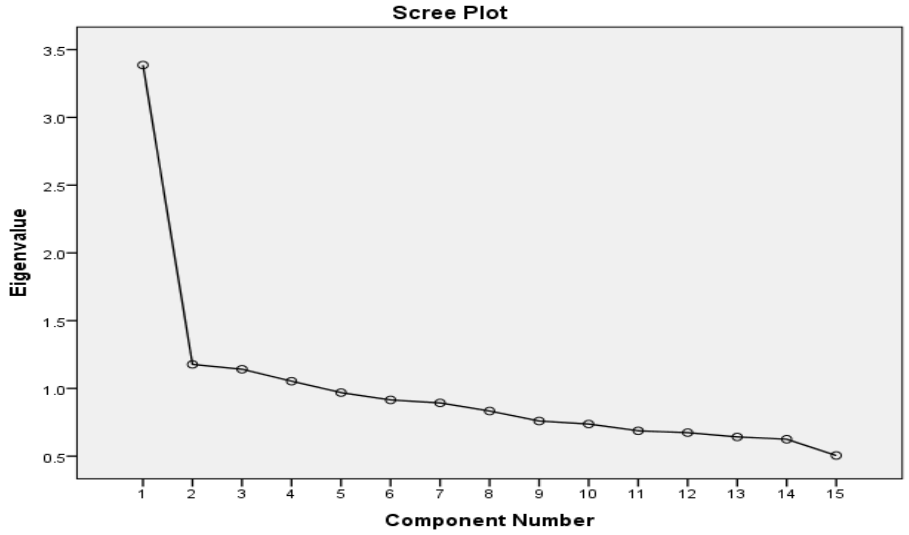

Figure 1: Scree plot Showing extraction of Factors of Cognitive error scale.

On a scree plot, or a simple line segment plot, the percentage of the total variance in the data that is explained or defined by each component is indicated. Figure 1 illustrates the scree plot for the Factor Matrix of 15 items using Principal Component Analysis and the Promax Rotation Method. The Principal Component shows the percentage of total variance that each component contributes to on the X-axis in decreasing order. On the Y-axis is the percentage of the total variance that can be explained. A graph makes it clear that the five factors make a significant contribution to the variance.

Psychometric Properties of the Newly Developed Scale

Table 2
Reliability Analysis of the Cognitive Error Scale

Cronbach Alpha	*N*	*M*	*SD*
.75	15	49.74	6.72

Table 2 showed that the Cronbach Alpha value of the Cognitive error scale was .75 and it fall in acceptable range ($p<.05$). Mean (*M*=49.74) and standard deviation (*SD*=6.72) were computed to determine the general average scores of participants on cognitive error scale used in this study.

Table 3
Item-total correlation of Cognitive Error Scale

No. of items	Correlated Item-total correlation (r)
1	.35
2	.45
3	.34
4	.40
5	.49
6	.52
7	.49
8	.47
9	.37
10	.35
11	.37
12	.35
13	.37
14	.38
15	.45

Note. (values >.03)

Table showing the item-total correlation of item pool (15-items) of Cognitive error scale. Items with higher than 0.3 values were retained, and these values showed that the 15 items were appropriate for scale development.

Table 4
Inter-item correlation of 15 items of Cognitive Error Scale

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-	.20**	.15**	.04	.07	.16**	.12*	.13**	.09	.15**	.21**	.11*	.12**	.24**	.10*
2		-	.20**	.18**	.21**	.32**	.22**	.22**	.12*	.11*	.10	.16**	.18**	.11*	.19**
3			-	.09	.21**	.20**	.24**	.13*	.08	.08	.14**	.06	.06	.09	.09
4				-	.22**	.26**	.20**	.17**	.17**	.09	.14**	.08	.24**	.06	.23**
5					-	.33**	.31**	.23**	.22**	.10	.09	.18**	.13**	.21**	.21**
6						-	.17**	.26**	.26**	.18**	.21**	.16**	.06	.15**	.23**
7							-	.21**	.18**	.15**	.18**	.20**	.15**	.20**	.21**
8								-	.13*	.23**	.19**	.14**	.19**	.18**	.24**
9									-	.03	.09	.18**	.11**	.19**	.15**
10										-	.19**	.17**	.12**	.09	.21**

11	-	.07	.16**	.12**	.13**
12		-	.10	.17**	.11*
13			-	.14**	.28**
14				-	.15**
15					-

Note. *p<.05, **p<.01

Table 4 showed that there was a significant but weak relationship between the items of the cognitive error scale which indicated that inter-item correlation of Cognitive error scale is high.

Discussion

When mental shortcuts that allow for problem solving and judgments are misused, it can lead to a systematic mistake in reasoning known as cognitive errors (Itri et al., 2018). Cognitive errors are the patterns of inaccurate or negative thinking that characterize emotional difficulties. Some cognitive errors like Mental filtering, Overgeneralization, Emotional reasoning, Catastrophizing, All or nothing described by Beck. Cognitive errors were measured in many different ways like experimental studies based on the Vigilance tasks, Digit Span task, Iowa Gambling task, Card sorting task (Piper et al., 2015). Prior tests evaluated cognitive bias by using Cognitive bias questionnaire and Cognitive error questionnaire. The Cognitive Error Scale (CES) enable researchers to measure individual's cognitive errors related to Overgeneralization, Mental filtering, Emotional reasoning, Catastrophizing, and All or nothing thinking, no existing scale was available to find these general cognitive errors.

The present study aimed to develop the scale and investigated the psychometric characteristics of the Cognitive Error scale (CES). The factor analysis showed that the scale could be defined by the five-factor structure. The first factor, labeled Overgeneralization, comprised 6 items, Catastrophizing comprised 3 items, Mental filtering comprised 2 and All or nothing have 2 items (values >.30). Principle Component Analysis and the Promax Rotation Method were used to create a scree plot for the Factor Matrix consisting of 15 items. The Principal Component showed the decreasing order on the X-axis, the amount of total variance that each component contributes to. The percentage of the total variance that can be explained is plotted on the Y-axis.

Cronbach Alpha Reliability of the Cognitive Error Scale was .75, that was falling within an acceptable range (p<.05). Based on the cognitive error scale that was used in this study, the participants' general average scores were calculated using the mean (M=49.74) and standard deviation (SD=6.72). The item-total correlation of 15-item pool of the Cognitive Error Scale. The 15 items were considered suitable for scale development based on the retention of items with values greater than 0.3.

When examining the 15 items, it's observed that they exhibit high loadings with their respective factors but low loadings with the other factors after Rotation. These findings imply that each of these factors is quite distinct from the other, indicating that they might be measuring different facets of the construct. The variances explained by five factors of the scale were 22.56 % for first factor, 7.84 % for second, 7.61% for third, 7.02 % for fourth and 6.46 % for fifth factor. There was a significant correlation between the items of the scale. There was a significant but weak relationship between the items of the cognitive error scale which indicated that inter-item correlation of Cognitive error scale is high. The scale's items showed a strong association with one another. The inter-item correlation was found to be significant but weak association between its items. The Cognitive Error Scale will be widely used in fields related to psychology, psychiatry, and behavioral sciences. It will help to assess and identify patterns of thinking errors in individuals. This scale will be used in

clinical settings, counseling, therapy, and mental health research to address and understand the issues related to distorted thinking patterns.

Conclusion

The purpose of the present study was to develop and evaluate cognitive errors. Despite the presence of other measures of biased cognition, Cognitive error scale measured the disturbed or distorted thoughts about specific events or about any person that will affect the individuals negatively. Cognitive Error Scale will provide insight into the negative thoughts that will help them to encounter their problems and then they will be able to make a solution about them.

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