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PSYCHOMETRIC CHARACTERISTICS OF THE TEST OF EMOTION COMPREHENSION (TEC) IN PRESCHOOL AND PRIMARY SCHOOL AGED CHILDREN IN HUNGARY

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Abstract
Research on emotional comprehension in children highlights the importance of reliable assessment tools across cultural contexts. However, the relevant studies show the need for localized adaptations to account for cultural differences. This study aimed to adapt the Test of Emotion Comprehension (TEC) for Hungarian children. Age-related patterns, gender differences, and cross-cultural consistency were explored by comparing Hungarian children's responses to children from the UK, Portugal, and Italy. We hypothesized that older children would demonstrate higher emotional comprehension, with no significant gender differences, aligning with prior TEC research. Additionally, we expected Hungarian children's responses to broadly align with those of other cultural samples while displaying some unique variations. A cross-sectional design was used with 416 children aged 3 to 10 years, comprising 264 preschoolers, and 152 children from grades 1-3. Results confirmed developmental progression; however, cultural differences emerged in the order of emotional components. No significant gender differences were found. These findings highlight the TEC's utility for assessing emotional comprehension in educational settings. Nevertheless, limitations include the need for external validation and the omission of "disgust" as an assessed emotion. The study emphasizes the importance of culturally adapting assessment tools and provides insights for improving the TEC's cross-cultural applicability.

Keywords: Test of Emotion Comprehension (TEC); emotional development; cross-cultural comparison; preschool and primary school aged children

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Introduction

Social-emotional skills are essential for children's well-being, contributing to empathy, relationship-building, and emotional regulation (CASEL, 2020). These skills also play a critical role in children's academic success and social competence (Denham, 2019; Raver, 2002). Understanding emotions is a fundamental aspect of emotional education (Bisquerra Alzina & Pérez Escoda, 2012; Casassus, 2017), and a key factor in children's cognitive and social development, contributing to a supportive school environment (Jones & Kahn, 2017).

Emotions provide valuable information that helps predict an individual's internal state based on perceptual indicators, such as facial expression, posture, tone of voice, and the context in which a specific event occurs. This knowledge is essential for emotional and social regulation, for communicating our emotional states to others, and understanding why people feel the way they do (Fernández-Angulo et al., 2016). Additionally, helps predict how various scenarios may influence our own feelings and the feelings of others (Van Kleef, 2010).

Emotion understanding refers to the ability to reflect on and conceptualize emotional cues, enabling individuals to recognize, interpret, and regulate their own emotions while responding appropriately to others (Pons et al., 2003; Pons & Harris, 2019; Denham, 1986).

In early childhood, emotion understanding is linked to enhanced adaptability in preschool (Shields et al., 2001), improved moral reasoning (Lane et al., 2010), and later academic success (Raver, 2002). Recent studies show an interaction between emotion understanding and social competence in predicting academic success (*e.g.*, Denham et al., 2012; Voltmer & von Salisch, 2017), peer acceptance (Sette et al., 2017), and sympathy (Eggum et al., 2011).

Furthermore, difficulties in emotion understanding can predict emotional and behavioral challenges, such as anxiety and depression (Dodge et al., 2003; Lansford et al., 2014).

These difficulties may persist into adulthood, affecting interpersonal relationships and career success (Sandler et al., 2011). Thus, early development of emotion understanding is closely linked to various aspects of healthy development. Within developmental psychology, the literature also explores children's Theory of Mind (ToM) studies (Astington et al., 1988; Harris et al., 1989; Wellman, 1992). Recent findings indicate that ToM has distinct cognitive and affective subcomponents (Shamay-Tsoory & Aharon-Peretz, 2007). Cognitive ToM involves the ability to attribute thoughts, beliefs, and intentions to others, which is essential for interpreting their behavior and predicting their actions (*e.g.*, Szabo & Brakas, 2020). Affective ToM involves recognizing emotions and understanding their implications, aligning with the broader construct of emotional understanding (Bender et al., 2011; Ziv et al., 2013). Emotional understanding develops alongside cognitive and affective ToM during early childhood (Baron-Cohen et al., 1985; Pons et al., 2004). As children's ToM matures, so does their capacity to understand

complex emotional states (Pons et al., 2004), further emphasizing the need for effective tools to assess this ability. Despite the growing recognition of emotion understanding, there remain limited age-appropriate, culturally sensitive assessment tools for measuring emotional comprehension in children. The *Test of Emotion Comprehension* (TEC) has proven effective in various cultural contexts but has not yet been adapted for Hungarian children. This study aims to address this gap by adapting the TEC for Hungarian children aged 3 to 10 years, providing insights into developmental patterns and identifying components that may require further refinement.

The developmental model of emotion understanding

Over the past 40 years, extensive studies have been conducted on emotion understanding (*e.g.*, Bretherton et al., 1986; Denham, 1998; Harris, 2008; Kestenbaum & Gelman, 1995; Lagattuta & Wellman, 2001; Lagattuta et al., 1997; Pons et al., 2003). A significant advance in this area is the empirically derived theoretical model developed by Pons and Harris (2019), which describes three clearly identifiable stages of the development of emotion understanding spanning from early childhood to preadolescence. Later in this paper, we will compare Pons and Harris's (2019) original theoretical model with the hierarchical patterns identified in the Italian (Albanese et al., 2006) and Portuguese samples (Rocha et al., 2017), as well as with our own findings.

Pons and Harris's theoretical model (2019) outlines a hierarchical relationship among these stages, where earlier stages are necessary, but do not fully determine the acquisition of later stages. In the first external stage (ages 1-2 to 4-5 years), children begin to name and identify basic emotional expressions. They also begin to recognize that external situational factors can cause emotional reactions and learn to link cause and effect between events, desires, and emotions. For example, losing a pet may lead to sadness, while receiving a gift can evoke joy. They also grasp, that imaginary scenarios, such as being chased by a dragon, can trigger fear. The second developmental stage (ages 4-5 to 7-8) involves children developing a more nuanced understanding of how mental states affect emotions. They learn to differentiate between the external expression of emotions and their internal experience. Around age 5, children comprehend the impact of reminders on emotions; for instance, viewing a picture of a loved one can evoke joy. Additionally, they realize that emotions can be simulated or concealed - for example, someone might cry without genuine sadness or smile despite feeling unhappy. Around age 5, most children understand that people's expectations can be either true or false.

During the third reflective stage (ages 7-8 to 10-11), children delve deeper into the complexity of individual emotions. They learn strategies to regulate their emotional experiences. For instance, thinking about pleasant things can alleviate sadness, and discussing emotional episodes can mitigate their impact. At this stage, children recognize that they can experience different or even contradictory emotions simultaneously. Around age 8, they understand that guilt arises from

morally questionable actions (*e.g.*, stealing or lying), while feelings of pride result from morally commendable actions (*e.g.*, resisting temptation).

In summary, Pons and Harris's developmental model (2019) outlines how children's emotional understanding evolves from recognizing basic emotions to understanding complex emotional states. It underscores the significance of emotional development in improving social interactions and emotional regulation, demonstrating how the growing complexity of emotional understanding is influenced by cognitive and social experiences.

The *Test of Emotion Comprehension* (TEC) has proven effective in various cultural contexts but has yet to be adapted for Hungarian children. This study aims to address this gap by adapting the TEC for Hungarian children aged 3 to 10 years, providing insights into developmental patterns and identifying components that may require further refinement to enhance its cultural applicability.

Objective

The primary goal of this study is to adapt the Test of Emotion Comprehension (TEC) for Hungarian children aged 3 to 10 years. This adaptation aims to enhance the accuracy of measuring emotion understanding in this population while identifying developmental patterns or areas that may require further refinement in the tool. A second objective is to compare Hungarian children's scores with international samples. We hypothesize that Hungarian children will show similar patterns to the original UK sample but may exhibit some cultural differences in their understanding of complex emotions. By comparing Hungarian data with findings from the UK, Italy (Albanese et al., 2006), and Portugal (Rocha et al., 2017), we aim to establish normative Hungarian scores and examine potential cultural variations in emotion comprehension. The study also seeks to explore the relationship between age and emotion comprehension. We hypothesize that emotional understanding improves with age, with older children demonstrating a more advanced grasp of emotions, particularly secondary emotions. Specifically, we expect older children to achieve higher TEC scores and display more nuanced emotional insights.

Additionally, we aim to explore gender differences in emotional understanding. While we do not anticipate significant overall gender differences, we hypothesize that girls may perform slightly better in recognizing empathy-related emotions.

Finally, we will examine whether Hungarian children's responses align with the hierarchical structure proposed by Pons and Harris (2019). We hypothesize that their responses will align with this hierarchical pattern and that these findings will be comparable to patterns observed in other cultural contexts, such as Italy and Portugal. In summary, this study aims to provide a comprehensive evaluation of the TEC in Hungary, establish reference points for future research,

and deepen our understanding of emotional development across different cultures, with a particular focus on age, gender, and hierarchical stages of emotion comprehension.

Method

Participants

The study included 416 typically developing children aged 3 to 10 years from middle-class backgrounds. The sample included 264 preschoolers, and 152 children from grades 1-3. The gender distribution was balanced, with 219 boys (52.6%) and 197 girls (47.4%). The mean age was 6.4 years (SD=1.8). Data were collected from multiple sites, including kindergartens in the capital and a smaller provincial town. Participants were selected using convenience sampling, ensuring a balanced gender distribution across age groups. Given the study's focus on a specific age range, randomization was not feasible. Instead, children were recruited from kindergartens and schools in both the capital city and a smaller provincial town to enhance diversity and improve representativeness.

Measures

The study examined several key variables. The primary dependent variable was the emotion comprehension score, measured using the Test of Emotion Comprehension (TEC). The independent variables included age (continuous variable), gender (male or female, categorical variable), and educational stage (preschool vs. primary school: grades 1-3). The TEC assesses emotional understanding through three hierarchical subscales - external, mental, and reflective - which represent progressively complex aspects of emotion comprehension. A detailed overview of the instrument is presented below.

Instrument - the Test of Emotion Comprehension (TEC)

The Test of Emotion Comprehension (TEC; Pons & Harris, 2000) is a widely used tool designed to assess children's understanding of emotions. It was initially tested with 100 typically developing UK children aged 3 to 11 years (Pons et al., 2004) and has since been translated and adapted for use in multiple cultural contexts. The TEC is available in 27 languages and has both male and female versions. It evaluates children's emotion comprehension across nine key components, grouped into three hierarchical subscales.

TEC subscales and components

1. External - focuses on basic emotion recognition and external influences:
I. Recognition: identifies and names emotions.
II. External cause: understands that emotions can result from external events.
III. Desire: recognizes that people can have different emotions about the same situation.

2. Mental - addresses cognitive influences on emotions:
IV. Belief: understands that beliefs influence emotions.

V. Reminder: assesses how recalling memories affects current emotions.
VI. Regulation: measures the use of strategies to manage negative emotions.

3. Reflective - involves complex emotional reasoning:
VII. Hiding: recognizes that expressed emotions may differ from true feelings.
VIII. Mixed: understands that individuals can experience conflicting emotions.
IX. Morality: evaluates how moral behavior influences emotions.

The TEC has demonstrated good test-retest reliability and stability over time (Pons et al., 2002), and high correlations with cognitive development and language ability (Tenenbaum et al., 2004). To ensure linguistic accuracy, the test was translated into Hungarian and then retranslated into English. A pilot study involving 22 preschool children was conducted to refine the methodology before full-scale data collection.

Procedure

Data collection took place during the 2020-2021 academic year. Written consent was obtained from principals, educators, and parents prior to assessments. The study followed strict ethical guidelines, with approval granted by the Research Ethics Committee of the ELTE Faculty of Education and Psychology (Ethics approval number: 2020/89-2). A team of trained psychology undergraduates and PhD students conducted the assessments across kindergartens and schools, ensuring consistent administration of the TEC.

Data analysis

Descriptive statistics were calculated to examine the mean scores and variability across the TEC components. Pearson's correlation coefficient was used to assess the relationship between age and emotional comprehension, for both the total TEC score and each subscale (External, Mental, and Reflective). A linear regression analysis was conducted to determine the predictive power of age on the total TEC score. ANCOVA was used to assess gender differences in emotional comprehension, controlling for age. To explore relationships between TEC components, Pearson's Chi-squared test was applied. Finally, Confirmatory Factor Analysis (CFA) was performed to assess the fit of the data to the theoretical model proposed by Pons and Harris (2019), using Weighted Least Squares and Bootstrapping for estimation. CFA allows us to validate our proposed measurement models by assessing how well observed variables (*e.g.*, TEC test components) reflect the underlying factors they are intended to measure (*e.g.*, External, Mental, and Reflective stages of emotional comprehension). Our goal was to determine if the theoretical model of the TEC accurately fits the correlations observed in the Hungarian sample. Since the children's responses were recorded on a dichotomous scale (correct/incorrect), we used Weighted Least Squares (WLS) for estimation and Bootstrapping to calculate standard errors of estimation. The model fit was evaluated using the following criteria:

1. The chi-squared test.

2. The ratio of chi-square value to degrees of freedom (χ^2/df), with an acceptable fit considered if χ^2/df
3. The root mean square error of approximation (RMSEA), where a good fit is indicated by RMSEA<.05, and its 90% confidence interval upper bound<.1.
4. The standardized root mean squared residual (SRMR), with a good fit indicated by SRMR<.08.
5. Relative goodness-of-fit indices: Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and Bentler-Bonett Normed Fit Index (NFI), where values >.90 indicate a good fit and values >.95 indicate an excellent fit.

Results

The purpose of this study was to provide standard scores for interpreting TEC outcomes and establish age-appropriate scores for children aged 3 to 10 years, covering developmental stages across one-year intervals.

Table 1. presents the mean number of correct answers for each TEC component across different developmental stages and age groups. Our findings revealed a clear developmental trajectory in children's emotional understanding. The comparison between Hungarian children and the original UK sample highlighted both similarities and differences in their developmental profiles. The developmental profile observed in our study largely aligns with the expected hierarchical structure. Specifically, while more complex components were generally more challenging in both groups, discrepancies were noted in the rankings of certain components. For instance, the Belief and Reminder components were more difficult for Hungarian children, while Desire, Hiding, and Morality components were easier for them compared to their UK counterparts.

Table 1. Descriptive statistics of correct answers by TEC components across developmental stages and age groups

	Hungarian Sample							UK sample		
	Preschool		Elementary School		Total			Total		
	M	SD	M	SD	M	SD	Rank	M	SD	Rank
Recognition	.841	.366	.961	.195	.885	.320	1	.84	.36	1
External cause	.640	.481	.947	.224	.752	.432	2	.79	.40	3
Desire	.636	.482	.849	.360	.714	.452	3	.66	.47	5
Belief	.322	.468	.711	.455	.464	.499	8	.68	.46	4
Reminder	.447	.498	.724	.449	.548	.498	6	.81	.39	2
Regulation	.405	.492	.717	.452	.519	.500	7	.39	.49	8.5
Hiding	.561	.497	.757	.431	.632	.483	4	.59	.49	6
Mixed	.239	.427	.566	.497	.358	.480	9	.39	.49	8.5
Morality	.583	.494	.638	.482	.603	.490	5	.40	.49	7

Our study also analyzed age-related patterns in emotional understanding. The results revealed a significant positive correlation between age and the total emotional understanding score (r=.69 p<.001). This positive correlation was

observed across all subscales: External (r=.50, p<.001), Mental (r=.58, p<.001), and Reflective (r=.47, p<.001). These subscales are based on the theoretical framework developed by Pons and Harris (2019). The similar strength of these correlations suggests that the test does not exhibit a ceiling effect for early-developing external emotional understanding or a floor effect for later-developing reflective emotional understanding.

Table 2. Mean total correct answers by age group

		External		Mental		Reflective		Total	
Age	N	M	SD	M	SD	M	SD	M	SD
3	31	1.977	1.637	1.455	1.247	1.668	1.496	5.100	4.380
4	84	3.553	1.916	1.983	1.696	1.982	1.618	7.518	5.230
5	69	4.814	1.575	2.744	1.584	2.498	1.768	1.056	4.927
6	75	5.226	1.392	3.579	1.643	2.879	1.695	11.684	4.730
7	55	5.429	1.214	4.100	1.662	3.407	1.864	12.936	4.740
8	66	5.638	.833	4.404	1.469	4.094	1.592	14.136	3.894
9	29	5.332	1.314	4.879	1.430	4.821	1.535	15.032	4.279
10	7	5.500	.707	4.900	1.255	4.400	.894	14.800	2.856

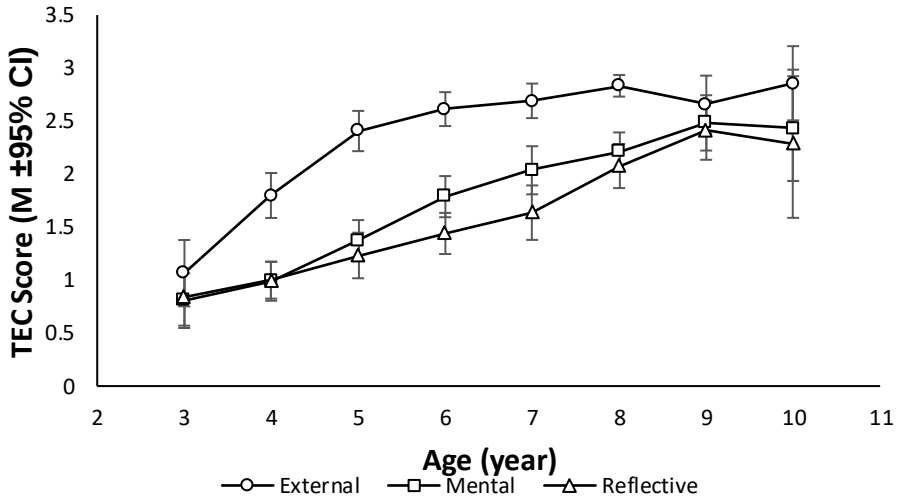

Figure 1. Mean total correct answers by age group

We also conducted a linear regression analysis to examine the effect of age on the total TEC score, supporting the finding that emotional understanding improves with age (F(1, 414)=363.12, p<.001), as shown in Table 2 and Figure 1. The regression model (TEC score=.808 * Age + .302) indicates that age accounts for approximately 46.7% of the variance in the total TEC score. On average, the TEC score increases by about .808 points for each additional year of age during early childhood (*see* Table 2). However, as illustrated in Figure 1, individual differences in scores are notable across all ages. When examining the effect of gender, it was necessary to control for age, as the sample of boys (M=6.626, SD=1.762) was significantly older than the sample of girls (M=6.2, SD=1.8), t(414)=2.64, p=.009. Therefore, we used ANCOVA to test the effect

of gender while controlling for age. No significant gender differences were found for any of the subscales (*see* Tables 3 and 4). There were no significant differences in the external subscale ($F(1, 413)=3.14$, $p=.077$, Partial $\eta^2=.008$) between the TEC scores of boys ($M=2.34$, $SD=.91$) and girls ($M=2.36$, $SD=.89$), neither in the mental subscale ($F(1,413)=1.72$, $p=.227$, Partial $\eta^2=.004$) between the scores of boys ($M=1.55$, $SD=1.00$) and girls ($M=1.50$, $SD=.97$), nor in the reflective subscale ($F(1, 413)=.83$, $p=.364$, Partial $\eta^2=.002$) between the scores of boys ($M=1.68$, $SD=.92$) and girls ($M=1.50$, $SD=.91$) when controlled for age (*see also* Figures 2 and 3).

Table 3. Mean total correct answers by age group for boys: analysis of age-related emotional understanding

		External		Mental		Reflective		Total	
Age	N	M	SD	M	SD	M	SD	M	SD
3	11	0.727	.786	.455	.522	.818	.751	2.000	2.059
4	38	1.553	.950	1.026	.854	.895	.863	3.474	2.667
5	38	2.395	.855	1.421	.793	1.079	.882	4.895	2.530
6	37	2.568	.647	2.000	.850	1.432	.867	6.000	2.364
7	35	2.629	.598	2.000	.874	1.457	.919	6.086	2.391
8	39	2.897	.307	2.256	.751	2.205	.951	7.358	2.009
9	19	2.632	.831	2.579	.607	2.421	.692	7.632	2.130
10	2	2.500	.707	2.500	.707	2.000	.000	7.000	1.414

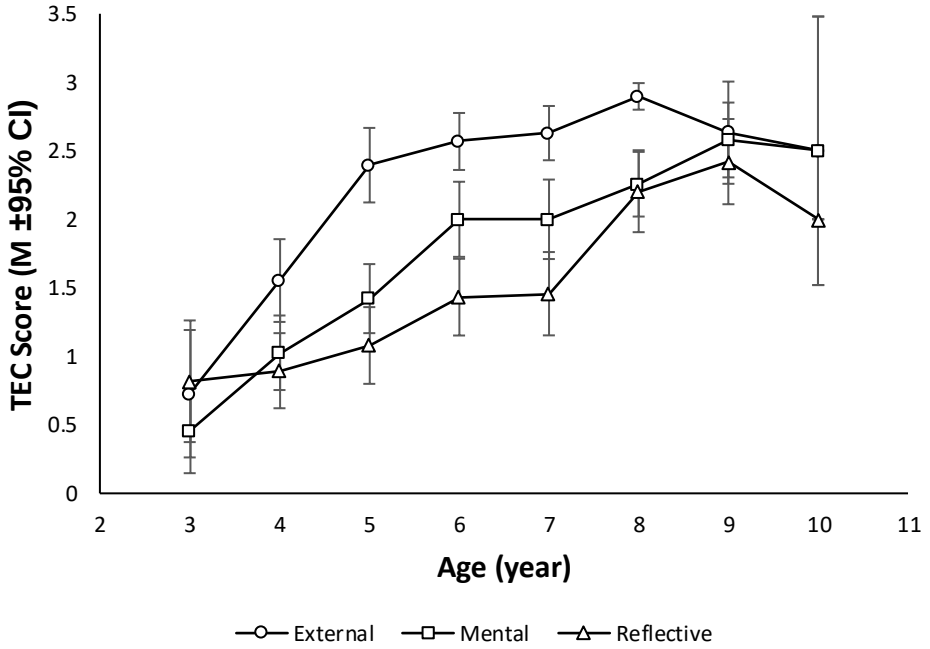

Figure 2. Mean total correct answers by age group for boys

Table 4. Mean total correct answers by age group for girls: age-related trends in emotional understanding

		External		Mental		Reflective		Total	
Age	N	M	SD	M	SD	M	SD	M	SD
3	20	1.250	.851	1.000	.725	.850	.745	3.100	2.321
4	46	2.000	.966	.957	.842	1.087	.755	4.044	2.563
5	31	2.419	.720	1.323	.791	1.419	.886	5.161	2.397
6	38	2.658	.745	1.579	.793	1.447	.828	5.684	2.366
7	20	2.800	.616	2.100	.788	1.950	.945	6.850	2.349
8	27	2.741	.526	2.148	.718	1.889	.641	6.778	1.885
9	10	2.700	.483	2.300	.823	2.400	.843	7.400	2.149
10	5	3.000	.000	2.400	.548	2.400	.894	7.800	1.442

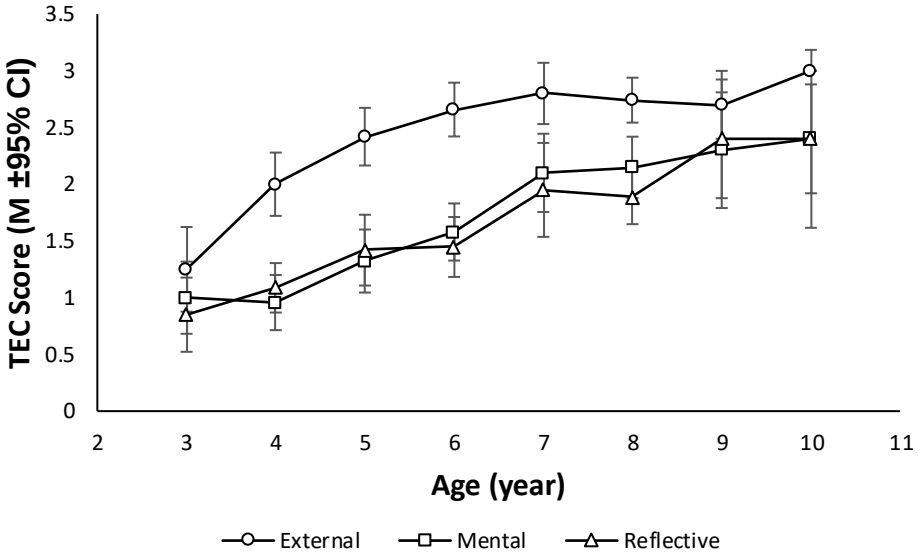

Figure 3. Mean total correct answers by age group for girls

There are also observable patterns in TEC components across age groups Table 5. displays the correct answers by TEC components across age groups.

Table 5. Ratio of correct answers by TEC components across age groups

	Correct answer (%)				Comparison
	Total	3-5yo	6-7yo	8-10yo	
Recognition	88.5%	8.4%	93.1%	97.1%	$\chi^2(2) = 21.714$ $p < .001$ $V = .288$
External cause	75.2%	55.4%	86.9%	96.1%	$\chi^2(2) = 72.043$ $p < .001$ $V = .416$
Desire	71.4%	54.3%	84.6%	85.3%	$\chi^2(2) = 46.956$ $p < .001$ $V = .336$
Belief	46.4%	26.6%	54.6%	71.6%	$\chi^2(2) = 58.424$ $p < .001$ $V = .375$
Reminder	54.8%	32.6%	63.8%	83.3%	$\chi^2(2) = 74.405$ $p < .001$ $V = .423$
Regulation	51.9%	35.9%	55.4%	76.5%	$\chi^2(2) = 44.242$ $p < .001$ $V = .326$
Hiding	63.2%	51.1%	7.8%	75.5%	$\chi^2(2) = 21.440$ $p < .001$ $V = .227$
Mixed	35.8%	15.8%	37.7%	69.6%	$\chi^2(2) = 83.057$ $p < .001$ $V = .447$
Morality	6.3%	54.3%	59.2%	72.5%	$\chi^2(2) = 9.181$ $p = .010$ $V = .149$

Note: For the total sample: N = 416; for children 2-4yo: N = 184; for children 6-7yo: N = 130; for children 8-10yo: N = 102. V: Cramer's V-value

Using Pearson's Chi-squared test, we investigated the relationships between the TEC components. Table 6 displays the effect sizes (phi-values) of

these Chi-squared tests, with significant results marked by asterisks. The results revealed several significant relationships between components, ranging from weak to moderate in strength. This suggests that while the TEC measures a partially homogeneous ability to understand emotions, the components also capture distinct aspects that can be clearly differentiated.

Table 6. Correlation analysis of TEC components

Variable	1.		2.		3.		4.		5.		6.		7.		8.	9.
Recognition	—															
External cause	.37	***	—													
Desire	.17	***	.41	***	—											
Belief	.08		.22	***	.16	***	—									
Reminder	.13	*	.21	***	.15	**	.12	*	—							
Regulation	.13	**	.33	***	.19	***	.17	***	.17	***	—					
Hiding	.06		.24	***	.19	***	.10	*	.14	**	.14	**	—			
Mixed	.08		.28	***	.23	***	.20	***	.15	**	.28	***	.14	**	—	
Morality	.22	***	.21	***	.13	**	.04		.05		.12	*	.14	**	.02	—

Note: Chi-squared test and phi-values. * p < .05, ** p < .01, *** p < .001

We employed confirmatory factor analysis (CFA) techniques to test whether our measurement of constructs aligns with the underlying theory of Pons and Harris (2019).

The results indicate a good to excellent fit: $\chi^2(24)=28.55$, $p=.237$; $\chi^2/df=1.19$; RMSEA=.021 [CI=.00-.047]; SRMR=.068; CFI=.990; TLI=.985; NFI=.940; IFI=.99. The Kaiser-Meyer-Olkin (KMO) measure is also satisfactory, with KMO=.77. All components load significantly ($p<.001$) and positively on their respective factors, with loading values (λ_{ij}) exceeding .4, except for Morality ($\lambda_{93}=.34$), as shown in Figure 4. Modification indices did not suggest a significant need for additional residual covariances or cross-loadings in the model. For the first factor, the explained variance is adequate: Recognition ($R^2=.40$), External cause ($R^2=.997$), Desire ($R^2=.46$). For the third factor, two components show adequate explained variance (Regulation: $R^2=.43$, Mixed: $R^2=.43$), but Morality has a low explained variance ($R^2=.11$), consistent with its lower loading value. The explained variance for components loading on the second factor is low: Belief ($R^2=.21$), Reminder ($R^2=.20$), Hiding ($R^2=.23$). The correlations between the resulting scales are significant and positive: External and Mental subscales ($r=.35$, $p<.001$), External and Reflective subscales ($r=.42$, $p<.001$), and Mental and Reflective subscales ($r=.32$, $p<.001$).

The three-factor structure of the TEC is illustrated in Figure 4. The strongest relationships were observed among the three components of the External subscale, which measure the lowest developmental level (Recognition, External cause, Desire). In contrast, the relationships among components of the Mental subscale (Belief, Reminder, Hiding) were much weaker. The same pattern is observed in the Reflective subscale components (Regulation, Mixed, Morality), and cross-relations between components from different subscales were also noted.

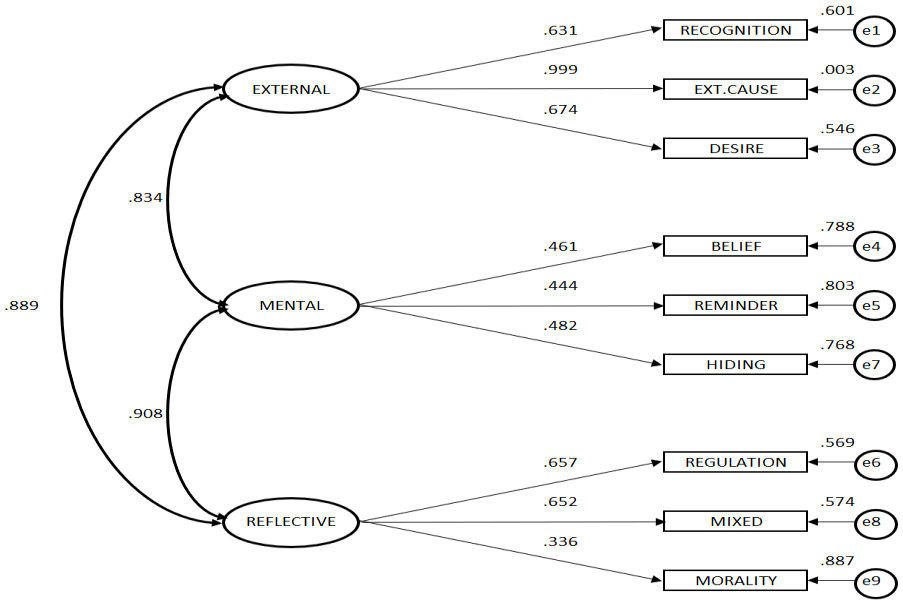

Figure 4. Confirmatory factorial model of TEC

When comparing the Hungarian and the original UK samples by both age and component, a clear hierarchical pattern can be observed in both samples (Tables 7 and 8). Children are generally able to master higher components at a later age. However, there are variations in the order of individual components compared to the theoretical model and also between the Hungarian and UK empirical samples.

Table 7. Percentage of success by TEC component and age group in the Hungarian sample: developmental trends in emotional understanding

Age	n	I	II	III	IV	V	VI	VII	VIII	IX
3 years	31	65	16	26	23	23	26	35	23	35
4 years	84	80	49	51	24	32	31	43	12	57
5 years	69	88	81	71	32	38	46	68	17	59
6 years	75	95	85	81	47	67	52	65	29	63
7 years	55	91	89	89	65	60	60	78	49	55
8 years	66	98	97	88	70	80	77	71	61	70
9 years	29	93	93	79	72	90	79	86	83	79
10 years	7	100	100	86	86	86	57	71	100	71

Table 8. Percentage of success by TEC component and age group in the UK sample

Age	n	I	II	III	IV	V	VI	VII	VIII	IX
3 years	20	55	45	30	20	20	5	5	0	10
5 years	20	75	80	65	55	40	50	15	20	20
7 years	20	90	80	100	75	85	65	20	35	30
9 years	20	100	100	100	80	95	80	65	60	50
11 years	20	100	100	100	100	100	95	90	80	90

We examined gender differences. Most previous studies using the TEC instrument (Pons et al., 2004; Bennett et al., 2005; Albanese et al., 2006) found

no significant gender differences. Similarly, we found no significant gender differences for any of the subscales when controlling for age.

We also aimed to determine whether a hierarchical pattern is evident in the Hungarian children's responses, and compare this to the original theoretical model by Pons and Harris (2019), as well as the hierarchical patterns observed in the Italian and Portuguese samples (*see* Table 9).

Table 9. Theoretical hierarchical pattern and hierarchical pattern found in Portuguese, Italian, and Hungarian samples

Theoretical	Portugal N=766 (3-13 years)	Italy N=367 (4-10 years)	Hungary N=416 (3-10 years)
I Recognition	I Recognition	I Recognition	I Recognition
II Cause	V Reminder	II Cause	II Cause
Ill Desire	II Cause	III Desire	III Desire
IV Belief	IV Belief	IV Belief	IV Belief
V Reminder	III Desire	V Reminder	V Reminder
VI Regulation	VII Hiding	VII Hiding	VII Hiding
VII Hiding	IX Morality	IX Morality	VI Regulation
VIII Mixed	VI Regulation	VI Regulation	VIII Mixed
IX Morality	VIII Mixed	VJII Mixed	IX Morality

Our study also clearly identified a hierarchical pattern; however, there were differences in the order of the individual components when compared to the theoretical model and the patterns found in the Portuguese, Italian, and Hungarian samples. The components that make up each of these subscales would therefore need to be fine-tuned to achieve consistent results. In the Portuguese sample, the Desire component was assigned to the Mental subscale, while the Reminder component was assigned to the External subscale. The Regulation component was assigned to the Reflective subscale in both the Portuguese and Italian samples. Compared to the theoretical model, the subscale assignments for the Regulation and Hiding components were reversed in the Hungarian sample, with Regulation being acquired by children in the third developmental stage across all samples. Interestingly, all subscales contained the same components in the hierarchical pattern observed in the Italian and Hungarian samples, and the Reflective subscale contained the same components in the hierarchical patterns found in the Portuguese, Italian and Hungarian samples.

When comparing the Hungarian sample to the original TEC model, we found differences in the order of components, with Hungarian children showing easier mastery of Desire, Hiding, and Morality components, while struggling more with Belief and Reminder, as seen with the reversed Regulation and Hiding components in the Hungarian sample, highlighting the need for adjustment in component assignments for consistency across cultures.

Discussion

This study aimed to provide standard scores for interpreting TEC outcomes and establish age-appropriate scores for children aged 3 to 10 years,

covering developmental stages across one-year intervals. Our findings revealed a clear developmental pattern in children's responses. We compared the order of success on each component of the TEC for Hungarian children with the original UK sample. The developmental profile observed in our study largely aligns with the expected hierarchical structure. However, some divergences were noted when compared with the pattern identified by Pons et al. (2004). This alignment and divergence are presented in Table 1, which contrasts the Hungarian and UK samples. In both groups, more complex components of emotion comprehension were more difficult. The hierarchical nature of emotional comprehension was evident in both samples. Despite these similarities, differences in the rankings of specific components were observed. Specifically, the Belief and Reminder components were found to be more challenging for Hungarian children, while the Desire, Hiding, and Morality components were easier for them compared to their UK counterparts.

Our study also analyzed age-related patterns in children's emotional understanding. Previous cross-study comparisons using the TEC (Pons et al., 2003; Pons et al., 2004; Pons & Harris, 2005; Albanese et al., 2006; Grazzani et al., 2018) have consistently shown that emotional comprehension improves over time, with children typically scoring higher as they age. In line with these findings, our analysis of age-related patterns revealed that older children in the Hungarian sample demonstrated a better understanding of emotional aspects compared to younger children, as shown in Table 2 and Figure 1. When comparing the Hungarian sample to the original UK sample by both age and component, we found a clear hierarchical pattern in both age and component (Tables 6 and 7, Figure 2). Children were generally able to master higher-level components at older ages. However, variations in the order of individual components were observed both when compared to the theoretical model, and between the Hungarian and UK empirical samples.

The analysis of gender differences in emotional comprehension found no significant differences between boys and girls on any subscale when controlling for age. This finding is consistent with most previous studies using the TEC instrument (Pons et al., 2004; Bennett et al., 2005; Albanese et al., 2006), which have also reported no significant gender effects on emotional understanding.

In addition to exploring age-related and gender-related patterns, we sought to determine whether a hierarchical pattern in children's responses was consistent with the original theoretical model by Pons and Harris (2019), and to compare this pattern to those observed in the Italian and Portuguese samples (Table 8 and Figure 3). Our study clearly identified a hierarchical pattern in the Hungarian sample. However, the order of the individual components in this hierarchical pattern differed when compared to the theoretical model, as well as to patterns found in the Portuguese, Italian, and UK samples. These differences suggest that the components within each subscale may need to be fine-tuned to ensure consistency across studies.

For example, in the Portuguese sample, the Desire component was assigned to the Mental subscale, while the Reminder component was assigned to the External subscale. Additionally, Regulation was assigned to the Reflective subscale in both the Portuguese and Italian samples. In contrast, the Hungarian sample showed a reversed assignment of the Regulation and Hiding components, with Regulation being acquired by children in the third developmental stage. Despite these differences, all subscales in the Hungarian and Italian samples contained the same components, and the Reflective subscale components were identical across the Portuguese, Italian, and Hungarian samples. These findings indicate that while a general hierarchical pattern exists, the specific order of components may vary depending on the cultural context, highlighting the need for further refinement of the TEC components to achieve consistent results across different samples.

Conclusions

This study makes a significant contribution by adapting the Test of Emotion Comprehension (TEC) for Hungarian children, providing an essential tool for assessing emotional understanding within this population, and offering age-appropriate mean scores. The TEC demonstrated strong psychometric properties, confirming its suitability for measuring emotional comprehension - an essential advancement given the increasing demand for reliable emotional assessment tools in both educational and psychological contexts. Additionally, it serves a practical purpose by supporting practitioners in identifying areas requiring intervention and tracking emotional development over time. The TEC, therefore, holds significant potential for use in social-emotional learning (SEL) initiatives and other educational programs.

Practical implications

On a theoretical level, this research extends the framework proposed by Pons and Harris (2019), highlighting both universal and culturally specific patterns in emotional comprehension. The inclusion of Hungarian data contributes to cross-cultural research, allowing comparisons with findings from the UK, Italy, and Portugal and other countries.

For example, Hungarian children interpreted the phrase "*He is ok*" as synonymous with "*happy*", demonstrating how language nuances can influence emotion comprehension. This aligns with previous research (*e.g.*, Rocha et al., 2015) emphasizing the importance of careful translation and adaptation of emotion-related tasks to ensure validity across cultural contexts. The inclusion of Hungarian data also helps identify cross-cultural similarities and differences, particularly in how emotional components (*e.g.*, Recognition, External causes, Desire, Belief) are ordered. The differences observed between the Hungarian and UK samples, as well as between the theoretical model and the empirical data

from the Portuguese, Italian, and Hungarian samples, suggest that further research is needed to explore and reconcile these variations.

Our study also underscores the importance of emotion comprehension as a key developmental milestone. As Jones (2016) noted, "*What gets measured matters*", reinforcing the significance of assessing emotional understanding to track children's emotional development. Although Hungary offers several training programs aimed at enhancing children's emotional skills, their effectiveness remains largely unexamined. The TEC could play a pivotal role in evaluating these programs, particularly those that adopt a metacognitive and meta-emotional approach (Pons et al., 2002; Ornaghi & Grazzani, 2013), ultimately informing interventions that enhance emotional and social skills.

Limitations and future research directions

Despite these contributions, the study has limitations. One major issue is the absence of an external validation measure for the TEC. While the test demonstrated strong internal consistency, further exploration into its construct, convergent, and discriminant validity is necessary. Additionally, the TEC may not adequately capture emotional comprehension in older children, as those over the age of nine found the test too easy, particularly its earlier components. Moreover, the TEC does not assess the emotion *"disgust"*, which is essential for a comprehensive understanding of emotions. Future versions of the TEC would benefit from including this emotion to provide a more complete assessment. While these limitations should be addressed in future research, this study provides valuable insights into how the TEC can be used to assess emotional comprehension in Hungarian children.

In conclusion, the adaptation of the TEC for Hungarian children underscores its potential as a reliable and effective tool for measuring emotion comprehension. By expanding its cross-cultural validity and integrating it into educational systems, the TEC could significantly deepen our understanding of emotional development, fostering better-targeted interventions to support children's emotional and social growth.

Ethics statement

This study was carried out in accordance with the recommendations of Code of Ethics of ELTE Faculty of Education and Psychology. The protocol was approved by the Ethics Committee for Research of ELTE Faculty of Education and Psychology, Ethics approval number: 2020/89-2. In accordance with the Declaration of Helsinki, all parents gave written informed consent for adolescents' participation in the study.

Conflicts of interest

The authors declare no conflict of interest.

Author contributions
All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.
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