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Young driving learners' intention to use a handheld or hands-free mobile phone when driving

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ABSTRACT

This paper presents a survey investigating young driving learners' intention to use a handheld or hands-free mobile phone when driving. A sample of 164 young driving learners completed a questionnaire based on the theory of planned behavior (TPB), which measured people's intentions to use mobile phone while driving in handheld condition or hands-free condition, along with their attitudes towards the behavior, subjective norms, perceived behavioral control. The regression analysis models revealed that the TPB was able to explain 43% and 48% variance in hands-free mobile phone use intention and handheld mobile phone use intention, respectively, with perceived behavioral control emerging as the strongest predictor. In addition, TPB components, usage frequency and perceived risk were more dependent on gender than age. These results have several theoretical and practical implications. In particular, interventions should emphasize on the risk of hands-free mobile phone use when driving for young drivers, especially for young male drivers.

1. Introduction

Epidemiological studies and correlation studies suggested that mobile phone usage might be one of major factors in a driver's distraction and it would increase the likelihood of serious driving accidents (e.g., Laberge-Nadeau et al., 2003; Lamble, Rajalin, & Summala, 2002; McEvoy, Stevenson, & Woodward, 2006; Violanti, 1999; Violanti & Marshall, 1996). Mobile phone use while driving can cause driver distraction, which can be divided into two sides: physical distraction (e.g., changes from steering wheel to holding and operating phone, diverting eyes from the road to phone's keyboard or interface), and cognitive distraction (e.g., the demands of the phone conversation may influence driving safety). In order to address the impacts of mobile phone use on driver behavior, there was a significant body of research that had been conducted in a variety of experimental contexts, and the research had shown the impairment of mobile phone use on driving performance (e.g., Gugerty, Rakauskas, & Brooks, 2004; Nasar, Hecht, & Wener, 2008; Rakauskas, Gugerty, & Ward, 2004; Strayer, Drews, & Johnston, 2003; Strayer & Johnson, 2001). These studies also varied in variables and conditions, including methods used (e.g., simulator, closed-track, and field testing), types and densities of roads (e.g., highway, urban, and rural road), demographic measures (e.g., age and gender) and experience of participants (professional or private drivers), modes of mobile phone (handheld or hands-free), and types of phone conversation (intense or not, demanding or not, naturalistic conversation or different types of arithmetical and grammatical tasks) (RoSPA, 2005).

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1.1. Literature review

Recently, the issue of driving safety using different mobile phone modes has been under considerable debates. Some countries (e.g., Australia, Norway) have legislation to restrict the use of a handheld mobile phone while driving. Instead of focusing on the physical tasks that driving requires (e.g., steering, gear changing), drivers have to use hand(s) to manipulate the phone. Although the physical distraction may be less for hands-free mobiles than for handheld mobiles, both modes can cause cognitive distraction which may have negative consequences (Tornros & Bolling, 2005). Haigney, Taylor, and Westerman (2000) found that negative effects (e.g., reduced speed) were particularly apparent when participants were using a handheld phone. Under a close-circuit driving track environment, Treffner and Barrett (2004) investigated the effect of using a hands-free mobile phone on biomechanical and perceptual factors that underlay the control of driving, and found that a driver's sensitivity to prospective information about upcoming events may be significantly degraded while simultaneously using a hands-free mobile phone. In Tornros and Bolling's (2005) study, the effects of hands-free and handheld mobile phone dialing and conversation on simulated driving were investigated, and the most important conclusion of this study was that hands-free mobile phones did not have any safety advantages. For conversations, it seemed quite similar between hands-free and handheld mobile phones, and hands-free phones may even be less safe with regard to dialing.

In spite of the negative effect of using a mobile phone (including hands-free mobile phone) while driving and the corresponding legal limitation, mobile phones are prevalently used in driving context. For example, in Australia, an estimated 55% of drivers have used a mobile phone and even more than 11% of them have written text messages while driving (McEvoy et al., 2006). Although understanding about the effects of mobile phone use when driving on driving performance is very important, there have been few studies to explain why these people use mobile phone while driving. Some studies focused on the impact of demographic variables (e.g., age and gender) on driver's mobile phone use while driving. There was evidence indicating that young and male drivers tended to use a mobile phone while driving more than older drivers or females (e.g., Brusque & Alauzet, 2008; Lamble et al., 2002; Poysti, Rajalin, & Summala, 2005), and females were almost twice as likely to expect certain mobile phone use restrictions as males were (Lamble et al., 2002). Therefore, how can we exclusively address the people's motivation or intention to use a mobile phone while driving, and how can we find out the effects of demographic variables and mobile phone mode on the intention? These questions are the main focus of this present research project.

1.2. The aim of the study

The first question is directly addressing people's intention to use a mobile phone while driving and also is the main aim of this study. The theory of planned behavior (TPB; Ajzen, 1991) is perhaps best suited for addressing this issue, because it is posited as a complete model of social behavior. According to TPB, intention is given a key role in the prediction of actual behavior, and it is determined by attitude toward the behavior (produced by *behavioral beliefs* about the likely outcomes of the behavior and the evaluations of these outcomes), subjective norms (resulted from *normative beliefs* about the normative expectations of others and motivation to comply with these expectations), and perceived behavioral control (induced by *control beliefs* about the presence of factors that may facilitate or impede performance of the behavior and the perceived power of these factors). Perceived control is also a co-determinant predictor of behavior. Much research has been conducted to support the validity of TPB in a wide variety of behavioral domains including driving safety. For example, it has been applied successfully to investigate drivers' compliance with the speed limit (Elliott, Armitage, & Baughan, 2003), and to account for drivers' intentions to commit four specific driving violations: drinking and driving, speeding, close following, and overtaking in risky circumstances (Parker, Manstead, Stradling, Reason, & Baxter, 1992). However, important research questions that have theoretical implications for the TPB and practical implications for driving safety remain unanswered. The central question investigated in the present study was "Can the TPB predict people's intentions to use a handheld or hands-free mobile phone while driving?" To date, no research has been found to apply the TPB to mobile phone use in driving context. The TPB can solve the challenge for psychologists to identify variables that mediate relationships between the demographic measures of drivers and their mobile phone use behavior. One of the aims of the present study was to use the TPB to determine the impact of demographic characteristics on people's intention of mobile phone use while driving whether in handheld condition or hands-free condition.

The second question addressed in the present study was related to how the behavior of mobile phone users in daily life and their perceived risk factor affect their intention to use a mobile phone in future driving context. It was well known that the frequency of mobile phone use while driving was related to mobile usage in daily life (e.g., Brusque & Alauzet, 2008), and those drivers who used phones everyday were more likely to want some restrictions for mobile phone use when driving, than those who had lower usage (Lamble et al., 2002). In order to know people's deep intention of mobile phone use while driving, we compared the subjective responses of different respondents whose usages mobile phone were different in daily life context and driving context: If a driver reports more frequent mobile phone use in daily life than in driving context, the conclusion will be that the driver can perceive higher risk for mobile phone use while driving, or be more willing to obey the restriction of mobile phone use when driving. At the same time, the comparisons among usage activities (e.g., dialing) could address whether there was a difference existing in these behavioral intentions. This investigation about the difference of the frequency of mobile phone usage was conducted regardless of mobile phone modes.

Finally, it is well known that the mobile phone use behaviors while driving are related to drivers' perceived risks for these behaviors, so in this present study, drivers' perceived risks were also collected. According to the comparison of total fre-

quency of use between driving context and daily life context, the participants were asked to report the degree of risk to "mobile phone use while driving", and this was entitled as *perceived general risk* in the present study. In order to explain the intention to use handheld or hands-free mobile phone when driving, this study also recorded the rate of agreement of participants' responses to "for driving, using hands-free mobile phone is safer than using a handheld one", and this was identified as *perceived hands-free use risk* in this study.

Age and gender were important factors in the analysis of usage frequency when comparing driving context with daily life context as well as perceived risk. According to the previous research (e.g., Brusque & Alauzet, 2008; Lamble et al., 2002; Poysti et al., 2005), young people tended to use mobile phone more frequently in both contexts of driving and daily life than older people. Therefore, our study focused on young people's intention to use a mobile phone while driving. In line with the previous studies (e.g., Lamble et al., 2002; Poysti et al., 2005), participants at 17–24 years and 25–34 years were recruited as young people.

To summarize, the main goals of the present study were to:

(1) Apply the TPB approach to examine mobile phone use behavior while driving.
(2) Examine the extent that the TPB components mediate the effects of mobile phone modes (hands-free and handheld) and demographic variables (age and gender) on mobile phone use while driving.
(3) Address mobile phone usage frequency in driving condition and daily life condition, as well as participants' perceived risk of mobile phone use while driving, to support the explanation of mobile phone use intention while driving in the context of TPB.

2. Method

2.1. Participant

There were totally 164 participants in this study (overall age range: 17–43 years old), including 43 males (17–24 years old), 30 males (25–34 years old), 41 females (17–24 years old), and 50 females (25–34 years old). None of the respondents held a driver's license, but they were learning how to drive at a driving training school in Beijing. Some of the them were learning current driving regulations in China, and others had passed the regulation test and were learning how to perform specific driving actions (such as steering).

2.2. Materials

2.2.1. Situation A

You use a mobile phone with *hand-set mode*. And now you are driving at 60 km/h. At this moment, you receive an important incoming call, so you answer the call while driving.

2.2.2. Situation B

You use a mobile phone with *hands-free mode*. And now you are driving at 60 km/h. At this moment, you receive an important incoming call, so you answer the call while driving.

2.2.3. Questionnaire

The standard TPB model included behavioral intention, attitude, subjective norm, and perceived behavioral control, which were asked in each situation. Also demographic measures, risk perception, future behavior, and previous behavior were asked.

2.2.3.1. Demographic measures. The following demographic variables were collected in this study: age, gender, education (*elementary school*, *junior high school*, *senior high school*, *associates*, *bachelors*, *masters*, and *PhD*), occupation and mobile phone mode (*hand free* and *hand set*) used.

2.2.3.2. Behavioral intention. Behavior intention was assessed by a mean of four items. Each item was rated on a 7-point bipolar scale ranging from −3 to +3. The four items were: "In such a situation, how likely is it that you will use a mobile phone"(*very unlikely* to *very likely*), "In a similar situation in the future, do you intend to use a mobile phone while driving " (*definitely do* to *definitely do not*), "In a similar situation in the future, what is the degree that you will avoid using a mobile phone while driving? " (*very little* to *very great*), "In a similar situation in the future, how likely or unlikely is it that you will use mobile phone while driving" (*very unlikely* to *very likely*).

2.2.3.3. Attitude. Attitude was measured directly by asking respondents to complete the following statement by rating five pairs of adjectives, each on a 7-point bipolar semantic differential scales: " For me, using a mobile phone while driving in this situation would be…" The five pairs of adjectives were: *bad – good*, *dangerous – safe*, *enjoyable – not enjoyable*, *necessary –*

unnecessary, *foolish – wise*. Each item was scored from −3 to +3. The mean of these items was calculated and used to produce a composite scale for attitude measure.

2.2.3.4. Subjective norm. The standard questionnaire items were used to measure the subjective norm by calculating the mean of three items, each rated on a 7-point unipolar scale ranging from 1 to 7. The three items were "People who are important to me would hope that I would use a mobile phone while driving in this situation" (*strongly disagree* to *strongly agree*), "People who are important to me would (*disapprove–approve*) of my using a mobile phone while driving in this situation", "People who are important to me would think that I (*should not–should*) use a mobile phone while driving in this situation".

2.2.3.5. Perceived behavioral control. The mean of two items was used as a measure of perceived behavior control. Each item was rated by respondents on a 7-point unipolar scale ranging from 1 to 7. The two items were: "In this situation, I believe that I have the ability to use a mobile phone" (*strongly disagree* to *strongly agree*), "For me, using a mobile phone in this situation would be" (*very easy* to *very difficult*).

2.2.3.6. Perceived risk. Risk perception was measured by two statements. Each statement was rated by respondents on a 7-point unipolar scale ranging from 1 to 7. The two statements were: "For you, while driving, what do you think is the effect of using a mobile phone on driving safely?"(*no effect* to *much effect*), "While driving, using a hands-free mobile phone is safer than using a hand-set mobile phone" (*strongly disagree* to *strongly agree*).

2.2.3.7. Future behavior of using a mobile phone while driving. Future behavior of using a mobile phone while driving was measured by rating five different kinds of mobile phone usage related behavior, each rated on a 7-point unipolar scale from 1 to 7: "For you, how frequently will you ____ while driving?" (*very frequently* to *very less*). The five kinds of behaviors were: *dialing a number*, *answering a call*, *refusing an incoming call*, *sending a short message*, and *reading a short message*.

2.2.3.8. Previous behavior of mobile phone usage in daily life. The behavior of mobile phone usage in daily life was measured by rating three different kinds of mobile phone using related behaviors, each on a 7-point unipolar scale: "In your daily life except for driving, how frequently you will _____?" (*very frequently* to *very less*). The three kinds of behaviors were: *dialing a number*, *answering a call*, and *checking a short message*". Each question was rated by a 7-point unipolar scales ranging from 1 to 7.

3. Results

3.1. Mobile phone mode and behavioral intention: the application of the TPB

3.1.1. Test of discriminate validity and consistent reliability

In accord with previous studies (Ajzen, 1991; Elliott et al., 2003; Holland & Hill, 2007), principal-components and internal consistency analysis were used to test the validity and reliability of the TPB scales. According to Holland and Hill's method (2007), principal-components analysis were used to analyze the items measuring behavioral intention, attitude, subjective norm, and perceived behavioral control. Also in order to test internal reliability, Cronbach's α coefficients were calculated for each of the self-reported scales used in TPB measures. In this study, the responses in the handheld mode situation and hands-free mode situation were used together for these analyses (e.g., Holland & Hill, 2007; and see Table 1). For each subscale (e.g., the behavioral intention, attitude, subjective norm and perceived behavioral control), only one factor with eigenvalues greater than 1 emerged from the corresponding data, and at least accounted for 62.67% variance. The results provided strong evidence for the independence of the self-reported scales used to measure each TPB component. In Table 1, the Cronbach's α statistics for each scale was high (0.74 or higher), and indicated reasonable inner reliability for each TPB component measured. These psychometric analyses showed that the self-reported measures designed in this study were sufficiently valid and reliable.

3.1.2. Descriptive findings

The first stage in the analysis of the data was to compare responses in the two situations. Mean scores of attitude, subjective norm, perceived behavioral control and behavioral intention were plotted by gender, age group and mobile phone

Table 1
Principal-components, Cronbach's α statistics for theory of planned behavior ($n = 191 \times 2$).

Variable	Number of Items	Cronbach's α	% of variance	Range
1. Behavioral intention	4	0.79	62.67	−3 to 3
2. Attitude	5	0.84	61.69	−3 to 3
3. Subjective norm	3	0.90	83.98	1–7
4. Perceived behavioral control	2	0.74	79.03	1–7

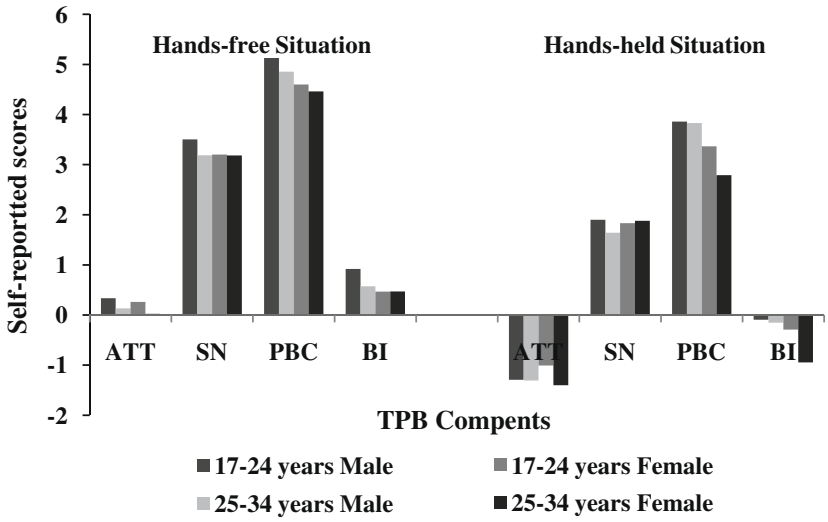

Fig. 1. Means of the components of the TPB.

mode in Fig. 1. The figure showed, (1) participants' response on attitude, subjective norm, perceived behavioral control and behavioral intention toward handheld mode had lower scores than toward hands-free mode, which suggested that in comparison with handheld mode, young driving learners considered hands-free mode to be safer, and they believed that significant other people (such as family members and friends) would support their using hands-free mobile, and thought they would have more control power to use it. Therefore, they reported they would have more intention to use a hands-free mobile phone when driving; (2) male respondents reported relatively stronger perceived behavioral control for using a mobile phone when driving than female respondents.

The above conclusions were tested by ANOVA. Attitude, subjective norm, perceived behavioral control and intention were subjected to a repeated measure analysis of variance: gender (subject-between variable, male vs. female) × age (subject-between variable, ages 17–24 years vs. ages 25–34 years) × situation (subject-within variable, handheld mode vs. hands-free mode). The results indicated that the differences of all the TPB components between different mobile phone mode situations were significant: behavioral intention, $F(1, 160) = 67.59$, $p < 0.001$; attitude, $F(1, 160) = 175.24$, $p < 0.001$; subjective norm, $F(1, 160) = 96.33$, $p < 0.001$; and perceived behavioral control, $F(1, 160) = 102.47$, $p < 0.001$. Also the main effects of gender were significant on perceived behavioral control, $F(1, 160) = 7.47$, $p < 0.01$. The main effect of age group and all the interaction effects (between gender, age group, and mobile phone mode situation) were not significant in this study. So the two conclusions were supported.

3.1.3. Correlations between TPB components

Consistent with the TPB, zero-order correlations were calculated between the standard TPB measures for each mobile phone mode situation, and the results are shown in Table 2. In each mode, the attitude, subjective norm, perceived behavioral control were all positively correlated with intention to use mobile phone when driving.

3.1.4. Predictors of intentions: regression analyses

To address the two main aims of the study, for each mobile phone mode situation, a series of hierarchical multiple linear regression analyses were used to assess the contribution of the components of the TPB to the prediction of behavioral intention, along with the contribution of gender and age to it. For each situation, the key predictors of driving learners' intention to use a mobile phone when driving were identified by regressing behavioral intention on the demographic variables (gender

Table 2
Zero-order correlations between the components of the TPB.

Variable	1	2	3	4
1. Behavioral intention	–	0.54	0.47	0.63
2. Attitude	0.53	–	0.47	0.59
3. Subjective norm	0.54	0.55	–	0.38
4. Perceived behavioral control	0.60	0.65	0.59	–

Note. Coefficients above the diagonal related to handheld mode, those below the diagonal related to hands-free mode.
For all correlation coefficients, $p < 0.01$.

Table 3
Hierarchical regression analysis: predicting behavioral intentions.

Step and predictor	Hands-free situation		Handheld situation	
	β (Step 1)	β (Step 2)	β (Step 1)	β (Step 2)
1. Age group	−0.06	−0.02	−1.07	−0.04
Gender	−0.09	−0.03	−1.67*	0.09
2. Attitude		0.18*		0.18*
Subjective norm		0.23**		0.23**
Perceived behavioral control		0.34***		0.41***
F	1.11	23.61***	3.71**	29.63***
R^2	0.01	0.43	0.04	0.48
ΔR^2	–	0.42	–	0.44

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

and age group) at Step 1 and the TPB variables (attitude, subjective norm, and perceived control) at Step 2. In this way, it was possible to assess the predictive utility of the TPB constructs after controlling the influence of age and gender (see Table 3).

In the hands-free situation, (1) age and gender were only able to explain 1% of the variance, so both variables were not significant predictors; (2) the TPB variables, when added to the regression equation, were able to explain 42% of the variance, and totally resulted in a substantial and statistically significant increment to 43%, with attitude, subjective norm and perceived behavioral control emerging as significant predictors (F (5, 158) = 23.61, $p < 0.001$). As for the handheld situation, (1) age and gender were able to explain 4% of the variance, with gender emerging as a significant predictor; (2) the addition of the TPB to the regression model resulted in an obvious increment to 58%, with attitude, subjective norm and perceived behavioral control emerging as significant predictors along with gender (F (5, 158) = 29.63, $p < 0.001$). Age was not a significant predictor for both regression models, and only gender had a significant impact in the handheld situation. In both mobile phone regression modes, it was very clear that attitude and subjective norm were less important predictors of intention to use mobile phone than perceived behavioral control was. In order to examine whether the model differed for the different age groups and gender, age and gender were grouped as male aged at 17–24 years, female aged at 17–24 years, male aged 25–34 years, and female aged at 25–34 years, and then separate regression analyses were computed for the different age and gender groups. Considering the possible differences between the mode situations in overall regression models, the mode situation was entered as a predictor at Step 1, and attitude, subjective norm, and perceived behavioral control were entered at Step 2. Results of these regressions were shown in Table 4. The following results were very clear. First, when entered to the regression model along with the TPB measures, mode situation did not add significantly to the variance predicted for any group. Second, although the model was a good fit for all age groups, accounting for between 40% and 61% of the variance, more variance is noted in the 25–34 year female group (68%) than in other groups. Third, attitude does not account for a significant independent amount of variance for male group aged 17–24 years and female group aged 17–24 years, but result indicates a significant predictor for male group aged 25–34 years and female group aged 25–34 years. Fourth, the contribution of perceived behavioral control to the model was more obvious for female groups than for male groups.

3.2. Future mobile phone usage when driving: comparison with daily usage

The mean calculations of self-reported different mobile phone usages in future driving and in prior daily life were plotted by gender and age group in Fig. 2. As provided in the figure, (1) participants' response on dialing, answering and short message usage had a higher score in daily life than responding behavior in future driving, (2) considering the usage in daily life,

Table 4
Comparison of regression models across the age and gender groupings.

Step and predictor	17–24 years male ($n = 43 \times 2$)		17–24 years female ($n = 41 \times 2$)		25–34 years male ($n = 30 \times 2$)		25–34 years female ($n = 50 \times 2$)	
	β (Step 1)	β (Step 2)	β (Step 1)	β (Step 2)	β (Step 1)	β (Step 2)	β (Step 1)	β (Step 2)
1. Mode situation	−0.34**	−0.01	−0.25	0.10	−0.25*	0.05	−0.41***	−0.02
2. ATT		−0.05		0.13		0.59***		0.25**
SN		0.42***		0.10		−0.06		0.09*
PBC		0.27*		0.60***		0.15		0.56***
F	10.92**	13.60***	3.79	14.60***	5.26*	14.08***	19.36***	50.47***
R^2	0.12	0.40	0.06	0.52	0.06	0.42	0.17	0.68
ΔR^2	–	0.28	–	0.46	–	0.36	–	0.51

* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

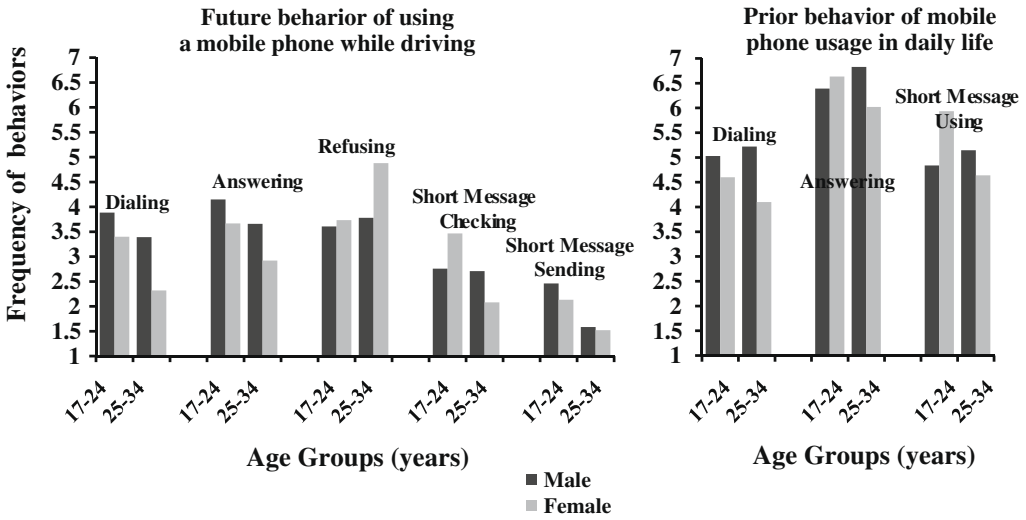

Fig. 2. Frequency of different behaviors plotted by age group and gender for future usage when driving and daily usage.

the difference between short message services use and dialing was not obvious, while short message services was used the least in future driving environment, (3) as for future driving behavior, male participants' response had a higher score on dialing, answering, short message sending than females' response, and females' response had a higher score on refusing mobile phone use than males' response, (4) in future driving behavior, no difference was found on short message checking between males aged at 17–24 years and 25–34 years, while ages 17–24 years females reported more short message checking than ages 25–34 years females.

All of these conclusions were supported by statistical analyses. Different mobile phone usages in future driving or in prior daily life were subjected, respectively, to a univariate analysis of variance: gender (subject-between variable, male vs. female) × age (subject-between variable, age at 17–24 years vs. age at 25–34 years). The results are summarized in Table 5. First, for short message services usage (both in future driving and prior daily life), and answering in the daily usage, there was no apparent difference between male and female participants; while the main effect of gender on other mobile phone usages was significant. The result may stand that male respondents tend to use mobile phone with activities of dialing and answering more frequently than females, but as short message services, which need more physical distraction, they reported less use as females. Second, as for mobile use in future driving, ages 17–24 years participants reported more usage frequency than ages 25–34 years participants, the main effects of age group on dialing, answering, short message checking, and short message sending were all significant. Third, the interaction effect indicated that ages 17–24 years female respondents reported more use on short message checking in future driving and on short message services in daily life, while no significant difference was found between male respondents aged at 17–24 and 25–34 years. Finally, in order to compare the self-reported frequency between different mobile phone usage behaviors, pairwise comparisons (independent of age groups and gender) were used. Considering the usage behavior in future driving, *t*-test showed the ordering of frequency was refusing ($M = 4.06$) > answering ($M = 3.56$) > dialing ($M = 3.20$) > short message checking ($M = 2.67$) > short message sending ($M = 1.90$), $t(163) \geqslant 2.97$. As for prior daily usage behavior, the ordering of answering (6.43) > short message services usage (5.00) > dialing (4.71) was supported, $t(163) \geqslant 2.19$. In total, the mean frequencies of every usage behavior in a future condition ($M = 2.83$, with the exception of refusing incoming calls) was lower than in prior daily condition ($M = 5.40$), *t*

Table 5
Summary of analyses of variance for the mobile usages in future driving and prior daily life.

Source	Usage in future driving					Prior daily usage		
	Dialing	Answering	Refusing	Short message checking	Short message sending	Dialing	Answering	Short message using
Age group	$F = 7.22^{**}$	$F = 4.39^{*}$		$F = 5.70^{*}$	$F = 9.07^{**}$			
Gender	$F = 7.03^{**}$	$F = 4.28^{*}$	$F = 4.05^{*}$			$F = 5.96^{*}$		
Age group × gender				$F = 4.94^{*}$			$F = 7.27^{*}$	$F = 6.89^{*}$

* $p < 0.05$.
** $p < 0.01$.

(163) = 20.40. All these results indicated that participants would be cognizant of the risk of using a mobile phone when driving, and corresponding frequency of different usage behavior was reported with visual, physical or cognitive distraction.

3.3. Perceived risk

In this study, participants' perceived risk was distinguished as general risk perception of mobile phone use and risk perception of hands-free mobile phone use when driving. Mean calculations of responding perceived risks were plotted by gender and age groups in Fig. 3. As can obviously be seen from the figure, (1) for risk perception of hands-free usage, females from ages 17–24 years perceived more risk than males from ages 17–24 years, (2) totally, participants perceived more risk for general perception than for hands-free mobile phone use. All of these conclusions were supported by statistical analyses. Perceived risks were subjected to a multivariate analysis of variance: gender (subject-between variable, male vs. female) × - age (subject-between variable, ages 17–24 years vs. ages 25–34 years). No main effect and interaction effect was found. Considering comparisons between the two perceived risks, T-test showed the risk of general perception ($M = 6.24$) was higher significantly than the perceived risk of hands-free mobile phone usage ($M = 5.42$), t (163) = 4.60, $p < 0.001$.

4. Discussion

In this study, self-reported handheld and hands-free mobile phone use while driving was addressed mainly with the TPB. The results indicated that the basic TPB model fit the data well. In this section, the validity of the TPB, how mobile mode combined with demographic variables affect intention to use a mobile phone while driving, as well as implications for road safety interventions are discussed. Also we address the limitations of the present study.

4.1. Support for the TPB

For the first aim, findings indicated strong support for the applications of the TPB to people's intention to use a mobile phone while driving. We used psychometric analyses to test the validity of basic subscales. The results showed strong evidence to support the applications of TPB. In accord with previous studies in the driving safety field, the basic TPB components including attitude, subjective norm, and perceived behavioral control were significantly positive related to intention to use a mobile phone in the driving context (e.g., Elliott et al., 2003). Overall, the results indicated the effectiveness of attitude, subjective norm, and perceived behavioral control as significant predictors of behavioral intention in relation to using either a handheld or hands-free mobile phone. These factors made a significantly positive contribution to the prediction of behavioral intention for handheld mode and hands-free mode, respectively. In all modes, the standardized beta weights in the regression analyses were positive, which demonstrated that behavioral intentions would be strengthened when attitude, subjective norm, and perceived behavioral control increased. The regression modes in both mobile phone situations also showed the three basic TPB variables were generally far more important than those demographic variables. In all regression

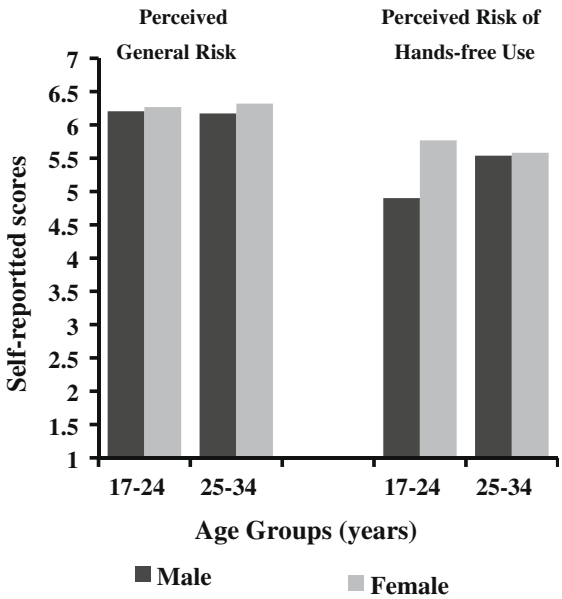

Fig. 3. Perceived risk of mobile phone use when driving plotted by gender and age groups.

models (e.g., the two mobile phone mode regressions and the four age-gender groups regressions), perceived behavioral control was the most important predictor of intentions, contributing almost as much to the prediction as attitude and subjective norm did.

4.2. Explaining intentions to use mobile phone while driving

The second aim in this study was to examine in what extent the intention would predict those different mobile phone modes in different demographic groups. The ANOVA statistical analysis indicated that there was a very strong significant difference between mobile modes. The results indicated that more participants would like to use a hands-free mobile phone while driving, since participants perceived more safety if they use hands-free mobile phone in driving context, which was consistent with the previous studies (e.g., White, Eiser, & Harris, 2004). For the different demographic groups, male respondents reported stronger intention to use a mobile phone in the driving condition than female respondents. In the regression analysis, the gender was a more significant predictor for the intentions to use a mobile phone in handheld situation than in hands-free situation. Different form the previous studies (e.g., Brusque & Alauzet, 2008), age was not represented as an important variables in the ANOVA statistics and regression analysis because we focused on young respondents in this study. Summarizing, the evidence of mobile mode and gender affecting mobile phone use was obvious.

Human behaviors are related with risk perceptions. Based on these perceptions, drivers adjust their behaviors (such as mobile phone use while driving) and their responses to the driving task (primary task) and/or a secondary task (e.g., phone task). If the secondary task is perceived as risky, a driver may slow down. Using a mobile phone in a car followed a decision motivated by its benefits that may be exaggerated while its risks that may be underestimated (Svenson, 1996). In this study, compared with mobile phone usage in daily life, participants reported less usage in the future driving context. This may indicate that they perceived using a mobile phone as a risky behavior while driving. Also, we asked drivers to report mobile phone usage frequency of different activities in future driving context and in daily life context, respectively. As a whole, the activities that cause more physical distraction were less reported, which was in line with previous study that addressed the drivers' subjective perceived risk for similar activities while driving (see Svenson & Patten, 2005), while the usage frequency may be dependent on the functions of the activities. Though, participants reported less mobile use in future driving because of their general risk perception while driving, they considered the use of hands-free mobile phones safer than handheld mobile phones when driving. This result could be used to support the reason why drivers reported stronger intention to use a mobile phone in a hands-free mode than a handheld mode. In the present study, no difference of risk perceptions was found between age groups and genders. As for different activities of mobile phone usage in future driving, male respondents reported more use of dialing and answering than female respondents, while males reported fewer refusals of incoming calls than females. These results supported why male respondents would be more likely to intend to use a mobile phone when driving than females. Since short message use behavior was reported the least or was perceived the most risk, no difference was found between males and females. Overall, the effect of age on these different uses was not significant.

4.3. Implications to develop road safety interventions and educations

Many previous studies (e.g., Elliott et al., 2003) indicated that the TPB can be used to develop interventions, rather than only test their effectiveness. The findings of the present study provided strong support to the TPB's application to participants' intentions to use a mobile phone when driving, and it seems feasible that the intentions to use a mobile phone might be changed with the corresponding changes in their attitudes, subjective norms, and perceived behavioral control. Especially given that the component of perceived behavioral control was most sensitive to predict behavioral intention as indicated by the size of the standardized beta weights in all regression models here, driving safety interventions may be most effective if this component were focused on the most. With promoting perceived control increase and behavioral intention change, it will be successful to perform an individual's social behavior intervention. Also the roles of the TPB components vary in different mobile phone situations and different demographic groups. Although, the perception of the risk was not subjected to the TBP models, results indicated that it impacted behavioral intention significantly. Therefore, based on the findings of this study, intervention and education to change the three TPB aspects in order to change intention to use a mobile phone while driving should be: (1) letting drivers know that hands-free mobile phone use may lead to cognitive distractions as handheld mobile phone use do. It will increase their perception risk, and the TPB components will change, then the intervention of less intention to use a hands-free mobile phone will succeed; (2) focusing on specific factors for different genders (e.g., affective attitudes for male participants).

4.4. Limitations of the present study

The main possible limitations of the present study are that the participants were driving learners, so no long-term-experience behavior could be covered. However, the main aim of the study was to test the sufficiency of the TPB model with variables of mobile phone modes and demographic measures, whereas the findings of the present study are held with confidence. A future study could focus on using the TPB model to compare non-drivers and drivers. The second possible limitation here is that the perceived risks were not subject to the TPB model. Measuring risk perception separately indicated that the participants' general understanding of mobile phone use as a risk while driving, but the study cannot answer the

question whether the risk perception is an important predictor for behavioral intention. Measuring the perceived risk in the hands-free and handheld situation separately is a potentially useful way for addressing this issue.

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