Psychometric properties of the Dysexecutive Questionnaire (DEX): a study with Brazilian older adults

Camila Rosa de Oliveira[1]
Margarida Maria Baptista Mendes Pedroso de Lima[2]
Sabrina Martins Barroso[3]
Irani Iracema de Lima Argimon[4]

[1]*IMED, Passo Fundo, Rio Grande do Sul, Brasil*
[2]*Universidade de Coimbra, Coimbra, Portugal*
[3]*Universidade Federal do Triângulo Mineiro, Uberaba, Minas Gerais, Brasil*
[4]*Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brasil*

Abstract
This study aimed to verify the psychometric properties of the Dysexecutive Questionnaire (DEX) through exploratory factor analysis (EFA), evidence of reliability, and convergent validity, in a sample of neurologically preserved older adults. Participants were 345 older adults who answered, in addition to DEX, a sociodemographic and clinical questionnaire, the Mini-Mental State Examination (MMSE), and two verbal fluency tasks. The EFA was conducted through Parallel Analysis based on the generation of a polychoric correlation matrix, as well as Pearson's correlation between the DEX scores, age, education, MMSE, and verbal fluency tasks. According to the EFA, the extraction of two factors ("Inhibition" and "Social Regulation and Planning") was suggested and DEX was negatively associated with age and MMSE. In conclusion, DEX presented a satisfactory factorial structure for older adults, which can be considered a reliable self-report measure for complaints of executive functions.
Keywords: factor analysis; aging; cognition; symptom assessment; executive function

Propriedades Psicométricas do Questionário Disexecutivo (DEX): Um Estudo com Adultos Idosos Brasileiros

Resumo
O objetivo deste estudo foi verificar as propriedades psicométricas do Questionário Disexecutivo (DEX) por meio de análise fatorial exploratória (AFE), evidências de confiabilidade e de validade convergente, em uma amostra de adultos idosos neurologicamente preservados. Participaram 345 adultos idosos que responderam, além do DEX, um questionário sociodemográfico e clínico, o Miniexame do Estado Mental (MEEM) e duas tarefas de fluência verbal. A AFE foi conduzida por meio de análise paralela com base na geração de matriz de correlação policórica, bem como correlação de Pearson entre os escores do DEX, idade, escolaridade, MEEM e tarefas de fluência verbal. A AFE sugeriu a extração de dois fatores ("Inibição" e "Regulação Social e Planejamento") e o DEX associou-se negativamente com a idade e com o MEEM. Conclui-se que o DEX apresentou estrutura fatorial satisfatória para adultos idosos, podendo ser considerado uma medida confiável de autorrelato para queixas de funções executivas.
Palavras-chave: análise fatorial; envelhecimento; cognição; avaliação de sintomas; função executiva

Propiedades psicométricas del Cuestionario Disejecutivo (DEX): un estudio con adultos mayores brasileños

Resumen
El objetivo de este estudio fue verificar las propiedades psicométricas del Cuestionario Disejecutivo (DEX) a través del análisis factorial exploratorio (AFE), evidencias de confiabilidad y validez convergente, en una muestra de adultos mayores preservados neurológicamente. Participaron 345 adultos mayores que respondieron, además del DEX, un cuestionario sociodemográfico y clínico, el Mini Examen del Estado Mental (MEEM) y dos tareas de fluidez verbal. La AFE se realizó mediante Análisis Paralelo basado en la generación de una matriz de correlación policórica, así como la correlación de Pearson entre las puntuaciones del DEX, edad, nivel de escolarización, MEEM y tareas de fluidez verbal. La AFE sugirió la extracción de dos factores ("Inhibición" y "Regulación y Planificación Social") y el DEX se asoció negativamente con la edad y con el MEEM. Se concluyó que el DEX presentó una estructura factorial satisfactoria para adultos mayores, lo que puede considerarse una medida de autoinforme fiable para las quejas de funciones ejecutivas.
Palabras clave:análisis factorial; envejecimiento; cognición; evaluación de síntomas; función ejecutiva

Executive dysfunction, also known as dysexecutive syndrome, refers to deficits in executive functions observed when performing daily activities (Chaytor & Schmitter-Edgecombe, 2007). Frontal lobe injuries are often associated with executive dysfunction, as this region is considered the superior cortical center for decision-making, planning, inhibition, and cognitive flexibility (Chan, 2001). Thus, there is an occurrence of

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executive dysfunction in individuals who have suffered injuries in the frontal lobes resulting from traumatic brain injury (Ozga et al., 2018; Wood & Worthington, 2017) and brain stroke (Povroznik et al., 2018; Veldsman et al., 2020). However, there are reports of this condition also in older adults with Mild Cognitive Decline (Junquera et al., 2020; Lee et al., 2019), Alzheimer's Disease (Amanzio et al., 2020; Guarino et al., 2019), and Frontotemporal Dementia (Amanzio et al., 2020; Baez et al., 2017), suggesting that this syndrome is related to neurodegenerative conditions that affect the frontal lobes (Mooney et al., 2006).

The Dysexecutive Questionnaire (DEX) was developed by Wilson et al. (1996) in order to be a scale of complaints of executive functioning based on daily activities. DEX is part of the Behavioral Assessment of Dysexecutive Syndrome, an instrument consisting of ecological activities that assess impairments in different components of executive functions in adults with frontal lobe injury. DEX has a self-report version, and another aimed at informants (for example, family members or caregivers). Both versions comprise 20 items that are answered using a five-point Likert scale, whose high scores indicate a higher frequency of executive losses. The items represent problems related to emotion/personality, behavior, cognition, and motivation, which are frequent in patients with frontal lesions (Fellows, 2019; Stuss & Knight, 2002). However, since the publication of DEX, few studies have reported its psychometric properties in clinical and non-clinical populations (Mooney et al., 2006), with no consensus regarding its factor structure (Pedrero-Pérez et al., 2015).

The first study that investigated the factorial structure of DEX was conducted by Burgess et al. (1998), which included in the sample neurological patients and controls who responded to the self-report version of the instrument. From the analysis of the main components, a solution of five factors was found (inhibition, intentionality, executive memory, positive affect, and negative affect). Other studies have identified a five-factor structure similar to that reported by Burgess et al. (1998), also conducted through principal components analysis (PCA), in a non-clinical population and with neurological conditions based on the self-report version (Amieva et al., 2003; Luna-Lario et al., 2012) and the informant version (Chan, 2001; Chaytor & Schmitter-Edgecombe, 2007). However, factorial structures of six (Pedrero-Pérez et al., 2009), four (Bodenburg & Dopslaff, 2008; Mooney et al., 2006; Yang et al., 2018), three (Shinagawa et al., 2007; Simblett & Bateman, 2011; Wilson et al., 2003), two dimensions (Pedrero-Pérez et al., 2011), and one-dimensional (Takeuchi et al., 2013) are found in the literature.

Specifically in aging, to date, only two studies aimed to identify the factor structure of DEX in the older adult population (Amieva et al., 2003; Shinagawa et al., 2007). Amieva et al. (2003) investigated a sample of neurologically healthy older adults who responded to the self-report version of the instrument, while Shinagawa et al. (2007) included in their sample older adults with Alzheimer's Disease, who responded to the DEX version for informants. The study by Amieva et al. (2003) suggested a five-factor solution for DEX, while the study by Shinagawa et al. (2007) suggested a three-factor solution.

In addition to the factor structure, some international studies searched evidence of convergent validity of DEX with clinical aspects or other instruments. For example, Emmanouel et al. (2014) demonstrated a relationship between DEX results and the presence of brain injury and perception of the severity condition by the professional team. In addition, in the study by Azouvi et al. (2015), DEX was related to years of education, cognitive deficit, dependence on activities of daily living, anxiety, depression, and inability to return to work.

However, the small sample size, the heterogeneity of data collection (self-report or informant), and the data analysis techniques of these studies (Amieva et al., 2003; Shinagawa et al., 2007) suggest the fragility of the results with the older adult population, especially regarding the factor structure of the instrument. Thus, this study aimed to verify the psychometric properties of DEX, through exploratory factor analysis (EFA) from a polychoric correlation matrix, evidence of reliability, and convergent validity, in a sample of neurologically preserved older adults.

Method

Participants

Initially, 381 community older adults, aged 60 years and over, were recruited for convenience from cities in the northern region of Rio Grande do Sul and in the Southwest of Santa Catarina. Among them, 13 were excluded due to a history of neurological or psychiatric illnesses, or primary sensory alterations that were not corrected at the time of the assessment (for example, absence of hearing aids or glasses). Still, another 23 participants were excluded for showing

signs of cognitive decline assessed by the Mini-Mental State Exam (MMSE) (adapted by Chaves & Izquierdo, 1992) considering the cutoff points for education for southern Brazil (Kochhann et al., 2010): ≥ 21 for illiterates, ≥ 22 for low education, ≥ 23 for intermediate education and ≥ 24 for high education. Thus, the final sample included 345 older adults.

Regarding years of age and education, the means were 74.51 (*SD* = 9.14, ranging between 60 and 104 years) and 7.85 (*SD* = 5.90, ranging between 0 and 27 years), respectively. The sample consisted of 105 men (30%) and 240 women (70%), of which 301 (87%) were retired. The written informed consent was obtained from all participants through the Informed Consent Form, which was individually assessed in a single session of approximately 60 minutes. The research received approval from the Research Ethics Committee removed by the IMED Ethics Committee (CAAE: 73088917.5.0000.5319).

Instruments

Sociodemographic and clinical questionnaire. Composed of questions regarding age, education, gender, current occupation, history of neurological or psychiatric diseases, and medication use.

Dysexecutive Questionnaire – DEX (adapted by Macuglia et al., 2016). DEX is a questionnaire answered through self-report or from an informant, consisting of 20 items that investigate the frequency of behaviors associated with dysexecutive problems present in daily activities. In this study, the self-report version was used. Items are answered using a five-point Likert scale ranging from "never" (0 points) to "almost always" (4 points). Thus, the minimum scale score is 0 and the maximum is 80 points, and higher scores suggest a greater occurrence of executive alterations. In its Brazilian version, DEX presented evidence of content validity from the analysis of expert judges (> .80), with a mean Kappa index of .75 (Macuglia et al., 2016).

Phonemic and semantic verbal fluency tasks (Strauss et al., 2006). Verbal fluency tasks are brief measures of cognitive flexibility and inhibition. In the phonemic modality (FAS), participants had 60 seconds to evoke the greatest number of words that started with the letters, F, A, and S. In the semantic modality (Animals), types of animals should be evoked, also in 60 seconds. The score considered for both modalities is the total number of words evoked correctly. In Brazil, the instrument presents evidence of validity for older adults of different age groups and educational levels (Esteves et al., 2015).

Data analysis

Descriptive analysis for variables related to the sociodemographic characteristics of participants (mean, standard deviation, and percentages), data normality, Pearson correlation between the total score and DEX factors with age, education, MMSE, and verbal fluency tasks. The alpha coefficient calculation was performed using SPSS software version 23 for Windows. The interpretation of the strength of associations in the Pearson correlation was based on the classification of Rosenthal (1996): weak ≤ .10, moderate ≥ .30, or strong ≥ .50. The EFA was conducted based on the generation of a polychoric correlation matrix, which was performed with the Factor software (v.10.02; Lorenzo-Seva & Ferrando, 2006).

The procedure adopted to determine the number of factors was Parallel Analysis with random permutation of the observed data (Timmerman, & Lorenzo-Seva, 2011), Robust Diagonally Weighted Least Squares method (RDWLS, Asparohov & Muthen, 2010), and Robust Promin rotation (Lorenzo-Seva & Ferrando, 2019). Unidimensional Congruence (UniCo) and Explained Common Variance (ECV) were used as complementary analyzes in order to verify the occurrence of unidimensionality in the instrument. The reference values to indicate unidimensionality were > .95 for UniCo, > .85 and for ECV (Ferrando & Lorenzo-Seva, 2018).

As a complement to the analyses, the stability of the factors was assessed using the H index (Ferrando & Lorenzo-Seva, 2018), which verified how well the factor is represented by the items, consisting of the H-Latent indices (capacity of the factor to be identified by the latent variable) and H-Observed (expected replicability for future studies). The H index values range from 0 to 1, with values above .80 suggesting a well-defined latent variable and greater stability between studies (Hancock & Mueller, 2001).

In addition, the quality and effectiveness analysis of the factor estimation was verified by Bayes Expected a Posteriori (EAP, expected values > .80), Factor Determinacy Index (FDI, expected values > .90), Sensitivity Ratio (SR, expected values > 2.00) and Expected Percentage of True Differences (EPTD, expected values > 90%) (Ferrando & Lorenzo-Seva, 2018). Composite reliability calculation was based on the formula proposed by Raykov (1997).

Results

The average obtained in the MMSE was 27.25 points (*SD* = 2.24, ranging between 21 and 30 points), while in FAS was 27.49 words (*SD* = 14.24, ranging between 3 and 77 words) and in Animals was 13.42 words (*SD* = 5.33, ranging between 3 and 29 words). Bartlett's sphericity tests (2217.6, *gl* = 190, $p < .001$) and KMO (.80) suggested interpretability of the correlation matrix of the items. The Parallel Analysis (Table 1), according to the RDWLS extraction method, indicated two factors as being the most representative for the data from the recommendation based on the 95th percentile for explained variance, which is a more accurate parameter than the recommendation based on the average (Timmerman & Lorenzo-Seva, 2011). The explained variance, considering the two factors, was approximately 38%. The UniCo (.840) and ECV (.743) indices did not suggest the unidimensionality of the instrument.

The means, standard deviation, factor loadings of items, quality estimates and measures of internal consistency of the DEX are presented in Table 2, as well as estimates of replicability of the factor scores (H index; Ferrando & Lorenzo-Seva, 2018). The analysis of the quality and effectiveness of estimating factor scores was considered adequate based on the EAP indexes (Factor 1 = .82 and Factor 2 = .86), FDI (Factor 1 = .90; Factor 2 = .93), SR (Factor 1 = 2.10 and Factor 2 = 2.51) and EPTD (Factor 1 = 90% and Factor 2 = 91%). Factor 1 was composed of six items (5, 6, 8, 10, 15, and 16), while Factor 2 was composed of nine items (2, 4, 7, 9, 12, 13, 14, 19, and 20). Items 1, 3, 11, 17, and 18 did not show factor loadings above 0.40 for any of the two factors.

In general, the items had high factor loadings, with no pattern of cross-loadings being found (for example, items with factor loadings above .40 in more than one factor). The composite reliability of the factors was also adequate (> .70). Analysis of the H index, a measure of

Table 1.
Factors Extracted in the Parallel Analysis by the RDWLS Method (n = 345)

Factors	% of explained variance of the real data	% of explained variance of random data (95% IC)
1	31.6035	11.3970
2	11.7983	10.2736
3	8.9685	9.4499
4	6.7083	8.7828
5	5.8149	8.1844
6	4.8773	7.6218
7	4.7295	7.0306
8	4.1157	6.5735
9	3.5076	6.0719
10	3.2957	5.6062
11	2.8770	5.1940
12	2.5290	4.7294
13	2.1987	4.2556
14	2.0467	3.8367
15	1.5742	3.3608
16	1.2797	2.9371
17	1.1054	2.3943
18	.7200	1.9345
19	.2500	1.2995

Note. The number of factors to be retained is equivalent to two, as two factors of the real data have a higher % explained variance than the random data.

Table 2.
DEX Descriptive Data and Factor Structure (n = 345)

	Itens	*M*	*SD*	Factors	
				1	2
16.	Inability to inhibit responses	1.23	1.38	**.715**	-.238
15.	Restlessness-hyperkinesis	1.07	1.26	**.664**	-.233
10.	Variable motivation	1.29	1.22	**.640**	.065
6.	Temporal sequencing deficits	0.82	1.06	**.480**	.145
5.	Euphoria	1.84	1.25	**.442**	-.218
8.	Apathy and lack of drive	1.07	1.21	**.437**	.126
12.	Aggression	.76	1.03	-.073	**.675**
9.	Disinhibition	.27	.68	-.160	**.653**
13.	Lack of concern	.44	.87	-.263	**.653**
2.	Impulsivity	.63	.95	-.039	**.636**
14.	Perseveration	.69	.97	-.083	**.619**
20.	No concern for social rules	.79	1.09	-.279	**.596**
7.	Lack of insight and social awareness	.71	.99	.145	**.537**
19.	Poor decision-making ability	.96	1.12	.258	**.508**
4.	Planning problems	1.02	1.20	.094	**.435**
1.	Abstract thinking problems	1.11	.97	.261	.372
3.	Confabulation	.35	.76	.273	.333
11.	Shallowing of affective responses	1.67	1.38	.296	.131
17.	Knowing–doing dissociation	.46	.77	.314	.326
18.	Distractibility	1.28	1.21	.313	.397
Eingen value				5.51	2.11
% of explained variance				27.55	10.52
composite trust				.74	.83
alpha coeficiente				.66	.71
H-Latent				.82	.86
H-Observed				.76	.81

Note. Minimum and maximum values for each item are equivalent to 0 and 4, respectively, with 0 being the minimum total score and 80 being the maximum total DEX score. Factor loadings ≥ 0.400 were highlighted.

replicability of the factor structure, suggested that Factor 1 might not be replicable in future studies (H < .80). The DEX showed satisfactory internal consistency considering the Composite Reliability values (> .70), which is a reliability measure that considers the contribution of the factor loadings of each item (Table 2).

The data regarding the correlation between the factors and total DEX score with sociodemographic variables, MMSE, PVFT, and SVFT are presented in Table 3. Factor 1 was negatively associated (weak intensity) with education, MMSE, and verbal fluency tasks. Factor 2 was negatively associated (weak intensity) with education and verbal fluency tasks, in addition to positively (moderate intensity) with age. The DEX total score was negatively associated with the MMSE and positively associated with age, both with weak intensity.

Discussion

This study aimed to investigate the psychometric properties of DEX in a sample of neurologically preserved older adults. In this study, a two-factor solution

Table 3.
Correlation Coefficients between DEX, Age, Education, MMSE, PVFT, and SVFT (n = 345)

	DEX		
	Factor 1	Factor 2	Total
Age (years)	.071	.302**	.162*
Education (years)	-.226**	-.209**	-.014
MMSE (escore)	-.189**	-.050	-.168*
PVFT – FAS (escore)	-.260**	-.204**	-.054
SVFT – Animals (escore)	-.192**	.165*	-.044

Note. MMSE = Mini-Mental State Exam; PVFT = Phonemic Verbal Fluency Task; SVFT = Semantic Verbal Fluency Task.

* $p \leq .01$; ** $p \leq .001$.

was found, which explained 38% of the variance, in addition to reliability indices between the factors that ranged from .74 to .83 (Composite reliability) and .66 to .71 (alpha coefficient). The first factor, consisting of six items, was called "Inhibition" and included questions related to euphoria, temporal sequencing problems, apathy, variable motivation, agitation, and response inhibition. The second factor, consisting of nine items, was called "Social Regulation and Planning", presenting issues related to planning, lack of insight, aggression, lack of concern, perseveration, decision-making, no concern for social rules, and social awareness

The observed two-factor solution differs from that identified in the original study by Burguess et al. (1998), which obtained five factors in a sample of adults. It also differs from other studies with the self-report version of the instrument, which identified between one and six factors with varied samples (Bodenburg & Dopslaff, 2008; Hellebrekers et al., 2017; Mooney et al., 2006; Pedrero-Pérez et al., 2009; Simblett & Bateman, 2011; Takeuchi et al., 2013; Wilson et al., 2003; Yang et al., 2018). However, the findings corroborate the model identified by Pedrero-Pérez et al. (2011), in which two factors were also identified: planning (disorganization/apathy) and ability to inhibit inappropriate behavior (disinhibition/impulsivity).

Specifically in older adults, dissonant results are also observed when comparing data from Amieva et al. (2003) and Shinagawa et al. (2007), who presented, respectively, solutions of five (interference management, intentionality, inhibition, planning, and social regulation) and three (apathy, planning and monitoring, and hyperactivity) factors from PCA. There is a possibility that the differences between the results are due to the sample size used between the surveys. The study by Amieva et al. (2003) included only 20 neurologically preserved elderly adults and that of Shinagawa et al. (2007) included 122 older adults with Alzheimer's Disease. The adoption of a sample with less than 10 participants per item of the evaluated instrument contradicts literature indication for psychometric or inferential analyzes (Pasquali, 2010; Tabachnick & Fidell, 2013). These characteristics, in addition to the factor extraction technique used, may have influenced the high value of explained variance between these studies, which ranged from 65% to 76%. Furthermore, Amieva et al. (2003) used the self-report version and Shinagawa et al. (2007) the informant's version.

Although in this sample DEX presented two factors, these resemble some of the original factors proposed by Burgess et al. (1998), which indicates the usefulness of DEX as an instrument for the assessment of executive dysfunctions in older adults. Furthermore, Pedrero-Pérez et al. (2011) demonstrated that executive control varies throughout the aging process. Thus, extreme ages, such as children (Fish & Wilson, 2021) and older adults (Shinagawa et al., 2007), may present different groupings of factors due to changes in this construct throughout the life cycle.

Correlation analyzes between DEX factors, sociodemographic characteristics, and cognitive measures suggested that higher Inhibition Factor scores were associated with less education time, lower overall cognitive ability (MMSE), and lower cognitive fluency/flexibility (PVFT and SVFT). While higher results in Social Regulation and Planning showed an association with lower education level and cognitive fluency/flexibility, in addition to older age. These data are in line

with the literature, identifying different executive components present changes in the aging process (Hirsiger et al., 2017; Turner & Spreng, 2012), susceptible to variables such as years of education (Azouve et al., 2015; Farina et al., 2018; Thow et al., 2017). The association between DEX, MMSE, and fluency tasks demonstrates evidence of convergent validity between scores of screening instruments for assessing general cognitive aspects, and executive functions and subjective complaints scale, indicating its usefulness for assessing aspects that impact functional capacity to perform daily activities.

Among the limitations, the non-inclusion of other gold standard instruments for executive functions is highlighted, for example, the Wisconsin Card Sorting Test and the Five Digit Test, in order to verify other validity evidence based on external variables. For future studies, factor analyzes conducted with different populations simultaneously are suggested, in order to test the impact of the external characteristics of the sample and to conduct comparisons between the self-report version and the informant version. Furthermore, it is possible to perform investigations of convergent validity between DEX and emotional and personality aspects, since executive difficulties may be present in neuropsychiatric conditions.

In general, the results of this study indicated that DEX had a satisfactory factor structure for older adults, in addition to its score being associated with formal measures of executive functions and cognition in general, suggesting clinical applicability. As far as known, this is the first study with a significant sample of older adults to conduct EFA, using statistical techniques more appropriate for the type of response scale of the instrument. Thus, DEX was an appropriate tool for the Brazilian context for the cognitive assessment that complements instruments of executive function performance.

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About the authors:

Camila Rosa de Oliveira – Post-Doctorate in Psychology (PUCRS), Doctorate in Biomedical Gerontology (PUCRS), Master in Psychology (PUCRS) and Psychologist (UFRGS). Professor of the Postgraduate Program in Psychology at IMED. CNPq Research Productivity Scholarship, level 2.
ORCID: https://orcid.org/0000-0003-2115-604X
E-mail: oliveira.crd@gmail.com

Margarida Maria Baptista Mendes Pedroso de Lima – Doctorate in Psychology (University of Coimbra), Master in Educational Sciences (University and Coimbra) and Psychologist (University of Coimbra). Professor of the Post-graduate Program in Psychology at the University of Coimbra.
ORCID: https://orcid.org/0000-0003-4559-9152
E-mail: mplima@fpce.uc.pt

Sabrina Martins Barroso – Doctor in Public Health (UFMG), Master in Psychology (UFMG) and Psychologist (UFSJ). Professor of the Postgraduate Program in Psychology at the Federal University of Triângulo Mineiro. CNPq Research Productivity Scholarship, level 2.
ORCID: https://orcid.org/0000-0003-1759-9681
E-mail: smb.uftm@gmail.com

Irani Iracema de Lima Argimon – Post-Doctorate in Psychology (UCV), Doctor in Psychology (PUCRS), Master in Education (PUCRS) and Psychologist (PUCRS). Professor of the Graduate Program in Psychology at the Pontifical Catholic University of Rio Grande do Sul. Research Productivity Scholarship from CNPq, level 1C.
ORCID: https://orcid.org/0000-0003-4984-0345
E-mail: argimoni@pucrs.br

Contact:

Rua Gen. Prestes Guimarães, 304, Vila Rodrigues
Passo Fundo-RS, Brasil
CEP: 99070-220