European Journal of Human Movement, 2015: **35**, 41-50

CHOICE REACTION TIME IS NOT RELATED TO COMPETITION SUCCESS IN KARATE COMBAT

Oscar Martinez de Quel [1]; Simon J. Bennett [2];
Enrique Lopez-Adan [3]; Augusto G. Zapico [1];
Francisco Saucedo-Morales [3]

1. Faculty of Education. Complutense University of Madrid. Spain
2. Research Institute for Sport and Exercise Sciences. Liverpool John Moores University, United Kingdom.
3. Faculty of Physical Activity and Sport. Technical University of Madrid

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ABSTRACT

Introduction: A thorough review of extant literature on choice reaction time (CRT) and performance in combat sports reveals much equivocality, which in part stems from comparisons of quite distinct groups of participants (e.g., athlete vs. non-athlete). Therefore, the current study was designed to determine whether choice reaction time (CRT) is a predictor of different performance levels of karate fighters. Methods: A unique cohort of 123 kumite athletes from regional to international level (including 11 world champions) and 32 control subjects with no experience of karate was studied. All participants completed a CRT test in which they responded to the appearance of a non-specific stimulus (black square in different positions on a computer screen) by pressing the appropriate key on a keyboard. Results: Multiple linear regressions on mean CRT indicated that age and sex, but not performance level, were weak significant predictors. Response accuracy was not influenced by these factors. Conclusion: Competition success in karate kumite does not depend on CRT, and thus caution should be exercised if this variable is to be used in training or talent identification.

Key Words: reaction time, karate, combat sports, martial arts, sports performance, training, talent identification, perception

RESUMEN

Introducción: La abundante literatura existente acerca del tiempo de reacción electiva (TRE) y el rendimiento deportivo en los deportes de combate todavía no ha mostrado resultados concluyentes sobre la relación entre ambos, esto posiblemente sea debido al hecho de haber comparado grupos muy diferentes (por ejemplo, deportistas y no deportistas). Así, este estudio fue diseñado para determinar si el TRE predice el nivel deportivo en el combate de karate (kumite). Método: 123 deportistas especialistas en kumite, desde nivel regional hasta nivel internacional (incluyendo 11 campeones del mundo), y 32 personas sin experiencia en karate realizaron un test de TRE en el que debían responder a un estímulo no específico (un cuadrado negro que aparecía en diferentes posiciones de una pantalla de ordenador) pulsando la tecla correspondiente. Resultados: El análisis de regresión lineal múltiple mostró que la edad y el sexo predijeron de manera débil aunque significativa el TRE, pero no lo hizo el nivel deportivo. La precisión de la respuesta (aciertos-errores) no se vio afectada por ninguno de estos factores. Conclusión: El nivel deportivo en kumite no depende del TRE. Así, esta variable debería usarse con cautela en el entrenamiento o en la detección de talentos deportivos.

Palabras clave: tiempo de reacción, karate, deportes de combate, artes marciales, rendimiento deportivo, entrenamiento, detección de talentos, percepción

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Correspondence:
Oscar Martinez De Quel
Faculty of Education. Complutense University of Madrid. Spain,
C/ Rector Royo Villanova s/n,
28040 - Madrid, Spain.
odequel@edu.ucm.es
Submitted: 25/05/2015
Accepted: 25/11/2015

INTRODUCTION

Reaction time (RT) has been widely studied by psychologists and sports scientists, and despite a shift in research emphasis toward anticipation and decision making (Williams and Elliott, 1999; Ward et al., 2002), trainers and practitioners of combat sports still believe RT to be a very important factor in success. RT is included in fitness test batteries (Chaabène et al., 2012) and is often recommended as part of training programs (Kim, 1999; Nishiyama and Brown, 1990). This focus on RT is perhaps not surprising when it is considered that sports such as karate combat (kumite) require practitioners to make rapid defensive and offensive responses in order to outscore their opponent. For instance, karate experts have been shown to punch in as short a duration of 242 ms (VencesBrito et al., 2011) or 298 ms (Martinez de Quel and Bennett, 2014), whereas kung-fu practitioners punch with hand speeds up to 5.79 m/s (Neto et al., 2012).

In sportspersons per se, classic studies that purport to measure RT indicated that this cohort is quicker to react to an imperative stimulus than sedentary people (Beise and Peaseley, 1937; Keller, 1942). However, many of the measurements made in these early investigations included both RT and movement time (MT), and thus were reflective of total response time (RT + MT). Nonetheless, latter studies that omitted MT also supported the finding of a simple reaction time (SRT) advantage in expert practitioners (Landers et al., 1986; Barcelos et al., 2009). With respect to the sport of karate, it has been suggested age-matched practitioners have quicker SRT than wrestlers (Rash and Pierson, 1963), and that karate fighters have quicker SRT than sedentary people (Lee et al 1999). Mori et al. (2002) also found differences in choice reaction time (CRT) between expert and novice karate fighters but not SRT. Finally, while Oehsen (1987) found no difference between karate experts and novices in CRT, experts did make fewer mistakes. The implication is that novices would have had slower CRT if they maintained comparable accuracy as the experts.

Notwithstanding methodological concerns with small sample sizes (e.g., 6 experts and 7 novices in Mori et al., 2002), it is notable that RT in combat sports has typically been examined by comparing one group of athletes with a group of sedentary individuals, or athletes of a much lower skill level. Therefore, it remains to be determined whether RT differs across a more complete range of sporting levels, and also if other factors could partially account for previously reported expert-novices differences. Indeed, a recent review of physical and physiological profile of elite karate athletes concluded that there is notable controversy in the findings on SRT and CRT, leading the authors to call for additional well controlled studies on successful and less successful karate athletes (see Chaabène et al., 2012). To this end, the present study used multiple regression to determine if performance on a CRT test (i.e., speed and accuracy of response) is predicted by participant skill level as defined by competition experience and success, and/or other factors (i.e., age, sex) specific to the cohort. A CRT task was used because, in karate combat, a participant's success is dependent on rapidly choosing different defensive or attacking responses based on the moves of their opponent. Importantly, however, the stimulus and response of CRT test was not specific to karate, thus minimizing effects of perceptual-cognitive expertise (e.g., knowledge led anticipation) (Starkers and Ericsson, 2003), as well as technical and physical factors, and thereby better elucidating underlying CRT.

METHOD

Participants

The participants were 155 volunteers all over 18 years of age: 32 with no experience in karate and 123 specialists in kumite. All karate fighters had taken part in Spanish national competitions in the preceding year. Participants were classified into five groups: *non-karate practitioners* – individuals who did not practice karate nor any other sport in which RT might be important (male: n=16, female: n=16, mean age=23.84±5.00); *regional karate fighters* – individuals who took part in competitions but who had not been selected to compete in the Spanish National Championships (male: n=14, female: n=8, mean age=23.00±2.98); *national karate fighters* (male: n=16, female: n=18, mean age=22.91±5.19); *national medalists* (male: n=22, female: n=10, mean age=20.97±3.93); and *international karate fighters* - fighters selected to take part in the European or World Championships (male: n=26, female: n=9, mean age=22.83±4.51, including 11 World Karate Federation Champions). All participants provided informed consent to be included in the study, in agreement with the ethical guidelines approved by the ethics committee of the host university.

Procedure

The stimulus of the CRT task was generated using SuperLab Pro v.2.0 software and was not specific to karate, thereby minimizing the influence of task-specific expertise (i.e., anticipation), as well as technical and physical factors. Participants viewed a computer screen (15" LCD) showing four white squares. One of the white squares was then replaced by a black square (see figure 1), signaling to the participant to respond by pressing a key with the corresponding finger, which was already placed on a key congruent with the spatial location of the square. Specifically, if the black square appeared at the top left corner, participants were required to press the "r" key with the middle finger of the left hand, whereas for a square appearing at the bottom left corner, the "f" key was pressed with the left index. For a square appearing at the top right corner, the "i" key was pressed with the middle finger and a square at the bottom right corner corresponded required the "j" key to be pressed with the index finger. Participants were encouraged to respond as quickly and accurately as possible.

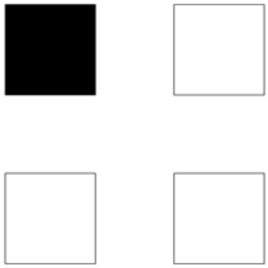

FIGURE 1: Pictorial representation of the stimulus used in the CRT test. For an explanation of the spatial congruence between the stimulus and effector response see main text.

A block of 25 trials was performed for familiarization, after which participants performed three blocks of 25 trials with a self-determined inter-block interval, during which they could rest in preparation for the next block. The location of the black square on each trial was randomly ordered, and was presented immediately after the response was given to the previous trial. Thus, there was not intertrial interval, which is representative of karate combat where athletes are required to respond continuously to stimuli from the opponent. Duration of testing was 30-40 min and was conducted under the supervision of an experienced researcher. All testing was performed in the absence of any distracting noise. No participant underwent testing having just performed intense exercise or having just woken up.

For each participant, the results of the first trial of each block were discarded because they followed a period of rest and thus were unrepresentative of normal CRT. From the remaining trials, mean CRT was calculated from trials with a correct response. The percentage of correct trials was also calculated as a measure of response accuracy. These dependent measures were entered into separate forward-stepwise multiple linear regression (for similar analysis of RT see Bleecker et al., 1987), with age, sex and skill level as predictor variables.

RESULTS

The outcome of the multiple regression are shown in table 1. For CRT, two predictors, age and sex, explained 11% of the variance (R^2=0.112, F(1,152)=9.61, p<0.001), whereas for the percentage of correct trials there were no significant predictors. β in the model for CRT was positive for age (0.28) and negative for sex (-0.20). CRT increased with age and was faster in males than females. Additional multiple regression was also run with the predictor, skill level, given a binary classification (i.e., defined as those with no experience or experience in karate kumite). The outcome was consistent with the initial analysis, confirming that task-specific experience per se did not result in quicker or more accurate CRT. Analysis of the correlations between predictors in both regression models indicated no significant multicollinearity, with the highest r being 0.27.

TABLE 1
Coefficients for multiple regression on CRT.

	b	SE *b*	*ß*	*p*
Constant	355.30	26.22		
Age	3.62	0.98	0.28	0.001
Sex	-22.71	8.89	-.20	0.01

DISCUSSION

In the present study we measured non-specific CRT and response accuracy of karate fighters ranging from regional to international standard (including 11 world champions), and participants with no experience of karate. Multiple regression on this unique cohort of participants indicated that age and sex, but not skill level, were significant predictors of CRT. This was reflected in a positive relationship with older participants exhibiting slower CRT, and males exhibiting faster CRT. Therefore, contrary to some previous empirical work (Lee et al., 1999; Mori et al., 2002) and the common belief of coaches and practitioners (Kim, 1999; Nishiyama and Brown, 1990), the highest achieving karate fighters did not have quicker CRT than lower level fighters or even people without karate experience. In this respect, the current results are consistent with the finding of no differences between hard-style martial arts practitioners and sedentary participants in SRT nor CRT (O'Donovan et al., 2006); or expert and novice fencers in a non-specific CRT test performed at rest (Mouelhi Guizani et al., 2006) and thus the statement that RT is not a key factor in fencing performance (Gutiérrez-Dávila et al., 2014). Moreover, Heller et al. (1998) concluded that the simple visual RT did not appear to be closely related with competitive performance in taekwondo athletes. Analysis of response accuracy in the current study indicated that the lack of skill-level difference in CRT was not explained by strategic differences in participant's speed-accuracy relationship. That is, novices and lower standard karate fighters did not sacrifice response accuracy in order to maintain quicker CRT similar to that of experts.

Given the duration and speed at which defensive and attacking moves are made in combat sports (VencesBrito et al., 2011), one might intuitively think that individuals with a better CRT (i.e., quicker and more accurate) would reach higher level of competition success. Indeed, a number of studies have reported that experts differ from novices in response timing and/or precision. For instance, Williams and Elliott (1999) report that karate experts respond quicker and with fewer errors than novices to film-based stimuli, whereas Ripoll et al. (1995) found expert French Boxers exhibit similar response to novices but make fewer errors. However, as has been recognized by these and other researchers, expert-novice differences in such sports is explained by task-specific expertise that underpins anticipation and decision making in the context of specific stimulus conditions. The results of the current study from a large cohort of participants of varying skill level are consistent with this interpretation. Moreover, while we agree that a certain level of speed and accuracy of CRT will be necessary in karate combat (i.e., within bounds of normal population), it would seem that competition-based skill level is not predicted by the individual's underlying capacity to react to non-specific stimuli with a non-specific motor response.

Although skill level did not enter into the final regression equations, participant age, and to a lesser extent sex, were weak significant predictors of non-specific CRT. How, then, can these results be reconciled with those of previous work? There have been several reports that CRT (Der and Deary, 2006; Gutnik et al., 2015) and SRT (Bleecker et al., 1987) is faster in males than females, and that this could reflect differential central processing strategies (Adam et al., 1999; Reimers & Maylor, 2007). In terms of combat sports, our results are consistent with the work of Vieten et al. (2007), who showed that male members of the German taekwondo squad had faster SRT than the female members. However, it should be noted that while the stimulus used by Vieten et al. was non-specific, SRT was derived from onset of limb motion in a simulated kicking task and could thus have been influenced by skill level and force production. Indeed, it has been suggested that males exhibit faster SRT than females in tasks such as sprinting because they generate force quicker due to peripheral motor factors (see Lipps et al., 2013). The implication, then, is that male combat sport athletes could exhibit faster CRT than their female counterparts as a result of both central and peripheral factors.

Putting aside studies that used entirely different tasks such as a writing test (Kim and Petrakis, 1998) as well as those that compared task-specific RT (e.g., fencing, Williams and Walmsley, 2000); or single groups of experts to sedentary individuals (Lee et al., 1999), it is evident that participant age has not been well controlled in studies reporting skill-based differences in RT. For instance, while Borysiuk and Bailey (2007) reported expert fencers have faster RT than novices, there were differences in age between the groups (mean age of 22.3 yrs and 14.8 yrs, respectively) that were not considered. This is important because it is known that simple and choice RT becomes faster from childhood to adulthood (Kiselev et al., 2009), and then slows (progressively for CRT) into old age (Der and Deary, 2006). The finding of a weak but significant positive relationship between age and CRT in the current study is consistent with this effect and would likely have become stronger had there been a wider range of participant age (i.e., younger and older). However, the predictive value of age to competition success in karate kumite is somewhat limited given that participants do not typically compete at high level beyond 30-35 years.

In conclusion, participant skill level in karate kumite does not predict CRT or response accuracy in a task requiring a non-specific response to non-specific stimuli. Therefore, participants underlying CRT does not predict their potential talent for karate kumite. Future research should investigate further how other physiological and psychological (e.g., perceptual-cognitive expertise) factors relate to performance in karate.

The practical implications of this study are:

- Talent identification in karate should not be based on underlying RT.
- It is more likely that perceptual-cognitive expertise is a key factor to achieve sporting success in karate, along with physiological characteristics.
- Combat sports training should not focus on the reaction to general stimulus but instead should encourage use of specific stimulus analogous to those experienced in combat.

Acknowledgements

This research was funded by the *Facultad de Ciencias de la Actividad Física y del Deporte - Universidad Politécnica de Madrid* (Spain) via the predoctoral fellowship programme.

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