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Spanish adaptation and validation of the Dula Dangerous Driving Index (DDDI)

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Abstract

The Dula Dangerous Driving Index (DDDI) is a widely used questionnaire that measures the tendency to drive dangerously on the road through three different types of behaviors: aggressive driving, risky driving, and experiencing negative emotions while driving. This study aimed to develop a Spanish version of the DDDI and verify the reliability and validity of this questionnaire in the Spanish population. A community sample of 2174 Spanish participants (51.1% male; age range: 18–79 years) completed the 28-item Spanish version of the DDDI. Confirmatory factor analysis revealed that a three-factor model fitted adequately to the data. Analysis of internal consistency, test–retest reliability, and convergent validity showed that the Spanish adaptation of the DDDI had good psychometric properties and retains the theoretical consistency of the original scale. Gender and age differences were observed. The Spanish version of the DDDI can be considered a good instrument for assessing dangerous driving behavior, thus contributing to the cross-cultural study of these types of behaviors and the possible development of intervention programs aimed at reducing road traffic accidents.

KEYWORDS
dangerous driving, DDDI, reliability, risky driving, Spanish adaptation, validity

1 | INTRODUCTION

Road safety is an issue of great political and social concern. According to the latest WHO global status report on road safety (World Health Organization, 2018a), road crashes account for 1.35 million deaths per year globally and are the leading cause of death in young adults and children while causing serious and irreversible injuries to 50 million victims. Although road accidents have multiple causes, most studies agree that the human factor is the main contributor (Bucsuházy et al., 2020; Rolison et al., 2018; Wierwille et al., 2002).

Sometimes, drivers can inadvertently engage in behaviors that involve risks, which often stem from a lack of experience or unintended distractions. However, a surprisingly large number of road accidents result from dangerous behaviors that are performed intentionally or consciously (e.g., exceeding the speed limit, illegal overtaking, or driving aggressively; DGT, 2021; Iversen, 2004; Lajunen et al., 1998; NHTSA, 2018).

Concerning these intentionally dangerous behaviors, Dula and Geller (2003) made a notable distinction between aggressive and risk-taking behaviors. Aggressive driving (AD) involves behaviors aimed at causing harm to other road users and includes actions such as aggressive gesticulations and verbalizations or physical aggressions towards the vehicle or person. These behaviors are often conducted as a means of expressing frustration and anger (Deffenbacher et al., 2002; Dula & Geller, 2003). In contrast, the term risky driving (RD) encompasses those behaviors that involve deliberate risk-taking, but their purpose is not to harm other road users. Speeding, driving under the influence of alcohol, using a mobile phone, or disregarding traffic rules are all examples of RD behavior. Moreover, this driving style is not necessarily associated with negative emotional states (Dula & Geller, 2003; Richer & Bergeron, 2012).

In general, the definitions and terminology employed for AD and RD are often used interchangeably in the literature (see Dula & Geller, 2003] for some examples). This ambiguity can create a barrier to the correct understanding and communication of the findings and implications of these studies. It is important to emphasize that AD is inherently motivated by the intent to harm others (e.g., activating high-beam headlights to dazzle the driver ahead, who is perceived as aggravating). On the other hand, RD behavior is not inherently intended to cause harm to others but is instead motivated by the pursuit of a reinforcer (e.g., driving over the speed limit to reach a destination sooner), which may have the potential to harm others as a collateral effect. Using consistent definitions that consider these differences would help to better understand the factors underlying these behaviors and discriminate between distinct driver profiles.

In addition, following the works of Dula et al. (Dula & Ballard, 2003; Dula & Geller, 2003; Willemsen et al., 2008), these authors integrated a third idea into the overall concept of dangerous driving behavior, which is related to experiencing negative emotions while driving, such as anger, frustration, discontent, or jealousy. Negative emotional driving (NED) pertains to the act of driving under the influence of negative emotions or being guided by negative attitudes toward certain driving situations (e.g., driving while angry or becoming highly agitated in a traffic jam). Although the literature has shown a clear positive relationship between negative emotions and the tendency to behave in an aggressive manner (Kovácsová et al., 2016), people can use coping strategies to manage their emotions and thus do not necessarily show aggressive behaviors (Galovski et al., 2006; Gutiérrez-Cobo et al., 2018; Zhou et al., 2022). However, regardless of whether or not negative emotions lead to aggressive behavior, the fact that these emotions are present while driving is in itself a potential source of danger, as it deprives the driver of cognitive resources and decreases their levels of attention,

which, in turn, increases the likelihood of being involved in an accident (Megías et al., 2011, 2014; Richer & Bergeron, 2012; Sullman et al., 2007; Willemsen et al., 2008). Hence, it is important to include this variable as an additional and independent facet to consider when explaining dangerous behavior.

Dula and Ballard (2003) created the Dula Dangerous Driving Index (DDDI), a 28-item self-report scale to study dangerous driving behaviors. The scale measures, in a single instrument, the propensity to behave dangerously while driving through the three facets previously described: AD (seven items), RD (12 items), and driving under negative emotions (nine items). The independence of these three factors (AD, RD, and NED) has been corroborated by several DDDI validation studies (Dula & Ballard, 2003; Iliescu & Sârbescu, 2013; Willemsen et al., 2008).

Prior research has shown that high scores on the DDDI are associated with negative outcomes, such as a higher frequency of driving offenses, administrative sanctions, and the number and severity of traffic accidents (e.g., Balzarotti et al., 2023; Gianfranchi et al., 2017; Megías-Robles et al., 2022; Monteiro et al., 2019; Wu et al., 2014). For instance, Wu et al. (2014), using naturalistic driving data, observed that high scores on the DDDI were associated with an increased likelihood of driver involvement in crashes. Gianfranchi et al. (2017) conducted a study with a moped-riding simulator. They found that participants classified as imprudent riders (through a set of indexes extracted from the simulator) obtained higher scores on AD and total DDDI. This effect was also modulated by driving experience in terms of mileage.

Currently, the DDDI is a widely used instrument, and the original English version has been translated and validated for use in different populations, including French (Richer & Bergeron, 2012), Chinese (Qu et al., 2014), Dutch (Willemsen et al., 2008), and Romanian (Iliescu & Sârbescu, 2013). However, no Spanish validation has been published to date. Given that the latter is the second most widely spoken language worldwide with around 500 million native speakers, studies of road safety would benefit from having a Spanish adaptation of the DDDI, not only for linguistic reasons but also because of the cross-cultural differences often observed in driving styles (Di Stasi et al., 2020; Özkan et al., 2006; Sagberg et al., 2015). Therefore, the present study aimed to develop and analyze the reliability and validity of the Spanish version of the DDDI based on the original instrument of Dula and Ballard (2003) to obtain an effective and reliable measure of dangerous driving behavior in the Spanish-speaking population.

As a supplementary aim, we also explored potential gender and age differences in driving styles based on previous literature (Megías-Robles et al., 2022; Navas et al., 2019; Ventsislavova et al., 2021). Several studies have found a higher degree of AD in men compared with women (Deffenbacher et al., 2002; Herrero-Fernández, 2011b; Shinar & Compton, 2004), a finding confirmed by Dula and Ballard (2003) in the DDDI with a US sample. These authors reported lower scores on the AD and RD subscales in women, whereas the same pattern of results was found in a Canadian sample studied by Richer and Bergeron (2012). Concerning age, various studies have reported disparities in dangerous driving behavior across different age groups

(Deffenbacher et al., 2002; Dula & Ballard, 2003; Herrero-Fernández, 2011b; Iliescu & Sârbescu, 2013; Richer & Bergeron, 2012; Shinar & Compton, 2004). Although there is a general tendency for dangerous driving behaviors to decrease with age, the results are not always consistent since age and driving experience are not always jointly measured. For instance, whereas Qu et al. (2014) indicated that younger individuals tend to have higher RD scores, these authors also found that a greater number of driving years correlated with higher scores on aggressive and dangerous driving.

2 | METHODS

2.1 | Participants

The study included a community sample of 2174 Spanish drivers with a valid driving license, of whom 1127 were men (51.8%). Ages ranged from 18 to 79 years (M_{age} = 38.05; SD = 14.28). Participants were recruited using the snowball technique with the help of psychology students from the University of Málaga. Those interested in participating in the study contacted the authors by email. Subsequently, they received a link to access and complete the questionnaires online. The inclusion criteria for participating in the study were possessing a valid driving license and being 18 years or older. All participants were informed of the confidentiality and anonymity of their data and treated in accordance with the Helsinki Declaration (World Medical Association, 2009). The study was previously approved by the Research Ethics Committee of the University of Málaga (approval number: 10–2019-H).

2.2 | Procedure

The process of translating and adapting the DDDI instrument followed the protocol outlined by the World Health Organization (2018b) and the International Test Commission (2017). The preconditioning, test development, confirmation, administration, score scales and interpretation, and documentation guidelines were satisfied (International Test Commission, 2017). First, a bilingual translator (English/Spanish) translated the original scale into Spanish. Then, a second independent translator translated the scale back into English. The translators and the authors (experts in traffic research) assessed the congruence between the original and the back-translated versions and identified and resolved possible inconsistencies regarding concepts and expressions. Semantic equivalences and discrepancies were compared and resolved by consensus. The original 5-point Likert scale was maintained in the Spanish version. The final version is presented in the Appendix Table A1.

All participants completed the Spanish version of the DDDI online via the Limesurvey platform (www.limesurvey.com). The authors granted participants access to the survey via email. In addition to the full sample, a smaller randomly selected subset of participants completed the following questionnaires to assess the convergent validity of the DDDI: The Driving Anger Scale (DAS), the Distracted Driving Scale (DDS), and the Manchester Driver Behavior Questionnaire (DBQ). Finally, 3 months after the initial evaluation, a group of 100 participants was randomly selected and contacted via email. They were again invited to complete the DDDI questionnaire online to determine the instrument's test–retest reliability.

2.3 | Instruments

The DDDI (Dula & Ballard, 2003; Willemsen et al., 2008) is a self-report questionnaire designed to measure dangerous driving behavior. The questionnaire is composed of 28 items divided into three dimensions: AD, RD, and NED. This questionnaire allows a score to be obtained for each of the subdimensions and a total score. Participants are asked to respond on a 5-point Likert scale (1 = Never; 2 = Rarely; 3 = Sometimes; 4 = Often; and 5 = Always) about the frequency with which they engage in behaviors such as "I verbally insult drivers who annoy me," "When passing a car/truck on a two-lane road, I will barely miss on-coming cars", and "When I get stuck in a traffic jam, I get very irritated." This questionnaire has shown good internal consistency (Cronbach's α for AD = .84; Cronbach's α for RD = .83; Cronbach's α for NED = .85; total DDDI = 0.92), and adequate construct validity (Willemsen et al., 2008).

To assess the convergent validity of the DDDI, we employed the DAS, DDS, and DBQ instruments. These three questionnaires evaluate various types of dangerous driving behavior. The previous literature has already demonstrated the relationship between the DDDI and certain behaviors measured by these instruments (Balzarotti et al., 2023; Deffenbacher et al., 2002; Gianfranchi et al., 2017; Megías-Robles et al., 2022; Monteiro et al., 2019; Richer & Bergeron, 2012). It should be noted that there is no validated Spanish version of the DDS. Consequently, this questionnaire was translated into Spanish for this study, showing good psychometric properties similar to those of its original versions (see the questionnaire description below).

The short version of the DAS (Herrero-Fernández, 2011a) is a self-report questionnaire that assesses the degree of anger provoked by certain driving situations. It is composed of 14 items divided into three subscales: Impeded Progress by Others (assesses the degree of anger provoked by situations in which our driving fluency is affected by the actions of others, e.g., "Someone is slow in parking and holds up traffic"), Reckless Driving (measures the degree of anger provoked by situations in which other drivers perform risky maneuvers, e.g., "Someone runs a red light or stop sign"), and Direct Hostility (evaluates the degree to which we are provoked by other drivers' hostility towards us, e.g., "Someone makes an obscene gesture toward you about your driving"). Each item is answered on a 5-point Likert scale (1 = not at all; 3 = some anger; 5 = a lot of anger), yielding a total score and a score for each subscale. This questionnaire has shown good psychometric properties (Impeded Progress by Others: α = .77; Reckless Driving: α = .66; Direct Hostility: α = .87; total DAS:

α = .84; Herrero-Fernández, 2011a). In our sample, the psychometric properties of this scale were also good (α = .89).

The DDS (Engelberg et al., 2015) is a self-report questionnaire that measures the frequency of using a mobile phone while driving. It includes 14 items on driving behaviors, such as: "Of the time you spend driving, how much of the time is spent using any function of a cell phone (i.e., talking, texting, music, apps)?" Participants are asked to respond on a 5-point Likert-type scale (0 = *never*; 1 = *rarely*; 2 = *sometimes*; 3 = *often*; 4 = *frequently*). This questionnaire has shown good psychometric properties (α = .88; Engelberg et al., 2015). In our sample, the psychometric properties of this scale were also good (α = .89).

The DBQ (Reason et al., 1990) is also a self-report instrument that measures aberrant driver behavior through four subscales: violations, aggressive violations, errors, and lapses (e.g., "Disregarding the speed limit on a residential road" or "Sounding your horn to indicate your annoyance at another road user"). This questionnaire consists of 28 items and uses a 6-point Likert scale (0 = *never*; 1 = *rarely*; 2 = *sometimes*; 3 = *often*; 4 = *frequently*; 5 = *all the time*) and has shown good psychometric properties with α values ranging between .70 and .76 (see Gras et al., 2006). Similarly, the psychometric properties of this questionnaire in our sample were also good (violations: α = .74; aggressive violations: α = .75; errors: α = .82; lapses = α = .74; DBQ total: α = .91).

2.4 | Data analysis

First, to explore the characteristics of the sample and the DDDI scores, we conducted a descriptive analysis of the data along with t tests and Pearson's correlations to study possible gender and age differences.

Second, to verify that the Spanish version of the DDDI maintained the same three-factor structure as the original English version, a Confirmatory Factor Analysis (CFA) was carried out. Given that the collected data were ordinal and the levels of skewness and kurtosis (absolute values >3) indicated that the multivariate normality assumption was not met, we used diagonally weighted least squares as an estimation method (see Li, 2016). The following indices were used to assess model fit: chi-square (χ^2), root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and goodness-of-fit index (GFI)

(see Wang & Wang [2012] and McDonald & Ho [2002] for interpretation and criteria used to evaluate the goodness-of-fit of the model). In addition, based on previous literature (Qu et al., 2014), we also assessed the fit of a one-factor model and a four-factor model, and examined whether it provided a better fit than the original three-factor model. Finally, possible gender differences in the model fit were examined using a multigroup CFA.

Third, the internal consistency of the scores for the total scale and the three subscales was analyzed using Cronbach's α coefficient. Fourth, a test–retest analysis (more than 3-month interval) was carried out using Pearson's correlation coefficient to examine the temporal stability of the DDDI scores. Finally, we examined the convergent validity of the DDDI by analyzing its relationship with the DAS and DDS questionnaires, two measurement instruments that assess driving actions or beliefs previously associated with dangerous behavior (Bergmark et al., 2016; Ge et al., 2017), using Pearson's correlations. The statistical R package lavaan 0.6–16 and JASP 0.18.1 were used to conduct the CFA (Rosseel, 2012). The software IBM SPSS 24.0 was used for the remaining analyses.

3 | RESULTS

3.1 | Descriptive analysis

Table 1 shows the means and SDs of the DDDI scores and t tests examining gender differences. Results of the t tests revealed significant gender differences on all DDDI subscales and the total score, with men scoring higher than women ($p < .001$). Cohen's d ranged from 0.20 to 0.53, indicating that the effect sizes for these gender differences were small to medium. Regarding age, Pearson's correlations revealed that age was negatively related to Total DDDI ($r = -.15$; $p < .001$), AD ($r = -.08$; $p < .001$), RD ($r = -.20$; $p < .001$), and NED ($r = -.09$; $p < .001$).

3.2 | CFA

Figure 1 shows the path diagram of the three-factor model, including the factors of AD, RD, and NED. Before conducting the CFA, the Kaiser–Meyer–Olkin test (0.95) and Bartlett Sphericity tests

TABLE 1 Descriptive statistics (means and SD) and t tests examining gender differences (t value and Cohen's d effect size) for the total DDDI scores and the three DDDI subscales.

	Mean for the total sample (SD)	Mean for men (SD)	Mean forwomen (SD)	Gender differences	
				t value	Cohen's d
AD	1.69 (0.62)	1.81 (0.67)	1.57 (0.55)	9.14**	0.39
RD	1.68 (0.55)	1.81 (0.60)	1.53 (0.45)	11.93**	0.53
NED	2.29 (0.61)	2.35 (0.63)	2.23 (0.58)	4.58**	0.20
Total DDDI	1.88 (0.52)	1.98 (0.57)	1.77 (0.44)	9.85**	0.41

Note: Scores are presented for the total sample and the sample split by gender.

Abbreviations: AD, aggressive driving; RD, risky driving; NED, negative emotional driving; Total DDDI, Dula Dangerous Driving Index.
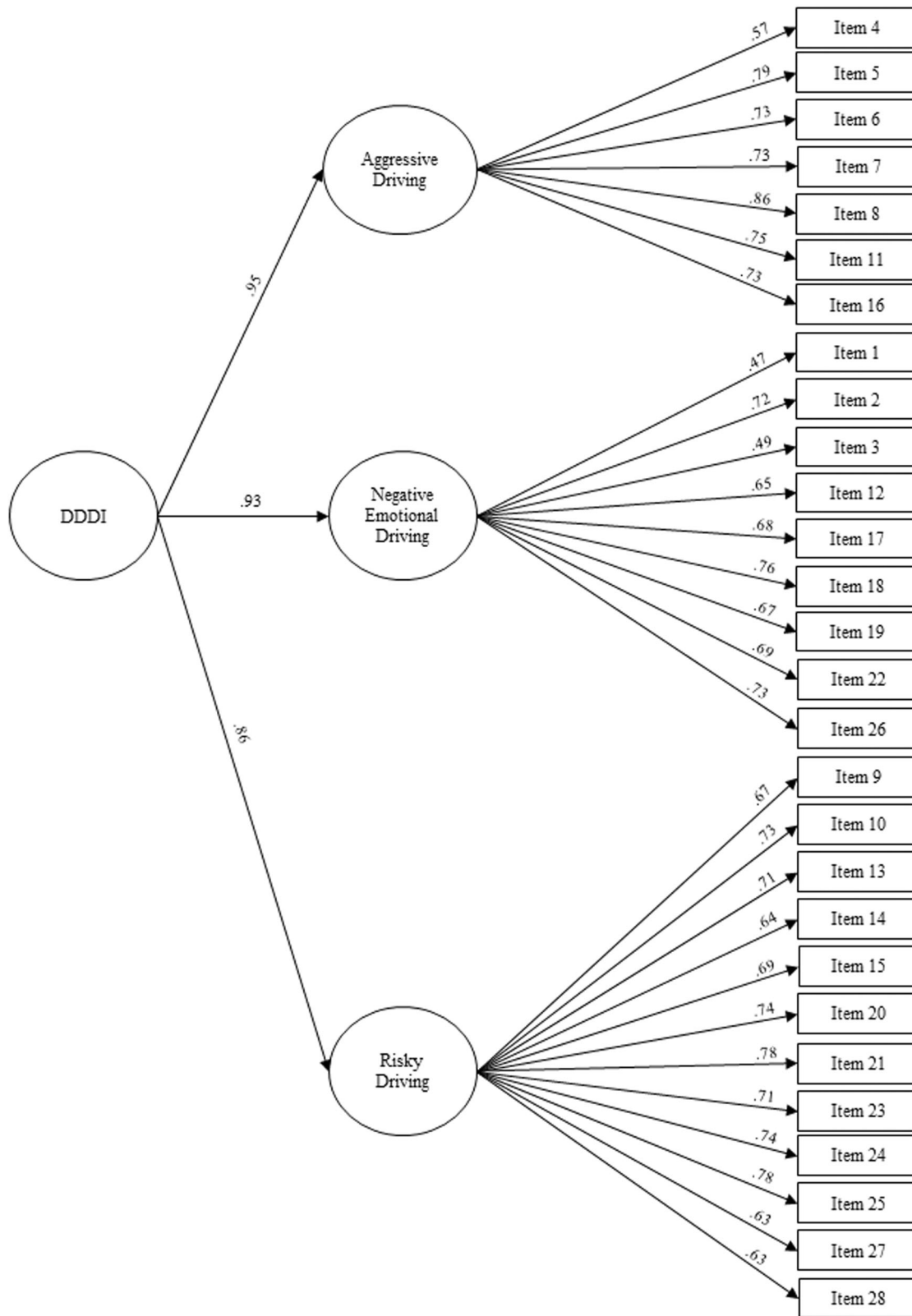
**p < .001.

FIGURE 1 Path diagram showing the confirmatory factorial analysis for the three-factor model. Factor loadings are shown.

(p < .001) confirmed the sampling adequacy for the factor analysis. The CFA revealed a good fit of the model ($\chi^2(347) = 4028.64$, $p < .001$; CFI = 0.98, GFI = 0.98, RMSEA = 0.07, SMR = 0.05) and all factor loadings were statistically significant ($p < .001$).

Given that prior studies validating the factor structure of the DDDI have also observed a good fit for a four-factor model when items related to driving under the influence of alcohol were considered as a separate factor (Items 15 and 25; Qu et al., 2014),

we decided to compare this four-factor model with the previous three-factor model. Moreover, we explored the possible fit of a one-factor model. The CFAs revealed good fit indices for both the four-factor model ($\chi^2(346) = 3260.35$, $p < .001$; CFI = 0.98, GFI = 0.98, RMSEA = 0.06, SRMR = 0.05) and the one-factor model ($\chi^2(350) = 6148.65$, $p < .001$; CFI = 0.96, GFI = 0.97, RMSEA = 0.09, SRMR = 0.07), although in the latter case the values were slightly lower. Chi-square difference tests revealed significant differences between the three models (all $p < .001$). However, the χ^2 test is strongly influenced by sample size, being highly sensitive in large samples (as in our case; see Cheung & Rensvold, 2002; Meade et al., 2008). Consequently, given that the model fit indices displayed a similar fit for the three- and four-factor models, and the original version of the DDDI consists of three factors, we decided to accept the three-factor model as the most appropriate.

Finally, in a supplementary analysis, we confirmed that the three-factor model demonstrated an acceptable fit for both genders (men: $\chi^2(347) = 2447.76$, $p < .001$; CFI = 0.98, GFI = 0.98, RMSEA = 0.07, SRMR = 0.05; women: $\chi^2(347) = 1988.83$, $p < .001$; CFI = 0.97, GFI = 0.98, RMSEA = 0.07, SRMR = 0.06). A multigroup CFA examining measurement invariance between genders revealed significant differences in factor loadings (configural vs. metric models: $p < .001$). These differences were attributed to the generally higher factor loadings for men than women (note the already mentioned high sensitivity of the chi-square test in large samples). Nevertheless, the factor structure was reliable for both men and women, with all factor loadings being statistically significant in both groups ($p < .001$).

3.3 | Internal consistency

The internal consistency of the Spanish version of the DDDI was excellent for the total score (Cronbach's $\alpha = .93$) and good for the three subscales (Cronbach's α for AD = .82; Cronbach's α for RD = .86; Cronbach's α for NED = .82). These results are similar to those obtained in the original English version (Dula & Ballard, 2003; Willemsen et al., 2008).

3.4 | Test–retest reliability

Regarding the test–retest analyses conducted over more than a 3-month time interval ($N = 51$), Pearson's correlations were statistically significant ($p < .001$) and showed r coefficients that suggest good or acceptable reliability for the Total score ($r = .79$), the AD subscale ($r = .70$), the RD subscale ($r = .71$), and the NED subscale ($r = .76$). These results indicate the stability in the scores obtained in the DDDI questionnaire. Note that although the sample size was small, the means for the total score and each DDDI subscale among participants included in the test–retest were similar to those of the overall sample (t tests comparing these DDDI means revealed no significant differences: all $p > .05$).

TABLE 2 Pearson's correlations between the DDDI scores (total and subscales) and the DAS, DDS, and DBQ questionnaires.

Questionnaires	Total DDDI	AD	RD	NED
DAS total	0.49**	0.42**	0.35**	0.55**
DAS impeded progress by others	0.56**	0.46**	0.46**	0.47**
DAS reckless driving	0.35**	0.31**	0.21**	0.43**
DAS direct hostility	0.39**	0.37**	0.27**	0.44**
DDS total	0.48**	0.39**	0.53**	0.34**
DBQ total	0.74**	0.64**	0.72**	0.57**

Abbreviations: DAS, Driving Anger Scale; DDDI, Dula Dangerous Driving Index; DDS, Distracted Driving Scale.
**$p < .01$.

3.5 | Convergent validity

To assess the convergent validity of the Spanish version of the DDDI, Pearson's correlation analyses were conducted with a sample of 1573 participants for the DAS and 740 participants for the DDS and the DBQ. Table 2 shows the Pearson's coefficients for both the total scores and the subscales of the four questionnaires. The results revealed statistically significant positive correlations between the DDDI and the other three questionnaires (DBQ, DDDI, and DDS) both for the total scores and the subscales (all $p < .01$), with moderate to high effect sizes found for most of the relationships (see Table 2). These findings suggest that the Spanish version of the DDDI questionnaire maintains good convergent validity.

4 | DISCUSSION

The aim of this study was to develop and validate a Spanish version of the DDDI (Dula & Ballard, 2003; Willemsen et al., 2008) through the use of a large Spanish community sample of drivers. The results obtained in a sample of 2174 participants showed that the 28-item Spanish version of the DDDI has good psychometric properties and theoretical consistency similar to that of the original scale.

This work provides further evidence of the factorial structure of the DDDI since CFA revealed a good fit of the original three-factor model to our Spanish community sample (our results also provided evidence of an adequate fit for a four-factor model that has been previously studied in the literature). These findings are consistent with those of the original study and support the notion of a multidimensional model of dangerous driving behavior (Dula & Ballard, 2003; Richer & Bergeron, 2012). This model captures AD, RD, and experiencing negative emotions, while driving as three distinct and interrelated entities that constitute dangerous driving behavior.

Concerning the reliability of the questionnaire, the internal consistency of the scale was good, with all Cronbach's α values being

above .80 (.86 for the AD and RD subscales, .82 for the NED subscale, and .93 for total dangerous driving). These values are similar to (and even higher than) those found in the original scale, whose α values ranged between .67 and .88 for the three subscales and between .90 and .93 for the total score (Dula & Ballard, 2003; Willemsen et al., 2008). In addition, the test-retest reliability coefficients were adequate for the total DDDI score and its three subscales, showing temporal consistency across different time points.

This study also provides evidence to support the DDDI as a valid measure of the tendency to engage in dangerous driving. The convergent validity analysis revealed positive relationships between the DDDI and the DAS (total and subscales), the DDS, and the DBQ questionnaires. A greater propensity to drive dangerously was related to a higher tendency to experience anger while driving (DAS), particularly in situations where progress is impeded by others (e.g., when a vehicle drives too slowly and blocks the way) and when someone takes reckless actions (such as unpermitted overtaking) or shows hostile behaviors (e.g., another driver yells at someone for their driving). This result is consistent with the recent findings of Balzarotti et al. (2023) who reported significant correlations between all the scales of the DDDI and the factors of the Driving Anger Expression Inventory developed by Deffenbacher et al. (2002) to measure driving anger. In addition, higher dangerous driving behavior scores were also associated with the risk behavior of using a mobile phone while driving (DDS) and with higher aberrant driver behavior on the road (DBQ). This is consistent with previous studies showing that higher scores on the DDDI are related to a higher frequency of risky behaviors, driving offenses, and number of traffic accidents (Gianfranchi et al., 2017; Megías-Robles et al., 2022; Monteiro et al., 2019; Richer & Bergeron, 2012). Moreover, results from Balzarotti et al. (2023) and Grasso and Tagliabue (2022), who investigated the relation between aberrant behaviors, as measured by using a validated Italian 27-item version of the DBQ, support the relationship between the DBQ scores and the performance of dangerous behaviors assessed by a driving simulator.

Finally, gender and age differences were observed in the three subscales of the DDDI, revealing that men have a greater tendency to drive dangerously than women, and as age increases, the tendency to dangerous driving decreases. These results are consistent with those found in previous studies (Megías-Robles et al., 2022; Navas et al., 2019; Ventsislavova et al., 2021). However, unlike the original validation of the DDDI (Dula & Ballard, 2003; Willemsen et al., 2008), our results revealed that men showed a higher likely to experience negative emotions while driving than women (in the original scale there were not significant differences in this subscale). Gender differences were also observed for the RD subscale in the study of Gianfranchi et al. (2017), whereas for the others DDDI subscales the effect of gender was modulated by other variables, such as mileage and previous experience.

4.1 | Limitations and future research directions

Concerning the limitations of this work, future studies should be directed toward addressing the possible social desirability and

subjectivity bias associated with self-report instruments and work on the applicability of the scale by employing real driving accident records or simulated driving techniques. It is worth noting that the present work represents a significant advancement in DDDI research, given that we have not only replicated the results of the original scale but have done so using a substantially larger and more diverse sample. The current study included 2174 respondents, in contrast to the original validation with 119 participants from the US population and the significantly larger sample sizes in other versions (246, 395, 255, and 953 for the Chinese, Canadian, Belgian, and Romanian validations respectively; and, moreover, our community sample was well-balanced in terms of age range and gender compared with the samples used in previous versions (Dula & Ballard, 2003; Iliescu & Sârbescu, 2013; Qu et al., 2014; Richer & Bergeron, 2012; Willemsen et al., 2008). However, it is important to note that due to the nonrandom recruitment method, our sample of participants may not be fully representative of the general population. Finally, considering the potential usefulness of this kind of information for interventions aimed at fostering road safety, further studies should be focused on all the potential intervening variables which affect dangerous driving, also considering the possible role of cultural and educational factors.

5 | CONCLUSION

The Spanish adaptation of the DDDI scale showed good reliability and validity, providing an adequate tool to assess the propensity toward dangerous driving in the Spanish population. This adaptation will allow the instrument to be applied in new regions of the world, facilitating cross-cultural comparisons. It is important to highlight the fact that the DDDI can discriminate between different behaviors (e.g., AD and RD styles) within the general concept of dangerous driving, which allows for a deeper understanding of the mechanisms that underlie and maintain such behavioral styles. In this regard, distinguishing between driving profiles can help to better identify the causes of accidents and develop more effective prevention and intervention programs aimed at reducing accidents and road traffic mortality rates.

CONFLICT OF INTEREST STATEMENT
The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT
The data used in this paper are available from the corresponding author upon request.

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REFERENCES

Balzarotti, S., Sullman, M., Abati, D., & Biassoni, F. (2023). The expression of driving anger in a sample of Italian drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 97, 383–395. https://doi.org/10.1016/j.trf.2023.08.001

Bergmark, R. W., Gliklich, E., Guo, R., & Gliklich, R. E. (2016). Texting while driving: The development and validation of the distracted driving survey and risk score among young adults. *Injury Epidemiology*, 3(1), 7. https://doi.org/10.1186/s40621-016-0073-8

Bucsuházy, K., Matuchová, E., Zůvala, R., Moravcová, P., Kostíková, M., & Mikulec, R. (2020). Human factors contributing to the road traffic accident occurrence. *Transportation Research Procedia*, 45(2019), 555–561. https://doi.org/10.1016/j.trpro.2020.03.057

Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, 9(2), 233–255. https://doi.org/10.1207/S15328007SEM0902_5

Deffenbacher, J. L., Lynch, R. S., Oetting, E. R., & Swaim, R. C. (2002). The driving anger expression inventory: A measure of how people express their anger on the road. *Behaviour Research and Therapy*, 40(6), 717–737. https://doi.org/10.1016/S0005-7967(01)00063-8

DGT. (2021). *Las principales cifras de la siniestralidad vial España 2019 [The main figures of the road accident rate Spain 2019]* (Dirección).

Dula, C. S., & Ballard, M. E. (2003). Development and evaluation of a measure of dangerous, aggressive, negative emotional, and risky driving. *Journal of Applied Social Psychology*, 33(2), 263–282. https://doi.org/10.1111/j.1559-1816.2003.tb01896.x

Dula, C. S., & Geller, E. S. (2003). Risky, aggressive, or emotional driving: Addressing the need for consistent communication in research. *Journal of Safety Research*, 34(5), 559–566. https://doi.org/10.1016/j.jsr.2003.03.004

Engelberg, J. K., Hill, L. L., Rybar, J., & Styer, T. (2015). Distracted driving behaviors related to cell phone use among middle-aged adults. *Journal of Transport & Health*, 2(3), 434–440. https://doi.org/10.1016/j.jth.2015.05.002

Galovski, T. E., Malta, L. S., & Lanchard, E. B. (2006). *Road rage: Assessment and treatment of the angry, aggressive driver*. American Psychological Association. https://doi.org/10.1037/11297-000

Ge, Y., Zhang, Q., Zhao, W., Zhang, K., & Qu, W. (2017). Effects of trait anger, driving anger, and driving experience on dangerous driving behavior: A moderated mediation analysis. *Aggressive Behavior*, 43(6), 544–552. https://doi.org/10.1002/ab.21712

Gianfranchi, E., Spoto, A., & Tagliabue, M. (2017). Risk profiles in novice road users: Relation between moped riding simulator performance, on-road aberrant behaviors and dangerous driving. *Transportation Research Part F: Traffic Psychology and Behaviour*, 49, 132–144. https://doi.org/10.1016/j.trf.2017.06.016

Gras, M. E., Sullman, M. J. M., Cunill, M., Planes, M., Aymerich, M., & Font-Mayolas, S. (2006). Spanish drivers and their aberrant driving behaviours. *Transportation Research Part F: Traffic Psychology and Behaviour*, 9(2), 129–137. https://doi.org/10.1016/j.trf.2005.09.004

Grasso, A., & Tagliabue, M. (2022). Over-speeding trend across self-reported driving aberrant behaviors: A simulator study. *Frontiers in Psychology*, 13, 1–12. https://doi.org/10.3389/fpsyg.2022.1028791

Gutiérrez-Cobo, M. J., Megías, A., Gómez-Leal, R., Cabello, R., & Fernández-Berrocal, P. (2018). The role of emotional intelligence and negative affect as protective and risk factors of aggressive behavior: A moderated mediation model. *Aggressive Behavior*, 44(6), 638–646. https://doi.org/10.1002/ab.21788

Herrero-Fernández, D. (2011a). Adaptación psicométrica de la versión reducida del Driving Anger Scale en una muestra Española. Diferencias por edad y sexo. *Anales de Psicología*, 27(2), 544–549.

Herrero-Fernández, D. (2011b). Psychometric adaptation of the driving anger expression inventory in a Spanish sample: Differences by age and gender. *Transportation Research Part F: Traffic Psychology and Behaviour*, 14(4), 324–329. https://doi.org/10.1016/j.trf.2011.03.001

Iliescu, D., & Sârbescu, P. (2013). The relationship of dangerous driving with traffic offenses: A study on an adapted measure of dangerous driving. *Accident Analysis & Prevention*, 51, 33–41. https://doi.org/10.1016/j.aap.2012.10.014

International Test Commission. (2017). *The ITC guidelines for translating and adapting tests*. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:International+Test+Commission+Guidelines+for+Translating+and+Adapting+Tests#0

Iversen, H. (2004). Risk-taking attitudes and risky driving behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(3), 135–150. https://doi.org/10.1016/j.trf.2003.11.003

Kovácsová, N., Lajunen, T., & Rošková, E. (2016). Aggression on the road: Relationships between dysfunctional impulsivity, forgiveness, negative emotions, and aggressive driving. *Transportation Research Part F: Traffic Psychology and Behaviour*, 42, 286–298. https://doi.org/10.1016/j.trf.2016.02.010

Lajunen, T., Parker, D., & Stradling, S. G. (1998). Dimensions of driver anger, aggressive and highway code violations and their mediation by safety orientation in UK drivers. *Transportation Research Part F: Traffic Psychology and Behaviour*, 1(2), 107–121. https://doi.org/10.1016/S1369-8478(98)00009-6

Li, C. H. (2016). Confirmatory factor analysis with ordinal data: Comparing robust maximum likelihood and diagonally weighted least squares. *Behavior Research Methods*, 48(3), 936–949. https://doi.org/10.3758/s13428-015-0619-7

McDonald, R. P., & Ho, M. H. R. (2002). Principles and practice in reporting structural equation analyses. *Psychological Methods*, 7(1), 64–82. https://doi.org/10.1037/1082-989X.7.1.64

Meade, A. W., Johnson, E. C., & Braddy, P. W. (2008). Power and sensitivity of alternative fit indices in tests of measurement invariance. *Journal of Applied Psychology*, 93(3), 568–592. https://doi.org/10.1037/0021-9010.93.3.568

Megías, A., Maldonado, A., Catena, A., Di Stasi, L. L., Serrano, J., & Cándido, A. (2011). Modulation of attention and urgent decisions by affect-laden roadside advertisement in risky driving scenarios. *Safety Science*, 49(10), 1388–1393. https://doi.org/10.1016/j.ssci.2011.06.001

Megías, A., Di Stasi, L. L., Maldonado, A., Catena, A., & Cándido, A. (2014). Emotion-laden stimuli influence our reactions to traffic lights. *Transportation Research Part F: Traffic Psychology and Behaviour*, 22, 96–103. https://doi.org/10.1016/j.trf.2013.09.017

Megías-Robles, A., Sánchez-López, M. T., & Fernández-Berrocal, P. (2022). The relationship between self-reported ability emotional intelligence and risky driving behaviour: Consequences for accident and traffic ticket rate. *Accident Analysis & Prevention*, 174, 106760. https://doi.org/10.1016/j.aap.2022.106760

Monteiro, R. P., de Medeiros, E. D., da Silva Nascimento, B., de Oliveira, T. M., & Gouveia, V. V. (2019). Psychometric evidences of the Dula Dangerous Driving Index in Brazil. *Revista Iberoamericana de Diagnostico y Evaluacion Psicológica*, 51(1), 35–44. https://doi.org/10.21865/RIDEP50.1.03

Navas, J. F., Martín-Pérez, C., Petrova, D., Verdejo-García, A., Cano, M., Sagripanti-Mazuquín, O., Perandrés-Gómez, A., López-Martín, Á., Cordovilla-Guardia, S., Megías, A., Perales, J. C., & Vilar-López, R. (2019). Sex differences in the association between impulsivity and driving under the influence of alcohol in young adults: The specific

role of sensation seeking. *Accident Analysis & Prevention*, *124*, 174–179. https://doi.org/10.1016/j.aap.2018.12.024

NHTSA. (2018). *Traffic safety facts 2018: A compilation of motor vehicle crash data*.

Özkan, T., Lajunen, T., Chliaoutakis, J. E., Parker, D., & Summala, H. (2006). Cross-cultural differences in driving behaviours: A comparison of six countries. *Transportation Research Part F: Traffic Psychology and Behaviour*, *9*(3), 227–242. https://doi.org/10.1016/j.trf.2006.01.002

Qu, W., Ge, Y., Jiang, C., Du, F., & Zhang, K. (2014). The Dula Dangerous Driving Index in China: An investigation of reliability and validity. *Accident Analysis and Prevention*, *64*, 62–68. https://doi.org/10.1016/j.aap.2013.11.004

Reason, J., Manstead, A., Stradling, S., Baxter, J., & Campbell, K. (1990). Errors and violations on the roads: A real distinction? *Ergonomics*, *33*(10–11), 1315–1332. https://doi.org/10.1080/00140139008925335

Richer, I., & Bergeron, J. (2012). Differentiating risky and aggressive driving: Further support of the internal validity of the Dula Dangerous Driving Index. *Accident Analysis and Prevention*, *45*, 620–627. https://doi.org/10.1016/j.aap.2011.09.014

Rolison, J. J., Regev, S., Moutari, S., & Feeney, A. (2018). What are the factors that contribute to road accidents? An assessment of law enforcement views, ordinary drivers' opinions, and road accident records. *Accident Analysis & Prevention*, *115*, 11–24. https://doi.org/10.1016/j.aap.2018.02.025

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*(2), 1–36.

Sagberg, F., Selpi, B., Piccinini, G. F., & Engström, J. (2015). A review of research on driving styles and road safety. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *57*(7), 1248–1275. https://doi.org/10.1177/0018720815591313

Shinar, D., & Compton, R. (2004). Aggressive driving: An observational study of driver, vehicle, and situational variables. *Accident Analysis and Prevention*, *36*(3), 429–437. https://doi.org/10.1016/S0001-4575(03)00037-X

Di Stasi, L. L., Diaz-Piedra, C., Morales, J. M., Kurapov, A., Tagliabue, M., Bjärtå, A., Megias, A., Bernhardsson, J., Paschenko, S., Romero, S., Cándido, A., & Catena, A. (2020). A cross-cultural comparison of visual search strategies and response times in road hazard perception testing. *Accident Analysis & Prevention*, *148*, 105785. https://doi.org/10.1016/j.aap.2020.105785

Sullman, M. J. M., Gras, M. E., Cunill, M., Planes, M., & Font-Mayolas, S. (2007). Driving anger in Spain. *Personality and Individual Differences*, *42*(4), 701–713. https://doi.org/10.1016/j.paid.2006.08.014

Ventsislavova, P., Crundall, D., Garcia-Fernandez, P., & Castro, C. (2021). Assessing willingness to engage in risky driving behaviour using naturalistic driving footage: The role of age and gender. *International Journal of Environmental Research and Public Health*, *18*(19), 10227. https://doi.org/10.3390/ijerph181910227

Wang, J., & Wang, X. (2012). *Structural equation modeling: Applications using Mplus*. John Wiley & Sons.

Wierwille, W. W., Dingus, T. A., Keisler, A. S., Medina, A., Lee, S. E., Kieliszewski, C. A., Hankey, J. M., & Hanowski, R. J. (2002). *Identification of driver errors: Overview and recommendations* (p. 341). TRID.

Willemsen, J., Dula, C. S., Declercq, F., & Verhaeghe, P. (2008). The Dula Dangerous Driving Index: An investigation of reliability and validity across cultures. *Accident Analysis and Prevention*, *40*(2), 798–806. https://doi.org/10.1016/j.aap.2007.09.019

World Health Organization. (2018a). *Global status report on road safety 2018: Summary*. WHO.

World Health Organization. (2018b). *Process of translation and adaptation of instruments*. WHO.

World Medical Association. (2009). *Declaration of Helsinki: Ethical principles for medical research involving human subjects*. WMA.

Wu, K. F., Aguero-Valverde, J., & Jovanis, P. P. (2014). Using naturalistic driving data to explore the association between traffic safety-related events and crash risk at driver level. *Accident Analysis & Prevention*, *72*, 210–218. https://doi.org/10.1016/j.aap.2014.07.005

Zhou, Y., Qu, W., & Ge, Y. (2022). The role of trait emotional intelligence in driving anger: The mediating effect of emotion regulation. *Transportation Research Part F: Traffic Psychology and Behaviour*, *88*, 281–290. https://doi.org/10.1016/j.trf.2022.05.024

APPENDIX

Table A1

TABLE A1 Final version of the Spanish DDDI.

Responde a cada una de las siguientes afirmaciones con la mayor honestidad posible. Lee cada frase cuidadosamente y luego marca la respuesta. Si ninguna de las opciones es tu respuesta ideal, marca entonces la respuesta que más se acerque. **NO HAY RESPUESTAS CORRECTAS O INCORRECTAS. Selecciona tus respuestas rápidamente, no pases demasiado tiempo analizándolas.**

1	2	3	4	5
Nunca	Rara vez	Aveces	Frecuentemente	Siempre

1. Conduzco cuando estoy enfadado/a o molesto/a. (CEN)

2. Pierdo los estribos (es decir, me irrito mucho) cuando conduzco. (CEN)

3. Considero que las acciones de otros conductores/as son inapropiadas o "estúpidas". (CEN)

4. Uso las luces largas en forma de destellos o ráfagas cortas cuando me molesta otro conductor/a. (CA)

5. Hago gestos groseros (por ejemplo, "sacar el dedo" o maldecir a gritos) hacia los conductores/as que me molestan. (CA)

6. Insulto verbalmente a los conductores/as que me molestan. (CA)

7. Utilizo deliberadamente mi coche/camión para bloquear a los conductores/as que conducen demasiado pegados/as a la parte posterior de mi vehículo. (CA)

8. Intentaría conducir pegado/a a la parte trasera del vehículo de un conductor/a que me molesta. (CA)

9. Cuando estoy parado/a en un semáforo en rojo y este cambia a verde, acelero rápidamente para salir el/la primero/a. (CR)

10. Adelantaría de manera no permitida a un coche/camión que va demasiado lento. (CR).

11. Si creo que un conductor/a ha sido agresivo conmigo, siento que tengo derecho a responderle de la misma manera. (CA)

12. Me irrito mucho cuando estoy en un atasco. (CEN)

13. Si me encuentro en un paso de ferrocarril y veo que se acerca un tren a velocidad lenta, intentaría acelerar para cruzar antes de que pase el tren. (CR)

14. Evitaría el tráfico lento cambiando constantemente de carril. (CR)

15. Conduciría estando ligeramente ebrio/a. (CR)

16. Cuando alguien me corta el paso con su vehículo, siento que debería castigarle. (CA)

17. Cuando estoy conduciendo, me impaciento y/o me altero cada vez que voy con retraso a algún sitio. (CEN)

18. Cuando llevo pasajeros en mi vehículo, estos me suelen decir que me calme. (CEN)

19. Me irrito cuando el coche/camión que va delante de mí frena sin razón. (CEN)

20. Rebasaría la doble línea continua para comprobar si puedo adelantar a un coche/camión que conduce lentamente. (CR)

21. Cuando voy conduciendo, siento que tengo el derecho a llegar a mi lugar de destino lo más rápido posible. (CR)

22. Pienso que los conductores/as pasivos (es decir aquellos que circulan con excesiva precaución) deberían aprender a conducir o quedarse en casa. (CEN)

23. Conduciría por el arcén o por la mediana para evitar un atasco. (CR)

24. Cuando adelanto a un coche/camión en una carretera con dos carriles, suelo apurar la distancia (mantener poca distancia) con el coche que viene de frente. (CR)

25. Conduciría estando borracho/a. (CR)

26. Creo que podría perder los estribos (irritarme en exceso) si tuviera que enfrentarme a otro conductor/a. (CEN)

27. Me considero una persona que asume riesgos. (CR)

28. Pienso que la mayoría de las normas de tráfico podrían considerarse como sugerencias. (CR)

Nota: CA, Conducción agresiva; CEN, Conducción emocional negativa; CR, Conducción arriesgada. La puntuación total del cuestionario se obtiene mediante la suma de las respuestas a todos los ítems. La puntuación total de cada subescala se obtiene sumando las puntuaciones de los ítems de cada subescala.