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MEASURING BEHAVIORAL INHIBITION AND BEHAVIORAL ACTIVATION IN CHILDREN – VALIDATION OF CZECH BIS/BAS SCALE*

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Summary. Current trends to examine factors related to the risk of developing of anxiety disorders in children and adults require effective tools for measuring individual differences in experiencing fear during development. We present the self--report Behavioral Inhibition System/ Behavioral Activation System (BIS/BAS) scale for children. The BIS/BAS scale was developed by Carver and White (1994) and is based on reinforcement sensitivity theory (Gray, 1970, 1987, 1994). We verified the Czech version of BIS/BAS in a sample of 473 Czech children aged between 10 and 12 years. The item analysis and both the exploratory and confirmatory factor analyses showed that the Czech BIS/BAS scale has acceptable psychometric properties and can be used in schoolchildren.
Key words: BIS/BAS, reinforcement sensitivity theory, childhood, explanatory factor analysis, reward, punishment

Introduction

Personal sensitivity to reward and punishment has been recently given considerable attention, especially in adolescents. According to Galvan (2010), adolescence

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is a period characterized by increased reward-seeking behavior. Reward responsivity has been found to correlate with typical adolescent behavior, e.g., risk taking, as well as with some psychopathological conditions, such as schizophrenia, emotional disorders, and addictions (Pagliaccio et al., 2016). Much of the current research aims to explain reward responsivity on the biological level (Richards, Plate, Ernst, 2013), but what is missing is the link between neurobiological findings and psychological theories that have tried to conceptualize reward responsivity since the second half of 20th century.

Especially useful seems to be Gray's Reinforcement Sensitivity Theory (RST) (Gray, 1970, 1987, 1994). Gray presumed two regulative behavioral mechanisms (approaching versus avoiding), which each individual chooses to use according to the nature of actual stimuli. The behavioral approach system (BAS) is used especially when pursuing rewards or actively avoiding the punishment, and it helps people to reach goals, while the behavioral inhibition system (BIS) is used when there is a need to inhibit the behavior with potentially negative outcomes (punishment). The BAS causes activation and is connected with rather positive emotions (happiness, satisfaction or relief). The BIS, on the other hand, causes passivity and is connected with rather negative emotions (anxiety, fear, uncertainty). Gray (1982) presumed that the individual sensitivity to the BAS and BIS (in other words, how often an individual will use one system rather than the other) is a rather stable personality variable and can predict various types of psychopathologies, e.g., that high BIS sensitivity is connected with anxiety disorders and that low BIS, on the other hand, relates to attention disorders. High BAS sensitivity has been found to correlate with antisocial behavior (Quay, 1997; Vervoort, 2010; Vervoort et al., 2010), and low BAS sensitivity is connected with depression (Depue, Krauss, Spoont, 1987). Research dealing with RST further examined the relationship of the BIS/BAS to individual dimensions of personality, mainly to temperament and neuroticism. Studies have proven that the BIS reactions are positively linked to neuroticism and negatively to extraversion, while the BAS showed the exact opposite relationships – there is a positive link to extraversion and a negative link to neuroticism (Franken, Muris, Rassin, 2005; Muris et al., 2005).

To further develop RST, the measurement tool (BIS/BAS self-report scale) was created by Carver and White (1994). The BIS/BAS scale consists of a BIS scale and three BAS scales (Drive, Reward Responsiveness, and Fun Seeking). The splitting of the BAS scale into three subscales resulted from Carver and White's (1994) factor analysis and has since been the subject of controversy. The major advantage of the BIS/BAS scale is that it may be used in adults, adolescents, and even children. The valid and reliable instrument for measuring BIS/BAS sensitivity in children is especially useful when we witness increased anxiety in schoolchildren. BIS/BAS is not a tool focused on measuring anxiety and fear directly; however, it enables us to assess which way a child will react to certain complex incentive systems, such as school. With precise BIS/BAS diagnostics, an individually tailored approach can be

adopted in order to help children benefit from school education as much as possible (e.g., to encourage low BAS children with increased rewards or to comfort high BIS children by introducing punishment-free environment). However, there seems to be a long road to making to precise diagnostics of BIS/BAS in children. In the next chapter, we will summarize previous studies focused on BIS/BAS validation, and we will later present our findings from the validation of the BIS/BAS in a Czech sample of schoolchildren.

BIS/BAS measurement in children

Among many studies aimed to validate Carver and White's (1994) BIS/BAS scale, only a handful examined its fit in children. Muris et al. (2015) tested the scale's fit in 8- to 12-year-old Caucasian children and suggested its use in children under a two-factor model (with BAS subscales united in one BAS scale). Unfortunately, authors did not perform a confirmatory factor analysis to properly assess the 2-factor and 4-factor models. Another study from the Netherlands (Yu et al., 2011) tested the fit of the BIS/BAS scale in early adolescents (mean age = 13 years) and middle adolescents (mean age = 16.4 years) and their mothers (mean age = 45.2 years) and concluded that the 2-factor model showed better fit in all groups of respondents, although in both adolescent groups, the fit indexes were quite similar. They further recommended removing the reverse-coded items from BIS scales.

In contrast, Cooper, Gomez and Aucote (2007) found acceptable fit of 4-factor model in both young adult (21-40 years) or in adolescent (12-16 years) age groups. Similarly, Kingsbury et al. (2013) found a better fit for a 4-factor model while using it in 8- to 13-year-old children. They also suggested that reverse-coded BIS items should be removed from the scale.

The most recent revision of the BIS/BAS scale was reported by Pagliaccio et al. (2016). They investigated the scale's fit in five age groups, from 6- to 10-year-old children through early adolescents (11 to 13 years old) and late adolescents (14 to 16 years old), to young adults (18 to 22 years old) and middle-aged adults (30 to 45 years old). They tested either Carver and White's original model or their own model based on the separate exploratory factor analysis. Although their model showed generally better fit than the original model, neither one surpassed the fit criteria in the sample of children, which raises a question about the usability of the scale in young children. Similar to previous studies, Pagliaccio et al. (2016) identified some problematic items; nevertheless, they did not provide a satisfactory explanation for their poor scoring. They expected that one possible reason may be the specific idiomatic and semantic properties of reverse-scoring items and concluded that they were wrongly understood by the respondents. They suggested the simplification and rewording of those items and even removing the most problematic ones (see Pagliaccio's revised model further in the text). The fact is that reverse-coded items have been generally shown to be problematic in each BIS/BAS study reported thus far.

Methods

Participants

The sample consisted of 473 participants (242 boys and 231 girls, aged range 10-12 years) from randomly chosen elementary schools in the Czech Republic. The pen-and-paper inventory was administered in randomly selected schools in the Czech Republic during classes. Children had 45 minutes to complete the inventory, and their responses were anonymous. All respondents provided informed consent, which was confirmed by a parent. Respondents did not receive any reward for their participation. Data collection was conducted in October and November 2016.

Measures

All respondents completed the Czech translation of Carver and White's (1994) BIS/BAS scale modified for children aged 9-16 years of age, which had minor rewording of items in order to make them more appropriate and understandable for children (Muris et al., 2005). The inventory has 4 scales and altogether 20 items – one BIS scale (7 items) and three BAS scales: Response to Reward (5 items), Drive (4 items) and Fun Seeking (4 items). A Likert scale rated from 1 to 4 was used by respondents to express their agreement with the statement expressed in each item (0 = not true, 1 = somewhat true, 2 = true, 3 = very true).

The translation from English to Czech proceeded in five steps. First, all items were translated independently by two researchers; second, these translations were compared and discussed and united into one version; third, this version was given to the English translator for back-translation; fourth, the back-translation was compared with the original BIS/BAS, and changes in Czech wording were proposed; and fifth, the group of two researchers and a consulting expert (not involved in the translation) established the final Czech version based on back-translation and the translator's suggestions.

Hypotheses and data analysis procedures

The main aim was to verify the model fit of the Czech version of the BIS/BAS inventory. We tested both the 4-factor model (with BIS, BAS-Drive, BAS-Response to Reward, BAS-Fun Seeking) and the 2-factor model (with BIS and BAS), as there is not yet congruence on the proper factor structure among scholars (see above). We also tested the most recent revision of the original 4-factor model by Pagliaccio et al. (2016) with three items removed from the BIS scale (BIS1 = B13, BIS5 = B1 and BIS7 = B18), one item removed from BAS-Response to Reward (REWARD 3 = B14) and without the BAS-Fun Seeking subscale. The confirmatory factor analysis was used via the SEM package in R statistical software (R Core Team, 2014).

We also tested scale reliability via Cronbach's alpha measurement and conducted an exploratory factor analysis to see whether items do not tend to load on

any factor other than their respective factor, which seems very possible, especially in the 4-factor model.

As a minor goal, we searched for potential differences in responses caused by gender. Welch's *t*-tests were used for these analyses.

Results

Scale reliability

The inner consistency of BIS/BAS subscales was measured by Cronbach's alpha. The results suggested rather low internal consistency. Using the 4-factor model, we measured Cronbach's alpha, which was approximately 0.6 for each subscale (table 1). In the case of BAS subscales, the result is probably due to a small number of items on each subscale (4-5). The Cronbach's alpha for the composite BAS scale (13 items) was over 0.7, which is still lower, but acceptable (Tavakol, Dennick, 2011). The low consistency of the BIS subscale seems to be result of weaker correlations among all items (only item B10 has a correlation with the scale above 0.5). On the other hand, only one item (B1) showed a correlation with the scale below 0.3.

Table 1. BIS/BAS Reliability. Results for BIS factor, three BAS subfactors and for total BAS factor. Numerical summaries, correlation to scale, and the effect on internal consistency are shown for each item

Scale	Item	Mean	*SD*	r.cor*	α.drop**
BIS (α = 0.57)	B1	1.48	0.93	0.13	0.60
	B6	2.03	0.92	0.48	0.51
	B10	1.81	0.92	0.56	0.49
	B13	2.12	0.80	0.44	0.52
	B15	1.91	0.94	0.35	0.54
	B18	1.36	0.97	0.43	0.52
	B20	2.07	0.82	0.38	0.54
BAS Drive (α = 0.62)	B2	2.06	0.83	0.57	0.51
	B7	2.07	0.78	0.48	0.57
	B9	2.20	0.81	0.47	0.57
	B17	1.64	0.98	0.52	0.55
BAS Response to Reward (α = 0.64)	B3	2.54	0.62	0.37	0.64
	B5	2.60	0.66	0.55	0.57
	B11	2.30	0.75	0.52	0.58
	B14	2.57	0.63	0.45	0.61
	B19	2.59	0.68	0.59	0.55

cont. table 1

BAS Fun Seeking (α = 0.64)	B4	2.38	0.71	0.42	0.42
	B8	1.93	0.99	0.39	0.44
	B12	1.37	0.93	0.36	0.46
	B16	2.02	0.93	0.49	0.37
BAS (α = 0.73)	B2	2.06	0.83	0.46	0.71
	B3	2.54	0.62	0.28	0.73
	B4	2.38	0.71	0.36	0.72
	B5	2.60	0.66	0.48	0.71
	B7	2.07	0.78	0.49	0.71
	B8	1.93	0.99	0.39	0.72
	B9	2.20	0.81	0.54	0.70
	B11	2.30	0.75	0.58	0.70
	B12	1.37	0.93	0.16	0.74
	B14	2.57	0.63	0.36	0.72
	B16	2.02	0.93	0.48	0.71
	B17	1.64	0.98	0.47	0.71
	B19	2.59	0.68	0.45	0.71

Note. α = Cronbach◉s alpha of respective scale. * Item whole correlation corrected for item overlap and scale reliability. ** Cronbach◉s alpha of item's respective scale, if the item is dropped.

The relationships between the parts of inventory were measured by Pearson's correlation. All BAS subscales were significantly correlated with each other, although the correlation between Fun Seeking and Response to Reward was rather low (table 2). The BIS subscale showed weak correlations (below 0.2) with all BAS subscales; thus, we can conclude that the BIS and BAS are rather independent factors, which is consistent with the theoretical background and with previous research.

Table 2. Pearson Correlation Coefficient between the Parts of the BIS/BAS Inventory

	BAS			
Variable	Drive	Fun Seeking	Response to Reward	BIS
BAS	.811***	.729***	.705***	.130**
BAS Drive		.411***	.390***	.036
BAS Fun Seeking			.220***	.103*
BAS Response to Reward				.159***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Explanatory factor analysis

We tested both the 2-factor and 4-factor BIS/BAS models via EFA. The results obtained by the method of EFA using the VARIMAX rotation well reflect the main BIS/BAS structure of the inventory. Under the 2-factor model, 27% of the variance was explained (BAS-16%, BIS-11%). Under the 4-factor model, 42% of the variance was explained (BAS-Drive-12%, BIS-11%, BAS-Response to Reward-10%, BAS-Fun Seeking-9%).

Table 3. Exploratory Factor Analysis of the BIS/BAS inventory – 2 factor model

Item		BIS	BAS
B1(I)	I do not become fearful or nervous. Even when something bad happens to me. (R)	.14	.19
B2(A)	I do everything to get the things that I want.	-.21	**.55**
B3(A)	When I am doing well at something. I like to keep doing this.	.04	**.34**
B4(A)	I am always willing to try something new. When I think it will be fun.	-.01	**.41**
B5(A)	I feel excited and full of energy when I get something that I want.	.10	**.54**
B6(I)	I am hurt when people scold me or tell me that I do something wrong	**.62**	.00
B7(A)	When I want something. I usually go all the way to get it.	-.02	**.57**
B8(A)	I often do things for no other reason than that they might be fun.	.01	**.44**
B9(A)	When I see an opportunity to get something that I want. I go for it right away.	-.01	**.63**
B10(I)	I feel pretty upset when I think that someone is angry with me.	**.67**	.03
B11(A)	I get very excited when I would win a contest.	.05	**.64**
B12(A)	I often do things on the spur of the moment.	.04	.17
B13(I)	I usually get very tense when I think something unpleasant is going to happen.	**.55**	.03
B14(A)	I get thrilled when good things happen to me.	**.33**	**.38**
B15(I)	I feel worried when I think I have done poorly at something.	**.48**	.07
B16(A)	I crave for excitement and new sensations.	.08	**.53**
B17(A)	Nobody can stop me when I want something.	-.12	**.55**
B18(I)	I am very fearful compared to my friends.	**.48**	-.12
B19(A)	I get really excited when I see an opportunity to get something I like.	.29	**.48**
B20(I)	I worry about making mistakes.	**.53**	.08

Note. (I) = Items that are part of BIS subscale. (A) = Items that are part of BAS subscale. Factor loadings greater than 0.30 are bolded.

Table 4. Exploratory Factor Analysis of the BIS/BAS inventory – 4 factor model

Item		BAS Drive	BIS	BAS Response to Reward	BAS Fun Seeking
B1(I)	I do not become fearful or nervous. Even when something bad happens to me. (R)	.35			
B2(DR)	I do everything to get the things that I want.	.62			
B3(RR)	When I am doing well at something. I like to keep doing this.			.62	
B4(FS)	I am always willing to try something new. When I think it will be fun.				.61
B5(RR)	I feel excited and full of energy when I get something that I want.	.55		.44	
B6(I)	I am hurt when people scold me or tell me that I do something wrong.		.62		
B7(DR)	When I want something. I usually go all the way to get it.	.50			
B8(FS)	I often do things for no other reason than that they might be fun.				.49
B9(DR)	When I see an opportunity to get something that I want. I go for it right away.	.63			
B10(I)	I feel pretty upset when I think that someone is angry with me.		.69		
B11(RR)	I get very excited when I would win a contest.	.54		.38	
B12(FS)	I often do things on the spur of the moment.			-.31	.60
B13(I)	I usually get very tense when I think something unpleasant is going to happen.		.58		
B14(RR)	I get thrilled when good things happen to me.			.61	
B15(I)	I feel worried when I think I have done poorly at something.		.47		
B16(FS)	I crave for excitement and new sensations.	.41			.52
B17(DR)	Nobody can stop me when I want something.	.61			
B18(I)	I am very fearful compared to my friends.		.54		-.35
B19(RR)	I get really excited when I see an opportunity to get something I like.			.64	
B20(I)	I worry about making mistakes.		.48		

Note. (I) = Items that are part of BIS subscale. (DR) = Items that are part of BAS-Drive subscale. (RR) = Items that are part of BAS-Response to Reward subscale. (FS) = Items that are part of BAS-Fun Seeking subscale.
Factor loadings smaller than 0.30 are omitted.

Although most of items showed significant loadings to their respective subscales, there were some exceptions. Within the 2-factor model (table 3), the items B1 (BIS5 in the original Carver and White's scale) and B12 (FUN4) showed weak loadings (below 0.2). Within the 4-factor model (table 4), there were two items (B5, resp. RWD1 and B11, resp. RWD4) that showed the highest loading on the BAS--Drive subscale, although they belonged to BAS-Response to Reward. However, in both cases, these items also loaded significantly onto their respective factors. Thus, the only truly problematic item was B1, which loaded significantly onto BAS-Drive, rather than to its respective BIS factor. B1 is the only reverse-coded item in the inventory, and it seems that respondents tend to interpret it as a statement expressing "boldness" and "activity" (BAS-Drive) than a lack of fear and passivity (BIS).

Confirmatory factor analysis

To assess how our data fit the theoretical model, we performed a confirmatory factor analysis. Three models were tested: the 2-factor model with the BIS and BAS; the 4-factor model with the BIS, BAS-Drive, BAS-Response to reward and BAS-Fun seeking; and the revised model by Pagliaccio et al. (2016). Three indexes were used: chi-square/degrees of freedom ratio, RMSEA (root mean square error of approximation) and CFI (comparative fit index).

Table 5. Confirmatory Factor Analysis of BIS/BAS Inventory

Model	χ^2	*Df*	χ^2/Df	RMSEA	CFI
2-factor	540.99	169.00	3.20	0.0683	0.6967
4-factor	436.75	164.00	2.66	0.0594	0.7776
Revised (Pagliaccio)	169.51	51.00	3.32	0.0702	0.8370

Note. χ^2 = Goodness of Fit Index; *Df* = Degrees of freedom; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index.

All three models showed relatively acceptable fit (see table 5). The χ^2/df ratio ranged from 2.66 (4-factor model) to 3.32 (revised model by Pagliaccio et al., 2016), which did not meet the recommended value under 2.0 but reached the acceptable value under 5.0 (Hooper, Coughlan, Mullen, 2008). The RMSEA values showed good fit, while they are below 0.07 (Hooper, Coughlan, Mullen, 2008). The CFI value should be close to 1.0, or at least higher than 0.9 (Hu, Bentler, 1999), which our values of 0.70 to 0.78 did not reach. From the three tested models, the 4-factor model showed the best fit.

Gender differences

The differences in BIS/BAS scores between boys and girls were measured by Welch's *t*-tests, and no significant gender differences were found, although in the

BAS-Drive subscale, the *t*-value was close to 2 and $p = 0.08$ (table 6), suggesting that boys tend to score slightly higher than girls.

Table 6. Gender differences in BIS/BAS

	Boys ($N = 242$)		Girls ($N = 231$)		Difference	
	Mean	*SD*	Mean	*SD*	*t*	*p*
BIS	1.82	0.49	1.84	0.46	-0.46	0.64
BAS	2.20	0.40	2.15	0.38	1.47	0.14
BAS-Drive	2.04	0.58	1.94	0.59	1.78	0.08
BAS-Response to Reward	2.53	0.43	2.51	0.43	0.63	0.53
BAS-Fun Seeking	1.95	0.57	1.90	0.55	0.85	0.40

Discussion and limitations

Although the BIS/BAS scale has been used for research for more than 20 years, there are still many questions regarding its validity, proper factor structure and, especially, its usability in children. To date, there are few validated translations of the BIS/BAS, despite the popularity of reward responsiveness and other motivational factors, especially in children and adolescents worldwide. In this study, we presented the Czech translation of the BIS/BAS and its psychometric properties using a random sample of 473 children (10-12 years of age). Here, we will compare our findings with those from BIS/BAS studies using similar samples.

Reliability of BIS/BAS scale

The internal consistency of the BIS/BAS was relatively low in our sample. The BIS scale's Cronbach's alpha was only 0.57, which seems to be the lowest value thus far from published methodological studies (Pagliaccio et al., 2016). Additionally, in the case of BAS subscales, Cronbach's alpha values are relatively low in our study (0.62 to 0.64), but similar values are not unusual in other BIS/BAS studies (e.g., Franken, Muris, Rassin, 2005; Yu et al., 2011). The main reason for these values is probably the small number of items in each subscale. The aggregate BAS scale showed an acceptable internal consistency ($a = 0.73$).

Similar to other studies, we identified some problematic items in our study. In particular, item B1 (BIS5) did not correlate with the BIS scale, and in the EFA, it loaded significantly onto other factor (BAS-Drive). Items B5 (REWARD1) and B11 (REWARD4) also loaded onto other factors in the EFA. Surprisingly, Fun seeking items were relatively unproblematic, contrary to findings in previous BIS/BAS

studies (Pagliaccio et al., 2016). While the most problematic item in our model was also the only reverse-coded item, we believe that reverse-coded items should be generally reworded while using the BIS/BAS in children, as also suggested in other studies (Pagliaccio et al., 2016).

Factor structure of the BIS/BAS scale

There is a debate over whether to prefer a two-factor solution (based on original Gray's theory) or a four-factor solution (as proposed by Carver and White (1994)) when developing the BIS/BAS scale. Muris et al. (2005) stressed that in children, two-factor model seemed to have better fit. Pagliaccio et al. (2016), on the other hand, stated that four-factor model has better fit in all age groups, including children (with a mean age of 9 years). However, the model fit in children was lower than in other age groups. This finding was true also for the revised model in Pagliaccio et al. (2016), without the Fun seeking subscale and several other items removed (subsequently referred to as the "revised model").

Using CFA, we tested three models: a two-factor model, a four-factor model and a revised model. The four-factor model showed the best fit, although did not meet all criteria of good fit, namely, the CFI value. Surprisingly, the revised model showed slightly worse fit, as assessed by the χ^2/df and RMSEA indexes, but showed the best fit in terms of CFI.

Thorough examination of model structure showed some items with weaker loadings (< 0.3), namely, items B1 (BIS5), B3 (REWARD2), B14 (REWARD3), B4 (FUN3), B12 (FUN4). Since item B1 was shown to be the most problematic item and simultaneously the only reverse-coded item, we stress that using reverse-coded items in children is not advisable. Therefore, for children, we recommend using the adjusted reworded version of the BIS/BAS by Murris et al. (2005) rather than Carver and White's (1994) original scale, since the BIS/BAS by Murris et al. (2005) seems to hold the same factor structure but with fewer reverse-coded items. Ideally, item B1 (BIS5) should also be somehow rewarded in a positive way.

Limitations

The primary limitation of our study is that the data collection was held during a school class, which may influence the response style of pupils. Additionally, we did not cover all elementary schools in the Czech Republic; rather, we randomly picked twelve schools, which may be the source of distortion. Additionally, the inclusion of some external validity measures would be useful to see whether the Czech BIS/BAS shows similar relationships to other variables, as found in previous research.

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POMIAR BEHAWIORALNEGO HAMOWANIA I BEHAWIORALNEJ AKTYWACJI U DZIECI – WALIDACJA CZESKIEJ SKALI BIS/BAS

Streszczenie. Współczesne tendencje do badania czynników związanych z ryzykiem wystąpienia zaburzeń lękowych u dzieci i dorosłych wymagają skutecznych narzędzi do pomiaru indywidualnych różnic w ich doświadczaniu podczas rozwoju. Prezentujemy skalę samooceny systemu *Behavioral Inhibition System/ Behavioral Activation System* (BIS/BAS) dla dzieci. Skala BIS/BAS została opracowana przez Carver i White (1994) i jest oparta na teorii wrażliwości na wzmocnienia (Gray 1970, 1987, 1994). Sprawdziliśmy czeską wersję BIS/BAS w próbie 473 czeskich dzieci w wieku od 10 do 12 lat. Przeprowadzono analizę pozycji oraz eksploracyjną, a także potwierdzające analizy czynnikowe, które pokazały, że czeska skala BIS/BAS ma satysfakcjonujące właściwości psychometryczne i może być stosowana u dzieci w wieku szkolnym.

Słowa kluczowe: BIS/BAS, teoria wrażliwości na wzmocnienie, dzieciństwo, analiza eksploracyjna, nagroda, kara

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