THE IMPORTANCE OF VISION DURING A JUDO MATCH

An important step in the development of an evidence based classification system for the International Paralympic Committee

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Abstract

Purpose: The International Paralympic Committee (IPC) states within their Classification code that all classification systems used in Paralympic sports need to be based on evidence showing the relationship between impairment and performance in that sport. However most sports for visually impaired (VI) athletes, including judo, currently do not yet have evidence-based minimum impairment criteria (MIC) to determine which athletes are eligible to compete. In order to establish evidence based MIC, the aim of this study was to determine the minimum level of vision impairment which impacts the ability of a judoka to compete equitably against able-sighted opponents. The now current stated MIC for VI sports is based on the World Health Organization of low vision at logMAR 1.0.

Methods: Twenty-eight experienced able sighted judokas were paired up and asked to perform a specific judo task under different visual conditions. The task was to obtain and maintain an advantageous grip over the opponent right after the start of a bout under different levels of visual conditions. After each exchange, both participants provided a subjective rating grip fighting advantage. Four increasing levels of impairments (logMAR 0.6, 1.0, 1.3 and 2.0) were simulated using adapted swimming goggles. Two intervention checks were done using repeated measures ANOVA and Pearsons partial correlation analyses. The results of the three impairment condition were compare with the control condition to find out what the difference is with able-sighted judokas. The binary logistic regression model was used to calculate the probability of a significantly worse performance compared to control, relative to amount of VI. Based on this logistic model a new MIC can be suggested based on the cut-off value of the logistic model.

Results: The intervention checks demonstrated that there is a significant difference between the four conditions and in the visual acuity (VA) in logMAR or contrast sensitivity (CS) tests scores. The second intervention check showed there is a correlation between judo performance and VA or CS score. The binary logistic regression demonstrated that the cut-off point of decreasing judo performance is at a minimum of 1.335 logMAR (67.3% accuracy).

Conclusion: VA, better than CS, predicts a negative impact of vision impairment on performance in able-sighted judo. The minimum level of impairment which impacted performance in this study was found at a visual acuity of 1.335 logMAR what is higher than the now stated MIC of logMAR 1.0. These findings suggest the MIC for VI judo should be reconsidered.
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Introduction

To promote fair and equitable competition, many sports are divide their competitors into different classes into different competitive categories or classes, i.e. judo has weight classes, most youth sports have age classes and there is the handicap system in golf. This process of dividing competition in different classes is called classification. Different sports make use of different classification systems to promote participation and reduce one-sided competition (Tweedy & Vanlandewijck, 2011). Where classification systems are important to ensure fairness in regular sports, they can be considered even more important in Paralympic sports. In Paralympic classification specifically, the aim is to ensure fairness by minimising the impact of any impairment on the outcome of the competition. In other words, to make sure that the outcome of competition is determined by ‘skill, fitness, power, endurance tactical ability and mental focus’, rather than level of impairment (International Paralympic Committee, 2007). The International Paralympic Committee (IPC) states within their Classification code that all classification systems used in Paralympic sports need to be evidence based (Tweedy & Vanlandewijck, 2011). This means that empirical evidence indicates the methods used for assigning class (Vanlandewijck, 2014), and have as its purpose to promote participation in the sport from people with disabilities by minimizing the impact of eligible impairments. An impairment can affect the performance of the athletes in able-bodied sports, what could be a reason for an athlete to quit the sport. For this group of athletes there is para-sport, what is stimulating the participation for athletes with an impairment.

An important step in the development of an evidence-based classification system is to determine which athletes are considered eligible to compete in a certain para-sport (Tweedy & Vanlandewijck, 2011). To be eligible to compete a para-sport, an athlete needs to have a (relatively) permanent impairment which is relevant for the sport of interest, i.e. an athlete with an visual impairment can only compete in a para-sport caters for visually impaired athletes (e.g. judo). Next, the severity of the athletes’ impairment must meet the minimum impairment criteria (MIC) set for the sport (Tweedy & Vanlandewijck, 2011). The MIC describes the minimum level of impairment that has a negative impact on sport performance, such that the fairness for this athlete in competing in able-bodied versions of the sport is compromised, and therefore should be eligible to compete in para-sports (Ravensbergen, Mann, & Kamper, 2016). As a part of the development of an evidence-based classification system, MIC should be determined based on the relationship between impairment and performance limitation within able-bodied sport (Mann & Ravensbergen, 2018). Most para-
sports adapted their rules so that relevant impairment do not influence the performance, i.e. in para-judo there is no grip fight for obtaining and maintain an advantageous grip.

In violation of the IPC classification code, most sports for visually impaired (VI) athletes do not yet have an evidence-based classification system, with a sport specific MIC, in place (Ravensbergen, Mann, & Kamper, 2016; Tweedy & Vanlandewijck, 2011). Most VI sports use the same MIC, based on the World Health Organization (WHO) criteria for low vision (World Health Organization, 2001). This criteria is based on visual acuity (VA), clarity of sight, measured in logMAR, and the visual field (VF), the width of the visual field that can be seen without moving the head or eyes, measured in degrees. To be eligible for participation in most VI sports, including judo, an athlete needs to have a minimum VA logMAR 1.0 or worse, or a visual field not wider 20 degrees (International Blind Sport Federation, 2017). But for an evidence-based classification it maybe is necessary to use other measures of visual function. For example, in a study done by Allen et al., (2018) it was showed that shooting performance is better predicted by losses in contrast sensitivity (CS) than by VA.

Experts question whether the current MIC for judo are adequate. Ravensbergen, Mann and Kamper (2016), consulted experts across different VI sports, who advocated the development of sport-specific classification criteria for each individual VI sport. Krabben, Ravensbergen, Nakamoto and Mann (2018), conducted a similar expert consultation study specifically within VI judo. They found consensus amongst a group of VI judo athletes, coaches and administrators that the MIC for VI judo should either become less inclusive, excluding some athletes who are currently eligible to compete, or should stay at the current stated MIC.

Aside from the arguments provided by these Delphi studies, there is an idea that the current MIC does not ensure sufficient fairness. A study done by Krabben et al., (2017) found that there is a difference in the competitive success of VI judokas with different degrees of impairment. In their study they compared the competitive results of different professional VI athletes, and they found that essentially blind judokas won significantly less medals than their partially sighted opponents in two major VI judo championships. Similarly, Mashkovsky et al., (2016) analysed the outcomes of 1640 official fights across a total of 8 major international Paralympic judo competitions and found similar results, showing again that the most severely impaired judo players seem to be at a disadvantage within the current system. Furthermore, Krabben et al., (2017) found that able-sighted judo players competing in stimulated competition under VI judo rules, perform significantly worse when fighting blindfolded compared to when fighting with full vision. These findings suggest that an athlete’s degree of
visual functions plays an important role of their performance in competition VI judo. There is some evidence showing that vision also supports performance in able-sighted judo, specifically concerning grip fighting phase. At the start of an able-sighted judo, athletes start a few meters form each other and then bout fight to obtain the most advantageous grip of their opponent. This fight, and the outcome of it, is seen as essential key point for the success in judo (Santos, Fernández-Río, Almansba, Sterkowicz, & Callan, 2015). Instead of able-sighted judo in VI judo the two competitors start with a standard grip placed at the start of the match, whereas in able sighted judo the two competitors fight to get the most advantageous grip.

Another study done by Kajmovic et.al., (2014) showed that grip fighting plays an important role in judo. They investigated the gripping behaviours of male and female elite judokas, showing a difference in gripping behaviours, and concluded that a well-developed effort to establish a grip may be one of the key factors in determining the outcome of a fight.

Beyond the fact that grip fighting is important for the outcome and success of judo, it also turns out as highly visually demanding. Piras, Pierantozzi and Squatritio (2014) reported in their study that there is a difference between the visual search behaviour of able sighted judokas of different levels of expertise during the exchange of first grips. They found that experts fixate their gaze on the chest and face of their opponents. Novices, on the other hand, fixate their gaze on the hands and/or sleeve. These findings support the idea that vision is important in obtaining the grip on the opponent. Grip fighting is the biggest difference between able-sighted judo and VI judo, as determined by the rules, and it is highly visually demanding. It is plausible that especially in grip fighting the impact of VI becomes evident but there is no empirical evidence to support this yet. There is also no empirical evidence that supported the idea that the now stated MIC, and his classification for VI judo, describes the minimum level of impairment that has a negative impact on grip fighting performance and the outcome of the match.

To establish an evidence based MIC for VI judo, evidence is required showing the relationship between vision impairment and judo performance. The aim of this study was to determine the minimum level of vision impairment that has a negative impact on able-sighted judo performance. Because of the discussed evidence in grip fighting and the rule difference in grip fighting between VI judo and able-sighted judo, performance in this study, was operationalised as the ability to obtain and maintain an advantageous grip over the opponent in the starting phase of a bout. Based on expert opinions (Krabben et al., 2018), we expected that the level of impairment that has an impact on the judo performance would be either equal to or more severe than the current at least 1.0 logMAR.
Method

Pilot study

Before conducting the experiment, the impact of the control condition glasses on performance was tested in a pilot (N=10). A paired-samples t-test was conducted to compare the difference in impact on judo performance between wearing the control condition glasses (logMAR 0.6) and wearing no glasses. There was no significant decrease in scores when wearing the control condition glasses ($M = 61.65, SD = 7.18$) compared to wearing no glasses ($M = 60.60, SD = 10.50$), $t(9) = .456, p > 0.05$ (two-tailed).

Participants

28 adult experienced (brown or black belt) judoka participated in this study (22 male, 6 female; age $M \pm SD = 28.1 \pm 11.0$ years). Participant were paired up according to gender, weight, age and competition level. This study was ethically approved by the ethics committee of the VU university of Amsterdam. Each participant received an information sheet (appendix A) and signed an informed consent form (appendix B) prior to the start of the study.

Apparatus and Materials

This research took place at the Amsterdam University of Applied Science (AUAS) and at a training location of Judo Academie Amsterdam, the Instituut Schreuder. On both these locations a regular judo mat was prepared. This mat was a square of 6 by 6 meters, with 2 meters on every side for safety purposes (appendix C). Two cameras were used on either side of the mat to record the grip fighting exchanges from two angles. Visual impairment was simulated using modified swimming goggles using four different Bangerter Occlusion Foils. These types of foils were used to reduce the VA and CS in ascending order. The four types of foils that were used were three from Trusetal: the occlusive $\sim 0.1$ (control condition), occlusive $<0.1$ (low impairment) and light perception (medium impairment) and one from Rysero Optheamlogie the light perception (high impairment). These four increasing amounts of impairment were respectively the control condition (estimated at approximately 0.6 logMAR), low impairment (estimated at approximately 1.0 logMAR), medium impairment (estimated at approximately 1.3 logMAR), and high impairment (estimated at approximately 2.0 logMAR). Before this study fourteen people were asked to do the tumbling E protocol (appendix D) to determine the amount of vision for each condition. The levels of impairment were based around the stated MIC. The low impairment was around the now stated MIC, medium impairment was a bit above the criteria and the high impairment was far above the
criteria. To improve the reliability the control condition, with a minimal impairment, was added to prevent anyone in advance from being biased because of having no glasses or no VI. It became clear from the pilot test that it makes no difference whether you do not wear glasses or wear glasses with a minimal level of VI. So to avoid a bias deserved preference to where a control condition glasses with a minimal VI.

Two testes were used to measure the level of vision. Visual acuity was measured by using the Berkeley Rudimentary Vision Test (Bailey, Jackson, Minto, Greer, & Chu, 2012) (appendix D) and contrast sensitivity was measured using the Mars Numerical Contrast Sensitivity Test (appendix E). At the end the participant get a debriefing forms (appendix F).

Procedures

The experimental task consisted of ten trials of a 15 second grip fighting exchange, across seven different visual conditions (table 1), resulting in a total of 70 trials for each pair of participants. To improve the reliability, the seven conditions were ordered randomly for each pair of participants, to counter any bias due to learning or order effects. During each grip fighting exchange, the task for both participants was to achieve the best grip for them personally. This concerns the feeling that you are in an advantage in relation to the other and a better starting point for a possible future progress in the match. After each exchange both participants provided a subjective rating of the overall balance between the two judokas, by dividing 100 points among themselves in terms of grip fighting advantage, with higher percentages representing a perceived advantage and lower numbers a perceived disadvantage (e.g. 50/50 being equal). These ratings were given independently, after each trial, by each participant. The impairments were stimulated by the swimming goggles.

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<thead>
<tr>
<th>Experimental condition number</th>
<th>Participant 1</th>
<th>Participant 2</th>
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<tbody>
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<td>1</td>
<td>Control condition glasses</td>
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<td>2</td>
<td>Low impairment glasses</td>
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<td>7</td>
<td>Control condition glasses</td>
<td>High impairment glasses</td>
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Data analysis

The scores given by the participants were used to generate three variables, a rating of the participants own performance, a rating of their performance as given by their opponent and an average of these two ratings. If a participant gave himself a score of 60, than it means that the opponent rating 40 is for the other participant in the same condition. The average means of these values across 10 trials were used for analysis. First, three intervention checks were done by using an repeated measures ANOVA to compare the means of the average score between the rating of performance by the participant and the opponent per condition, VA- and CS- scores in the different conditions. All these three repeated measures ANOVA had a post-hoc test with a Bonferroni corrections comparing each condition against the other three condition combined. The data of the three impairment conditions were analysed compare the control condition to find out what the difference is between having an impairment and able-sighted view like in normal judo. This all to increase the validity. The effect sizes were calculated by a Cohen’s D calculation.

The second intervention checks were two Pearsons partial correlation analyses. Partial correlation was used to explore the relationship between VA or CS, and an average between the rating of performance by the participant and the opponent, while controlling for within subject variance, because each participant represented four data points.

For binary logistic regression check we used the same method as Allen et al., (2018) used in their shooting experiment. In order to determine which level of simulated visual impairment would result in a statistically significant decrease in judo performance, the individual score in each trial in the average control condition were normalized as a percentage of the overall individual average score in the in the control condition in order to establish a boundary (i.e., normalised control condition trial score= average individual trial score/overall individual average score in the control condition *100). Around these percentage scores a 95% CI was calculated. Then all the individual mean scores of the average rating of their performance were normalized as a percentage of the overall mean of average rating in the control condition (i.e., normalised trail score in one of the four conditions = individual mean in one of the conditions/overall individual average in the control condition *100). After the normalising of the scores each normalized score, and turned into a binary variable depicting either a normal or significantly worse performance compared to control by using the 95% CI boundary. All these scores lower than the lower boundary of 95% CI were classified as being a significant decrease in performance. We also trimmed all score by 5% and 10% because the
variation in judo performance is bigger than the shooting performance in the study from Allen et al. (2018). This to check if outliers has an big influence on the score. The binary logistic regression analysis was used to determine which level of impairment resulted in a significant decrease in judo performance. Using a forward stepwise method with both Contrast Sensitivity (CS) and Visual Acuity (VA), VA was selected as the best predictor, with higher scores of VA associated with poorer performance. To establish the cut of value for VA at which judo performance would be considered significantly worse the value at which the probability for a significantly worse performance was 50% was used. Thereafter a binary logistic regression model was used to calculate the probability of a significantly worse performance compared to control, relative to amount of visual impairment. This also were done to increase the validity because the control condition were based on the sighted of an able-sighted judoka. Based on this logistic model an new cut-off value was calculated (i.e. cut-off = -variable entered on step one/constant). The effect sizes were calculated by a Cohen’s D calculation.
Results

Repeated measures ANOVA:
There was a significant effect of impairment condition on performance (see Figure 1), Wilks’ $\Lambda = .436$, $F(3, 23) = 9.91$, $p < .01$, multivariate partial $\eta^2 = .564$. Post-hoc comparisons with Bonferroni corrections indicated that no difference was found between scores in the control condition ($M= 50.59$, $SD= 9.75$) and the scores in the low impairment condition ($M= 50.01$, $SD= 9.56$) $p > .05$ but the mean scores of the medium impairment and high impairment condition differed significantly from the control condition, respectively control ($M= 50.70$, $SD= 9.73$) and the medium impairment ($M= 45.24$, $SD= 12.13$) $p < .01$ ($d = 0.49$), high impairment ($M=42.16$, $SD=12.29$) $p < .01$ ($d = 0.77$).

Figure 1. Bars represent the means of an average between the participant and the opponents rating of performance in the four conditions. The error bars indicate 95% confidence intervals.
There was a significant effect for visual condition acuity (see Figure 2), Wilks’ $\Lambda = .006, F (3, 24) = 1405.53, p < .01$, multivariate $np^{2} = .994$. Post-hoc comparisons using the Bonferroni test indicated that the mean score differed significantly across conditions, respectively control ($M = .69, SD = .09$), low impairment ($M = .98, SD = .15$) $p < .01 \ (d = 2.34)$, medium impairment ($M = 1.27, SD = .11$) $p < .01 \ (d = 5.77)$, high impairment ($M = 2.07, SD = .09$) $p < .01 \ (d = 15.3)$.

![Figure 2. Bars represent the mean VA scores in the four conditions. The error bars indicate 95% confidence intervals.](image-url)
There was a significant effect for visual condition on contrast sensitivity (see Figure 2), Wilks’ $\Lambda = .028$, $F (3, 24) = 272.89$, $p < 0.01$, multivariate $\eta^2_p = .972$. Post-hoc comparisons using the Bonferroni test indicated that no difference was found between the medium impairment ($M = .55$, $SD = .24$) and high impairment ($M = .38$, $SD = .43$), but the mean score differed significantly across the other conditions, respectively control ($M = 1.64$, $SD = .15$), low impairment ($M = 1.08$, $SD = .35$) $p > .01$ ($d = 2.08$), medium impairment ($M = .55$, $SD = .24$) $p > .01$ ($d = 5.45$), high impairment ($M = .38$, $SD = .43$) $p > .01$ ($d = 3.19$).

Figure 3. Bars represent the mean CS scores in the four conditions. The error bars indicate 95% confidence intervals.
Pearsons partial correlation

We found a significant, but weak negative partial correlation between Visual Acuity and average performance, controlling for within subject variance, \( r = -0.327, n = 107, p < 0.01 \), with high levels of visual acuity associated with high ratings by the participants. An inspection of the zero order correlation \( (r = -0.326) \) suggested that controlling for within subject variance had little effect on the relationship between these two variables. These results are presented graphically in Figure 4.

Figure 4. The line represents the linear relationship between rating of performance averaged between the participant and the opponent and VA. Coloured dots represent individual average score in one of the conditions.
There was a weak, positive, partial correlation between Contrast Sensitivity and the averaged rating, controlling for within subject variance, \( r = .247, n = 107, p < 0.05 \). An inspection of the zero order correlation (\( r = .247 \)) suggested that controlling for within subject variance had no effect on the relationship between these two variables. These results are presented graphically in Figure 5.

Figure 5. The line represents the linear relationship between rating of performance averaged between the participant and the opponent and CS. Coloured dots represent individual average score in one of the conditions.
Binary logistic regression:
The ratings of performance of the average scores were normalized as percentage of the mean rating by the opponents in the control condition, and a 95% CI was calculated [97.21, 102.79]. Using a forward stepwise method with both Contrast Sensitivity (CS) and Visual Acuity (VA), VA was selected as the best predictor, with higher scores of VA associated with poorer performance. Using VA as a predictor, the first step of the model predicted the cut-off value to be 1,335 logMAR, as shown in figure 6. The analysis showed that this model was accurate in 67.3% of cases, with a sensitivity of 50.0% and a specificity of 81.7%.

Figure 6. Logistic regression model including VA only. The curve represents the logistic regression model, predicting an averaged rating of performance by the participant themselves and their opponent. The horizontal line indicates the probability of below expected performance of 0.5 and the vertical line indicates the cut off value of 1,335 logMAR. Coloured dots represent the conditions.
The same analysis was repeated twice, each time reducing the variance in the sample, by respectively using a 5% and a 10% trimmed mean. This was done by either removing the highest and lowest scores across 10 trials, or removing the two highest and lowest scores across 10 trials. However the logistic model predicted a similar cut-off value for both these analyses, respectively 1,308 logMAR and 1,264 logMAR.
Discussion

The aim of this study was to determine the minimum level of vision impairment (MIC) that had an negative effect on able-sighted judo performance. We showed that level of visual impairment has a negative effect on the ability to achieve an advantageous grip over the opponent. In agreement with our hypotheses, we found that VA was a better predictor of performance than CS, and that athletes who just meet the current MIC for VI judo of 1.0 logMAR, are not impacted in their grip fighting performance. A new MIC for VI judo was proposed at an impaired VA of 1.335 logMAR, which is a significant increase from the current IC.

It was to be expected that a higher VA score or a lower CS score had a negative impact on performance considering previous studies. These studies were done in able-sighted judo but support the findings of our study in VI judo. The findings of this study are reasonably in line with the findings of Krabben et al. (2017). They showed that able-sighted judoka’s competing in stimulated competition under VI judo rules, perform significantly worse when fighting blindfolded compared to when fighting with full vision. Piras et al., (2014) also support the idea that vision in obtaining the grip on the opponent is important. These two articles and the findings found in this study showed that the limit of vision is important and a VI has a negative impact on the performance.

The results in this study support also the findings that the current MIC criteria of logMAR 1.0 is not the point where VI has a negative effect on their performance. The current stated MIC do not correspond with the much higher cut-off point of 1.335 in this study. These results are consistent with results found in the Delphi study, done by Krabben et al., (2018). The experts panel in that study unanimously agreed that the MIC for VI judo should not become more inclusive or should either be less inclusive than the present MIC of logMAR 1.0, to exclude more athletes who are currently eligible to compete.

In this study there is found that VA is a better predictor for the negative impact on the performance than CS. In a comparable study, done by Allen et al., (2018) there was examined which measurement of impairment (VA and/or CS) would impact performance in shooting. Participants had to shot an 0.5 mm target from a distance of 10 m with different visual conditions. In this study, CS was found to be a better predictor. This is different compared to the findings of this study, where VA was found to be the better predictor. This difference in
findings could be explained by the difference in sport. In the shooting study participants had
to shoot at a small target far away, and focus on it. It could be that the ability to see contrast is
particularly important for these kinds of tasks. Whereas in judo it is not the most important
ting to focus on small details in the distance, but rather see the general shape of your
opponent and react to his movements. It could be that CS is less important for these types of
tasks. However, this showed the important it is to have an evidence-based classification
system with an sport-specific MIC. The importance of this was also states in the studies from
Ravensbergen et al., (2016) and Mann et al., (2018)

A possible disadvantage of the design of this study is that the participants were able-
sighted. Normally, athletes had a long-term adaptation to their VI in their sport. This could
undermine the performance of the able-sighted athletes because long term adaptation may
lead to an improvement in performance. If an athlete with an VI is able to adapt to his
impairment, their performance will be better. This means that the results of this study could be
an overestimation and MIC is higher than it is in real. But if an athlete with an long term
adaptation performance better it mean that he also can compete in the able-sighted classes.

Another point of criticism of the design of this study the control condition. This
condition was condition with a small impairment and was not the ‘normal’ view of the
participant. It may lead also lead to an underestimation of the scores with this glasses on. This
means that the MIC can be lower than it is in real, because the difference between the
conditions is not big enough. The subjective measurement is also a point of criticism. This
measure can create a bias that affects the performance what can be underestimate or
overestimate. This means that the stated MIC in this study is to high or to low. But the
subjective measurement give us a good view of the feeling of the participants during the task.
Beyond that, same study with an objective measurement and normal control condition can
overcome these problem.

The last point of criticism for this study is that the sensitivity in the binary logistic
regression analyses is at a low level. This means that the model does not predict well if
someone fits to the category that performs worse than with normal vision on VA basis. On the
other hand, the model in all cases are very specific and that means if model fits and the
participant performs worse on basis of VA, the decline of the performance with in the model
fits the participant.
The results of the current study do not apply for the entire judo match but only for
gripfighting. However, if we did a full judo match the difference would be not that much. In
another study done by Krabben et al., (2017) they showed that if an able-sighted judoka is
blindfold with a standardised grip he is also able to make some throws but less than the
participant without a blindfold. In our study the participants with a bigger impairment are also
able to grep their favourite grip, but they score most of the times lower than the other
participant. Our results show that vision plays an important part in what the difference is
between able-sighted judo and VI judo. The same study with a full judo match overcome this
problem and show us what it is to have a VI in a full judo match.
Conclusion

Vision impairment has a negative impact on the ability to obtain an advantageous grip over the opponent in able-sighted judo, and VA is a better predictor of this performance impact than CS. Athletes with a vision impairment at the current MIC of 1.0 logMAR are unlikely to be impacted in their judo performance. The minimum level of impairment which impacted performance in this study was found at a visual acuity of 1.335 logMAR, suggesting the MIC for VI judo should be reconsidered.
References


Dear madam, sir,

From [date] till [date] will will be organizing a study into the role of vision in judo performance. We would like to invite you to participate in this study.

**Why do we conduct this study?**

Currently within Paralympic judo visually impaired people compete together with legally blind people, while research suggests that this might lead to an unfair (dis)advantage. The Faculteit der Gedrags- en Bewegingswetenschappen from the Vrije Universiteit van Amsterdam therefore wants to investigate the role of vision in judo performance. We expect this project will yield useful information to help improve the quality and fairness of Paralympic judo.

**Course of the study**

During this study judo you will be asked to compete against another judoka in several short grip fighting matches under different conditions of simulated visual impairment. These matches will be recorded using video cameras. The recorder material will be treated confidentially (also see below under ‘Confidentiality of data’). In between the matches you will also be asked to report on your own performance relative to your sparring partner.

**Participation in this study is voluntary**

Participation in this study is voluntary. You are in no way obligated to participate in this study. You can withdraw from participating at any time, without specification of reason. This will have no negative repercussions.

**Confidentiality of data**

All data collected for the purpose of this study will be anonymized and kept on a password protected computer. Only members of the research team will have access to this data. The data will not be shared with third parties and will not be used for other purposes besides this research. Conform the common guidelines for conducting experimental research the data will be kept for 5 years after publication. The data can in no way be traced back to your individual performance.

**How do I participate?**

With this form you received an informed consent form for participation in this study. By signing this form and handing it to the experimenter, you will be able to participate in this study.

Kind regards,

Arnt van Helden BSc, executive researcher, a.d.van.helden@student.vu.nl
Youri Kalisvaart BEd, executive researcher, y.kalisvaart@student.vu.nl
Kai Krabben MSc, supervisor, k.j.krabben@vu.nl
Appendix B

Informed Consent MIC Study

You will participate in a scientific study. Within this research you will be expected to do some grip fighting matches while wearing swimming goggles. Additional information about the nature of this research can be found in the added information sheet.

**By participating in this study you agree with the following statements:**

1. Your participation is voluntary. The study will take approximately 2 hours.

2. At any time during the study you are free to withdraw from participating. This will have no negative consequences for you of any kind.

3. The collected data will be anonymized and treated confidentially by the researcher. The collected data will not be used for any purposes other than this study. In the later reporting of this research only averages will be presented and your performance during the study can not be traced back to you in any way.

4. The collected data will be kept, conform common guidelines, for 5 years after publication. The data will be kept in an anonymized format on a password protected computer.

When you agree with the above, please write down your name and signature below.

When you disagree or have any questions please contact the person that welcomed you in this room.

Name:

Date:

Signature:
Appendix C

Room preparation materials:

- Mat six by six meters
- Two meters mat on every side for safety purpose
- Two camera’s with tripod
- Two tables
Appendix D

“Tumbling E” Eye Chart

The Tumbling E eye chart can detect nearsightedness in young children who don’t yet know all letters of the alphabet. It’s also a good “game” to play with a child who might be apprehensive about his or her first eye exam.

Tumbling E eye charts also are useful to test the distance visual acuity of children or adults who cannot communicate verbally due to a physical or mental disability, language barrier or other reasons.

DIRECTIONS FOR USE

If the person being tested typically wears eyeglasses or contact lenses full-time, the eyewear should be worn during the test.

1. Place the chart on a wall or easel 10 feet away.

2. Have the person cover one eye with a hand, a large spoon or some other item that completely blocks the vision of the covered eye. If available, an eye patch with an elastic band is a good choice. (Do not apply pressure to the covered eye, as it might affect that eye’s vision when you test it.)

3. Start with the large single E at the top of the chart. Show the person the three parallel “fingers” of the E and ask them to show you with the fingers on their hand which direction the “fingers” on the E are pointing. (Show the person that they should hold their hand in a manner so their fingers point in the same direction as the “fingers” on the E.)

4. If possible, show other orientations of an E to confirm that the person being tested understands the task.

5. Point to each E on successively smaller lines to test visual acuity. Remind the person not to squint.

6. Stop when the person fails to correctly identify the orientation of at least 50 percent of the Es on a line.

7. Switch to the other eye and repeat. Record visual acuity for each eye by noting the line for which the person correctly identifies the orientation of either:

   a) More than half the tumbling Es on that line, but not all of them.

   b) All Es on that line, plus a few Es (less than half) on the next line.

Examples:

If the orientation of five of the seven Es on the 20/32 line is correctly identified, the tested person’s visual acuity for that eye is: 20/32–2/7

If the orientation of all seven Es on the 20/32 line is correctly identified, plus three of the eight Es on the 20/25 line, the tested person’s visual acuity in that eye is: 20/32+3/8

---

Appendix E

The Mars
Numeral Contrast Sensitivity Test

USER MANUAL
Description

The Mars Numeral Contrast Sensitivity Test is a set of charts for testing peak visual contrast sensitivity. While the more familiar visual acuity test assesses resolution of the eye and visual system and the processing of high retinal image spatial frequencies, this test instead assesses processing of relatively low retinal spatial frequencies. Low spatial frequency processing can be diminished by a host of retinal disorders and by ocular media opacities and other optical disorders, often with minimal or no diminution of visual acuity. As such it is a useful instrument in the clinician’s toolbox. The test can be used for establishing baseline contrast sensitivity prior to an intervention (such as cataract extraction), for identifying functional losses in low contrast perception (often associated with glare sensitivity), or for functionally monitoring disease progression. Its small format makes it ideal for near testing and for use in small office or laboratory spaces, and atypical locations such as mobile eye clinics and patients’ homes. With a design based on and similar to the widely used Mars Letter Contrast Sensitivity Test, it uses Arabic numerals, which may be more familiar to many patients than Roman letters. Both tests follow the design practices recommended by the Committee on Vision of the U.S. National Academy of Sciences and National Research Council (Advances in Ophthalmology, 41, 103-148, 1980) in terms of luminance, font, and optotype spacing. The test system is a set of three printed charts, supplied in three forms for independent left eye, right eye and binocular testing. The three forms, whose number is identified at the bottom of each chart, are identical except for the sequence of numerals. A sample score sheet can be found on the back cover of this manual. This score sheet may be photocopied for use by owners of the test.

Each chart form consists of 48 numerals, each subtending 2 deg at a 50 cm test distance (or 2.5 deg at 40 cm), arranged in eight rows of six numerals each. The contrast of each numeral, reading from left to right, and continuing on successive lines, decreases by a constant factor (0.04 log unit). The patient simply reads the numerals across lines and down the chart, as in standard letter acuity measurement. (Instead of the numerals decreasing in size, however, they decrease in contrast.) The contrast of the final numeral before which the patient misidentifies two consecutive numerals, with a correction for earlier incorrect responses, determines the log contrast sensitivity (CS). Contrast values associated with log CS scores of the Mars CS tests are given in the following table:

<table>
<thead>
<tr>
<th>log CS</th>
<th>Contrast</th>
<th>log CS</th>
<th>Contrast</th>
<th>log CS</th>
<th>Contrast</th>
<th>log CS</th>
<th>Contrast</th>
<th>log CS</th>
<th>Contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.04</td>
<td>0.012</td>
<td>0.08</td>
<td>0.032</td>
<td>0.12</td>
<td>0.759</td>
<td>0.16</td>
<td>0.692</td>
<td>0.20</td>
<td>0.631</td>
</tr>
<tr>
<td>0.28</td>
<td>0.525</td>
<td>0.32</td>
<td>0.479</td>
<td>0.36</td>
<td>0.437</td>
<td>0.40</td>
<td>0.398</td>
<td>0.44</td>
<td>0.363</td>
</tr>
<tr>
<td>0.52</td>
<td>0.302</td>
<td>0.56</td>
<td>0.275</td>
<td>0.60</td>
<td>0.251</td>
<td>0.64</td>
<td>0.229</td>
<td>0.68</td>
<td>0.209</td>
</tr>
<tr>
<td>0.76</td>
<td>0.174</td>
<td>0.80</td>
<td>0.158</td>
<td>0.84</td>
<td>0.145</td>
<td>0.88</td>
<td>0.132</td>
<td>0.92</td>
<td>0.120</td>
</tr>
<tr>
<td>1.00</td>
<td>0.100</td>
<td>1.04</td>
<td>0.091</td>
<td>1.08</td>
<td>0.083</td>
<td>1.12</td>
<td>0.076</td>
<td>1.16</td>
<td>0.069</td>
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<tr>
<td>1.24</td>
<td>0.058</td>
<td>1.28</td>
<td>0.052</td>
<td>1.32</td>
<td>0.048</td>
<td>1.36</td>
<td>0.044</td>
<td>1.40</td>
<td>0.040</td>
</tr>
<tr>
<td>1.48</td>
<td>0.033</td>
<td>1.52</td>
<td>0.030</td>
<td>1.56</td>
<td>0.028</td>
<td>1.60</td>
<td>0.025</td>
<td>1.64</td>
<td>0.023</td>
</tr>
<tr>
<td>1.72</td>
<td>0.019</td>
<td>1.76</td>
<td>0.017</td>
<td>1.80</td>
<td>0.016</td>
<td>1.84</td>
<td>0.014</td>
<td>1.88</td>
<td>0.013</td>
</tr>
</tbody>
</table>

How to Administer the Mars Numeral Contrast Sensitivity Test

Illumination: For best results, the chart should be illuminated uniformly, with an optimal luminance in the chart’s white background of 85 cd/m². The chart’s small size facilitates this, and the lamp on a standard ophthalmic equipment stand will generally provide sufficient and sufficiently uniform illumination. Luminance should be at least 60 and less than 120 cd/m² in all white areas of the chart. Luminance is best checked with a photometer. However, if one is not available, an inexpensive incident light meter can be used. Illuminance should be in the range 159 to 377 lux, and optimally 267 lux. Testing should not be conducted through any coatings, lamination, or coverings on the chart, even if these are transparent or translucent.

Viewing distance and correction: The patient’s viewing distance to the chart is by design 50 cm (20 inches), but may range from the standard near refraction distance of 40 cm (15.75 inches) to 50 cm (20 inches). Patients should wear their appropriate near correction, or their distance correction, with an add of +2.00 D, and an occluder or patch on the untested eye. The test is quite tolerant of small refractive errors since the numerals are large (20/400 equivalent at 50 cm). Testing, however, should be performed with the eyes undilated. For patients with very low visual acuity who cannot easily read the highest contrast numerals, test distance may be shortened to 25 cm (increasing the add, if necessary, to +4.00 D); in this case care must be taken not to allow the patient’s head to occlude the light source illuminating the chart.

Instructions to the patient: Ask the patient to read the numerals from left to right across each line of the chart. If the patient gives a response other than a numeral (e.g. a letter), do not score the response as incorrect. Instead, inform the patient of the restricted numeral set, and ask for another response. This is in order to support the assumption that the probability of a guess is 1/10. Encourage the patient to guess even when they report that the numerals appear too faint.

Recording responses and scoring: On the score sheet, mark in the grid corresponding to the chart form used, an X for each numeral incorrectly identified. Terminate testing only when the patient makes two consecutive errors or reaches the end of the chart. Do not terminate the test because the patient has given up and has stopped responding. If this happens, encour-
age the patient to guess, and score the guesses as ordinary responses. This will help to ensure that the score is based on what the patient can see and not on what the patient believes he or she can see.

The log contrast sensitivity (log CS) score is given by the log contrast sensitivity value at the lowest contrast numeral just prior to two incorrectly identified numerals, minus a scoring correction. The numeral just prior to the two consecutive misses is called the final correct numeral. If the patient reaches the end of the chart without making two consecutive errors, then the final correct numeral is simply the final numeral correctly identified.

**Example scoring:** In the example below, the test terminates after the patient has read the first numeral on the seventh row, because the consecutive numerals 5 and 2 were missed. The log CS value at the final correct numeral (7) is 1.40. A scoring correction of 0.04 is subtracted from this score because this patient also erred on the 3 a few numerals earlier in the test.

<table>
<thead>
<tr>
<th>Row</th>
<th>FORM 1</th>
<th>Left Eye</th>
<th>Right Eye</th>
<th>Binocular</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 0.04</td>
<td>2 0.08</td>
<td>8 0.12</td>
<td>5 0.16</td>
</tr>
<tr>
<td>2</td>
<td>1 0.28</td>
<td>7 0.32</td>
<td>9 0.36</td>
<td>4 0.40</td>
</tr>
<tr>
<td>3</td>
<td>4 0.52</td>
<td>1 0.56</td>
<td>6 0.60</td>
<td>2 0.64</td>
</tr>
<tr>
<td>4</td>
<td>0 0.76</td>
<td>7 0.80</td>
<td>5 0.84</td>
<td>4 0.88</td>
</tr>
<tr>
<td>5</td>
<td>3 1.00</td>
<td>4 1.04</td>
<td>8 1.08</td>
<td>1 1.12</td>
</tr>
<tr>
<td>6</td>
<td>9 1.24</td>
<td>6 1.28</td>
<td>1 1.32</td>
<td>3 1.36</td>
</tr>
<tr>
<td>7</td>
<td>2 1.48</td>
<td>9 1.52</td>
<td>0 1.56</td>
<td>8 1.60</td>
</tr>
<tr>
<td>8</td>
<td>7 1.72</td>
<td>0 1.76</td>
<td>9 1.80</td>
<td>1 1.84</td>
</tr>
</tbody>
</table>

**Additional testing:** To characterize contrast sensitivity more completely, test each eye alone and both eyes together, using different forms of the test for each to minimize letter sequence learning effects.

**Normal values for log contrast sensitivity**

<table>
<thead>
<tr>
<th>Chart Row</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.04</td>
<td>0.08</td>
<td>0.12</td>
<td>0.16</td>
<td>0.20</td>
<td>0.24</td>
</tr>
<tr>
<td>2</td>
<td>0.28</td>
<td>0.32</td>
<td>0.36</td>
<td>0.40</td>
<td>0.44</td>
<td>0.48</td>
</tr>
<tr>
<td>3</td>
<td>0.52</td>
<td>0.56</td>
<td>0.60</td>
<td>0.64</td>
<td>0.68</td>
<td>0.72</td>
</tr>
<tr>
<td>4</td>
<td>0.76</td>
<td>0.80</td>
<td>0.84</td>
<td>0.88</td>
<td>0.92</td>
<td>0.96</td>
</tr>
<tr>
<td>5</td>
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<td>1.04</td>
<td>1.08</td>
<td>1.12</td>
<td>1.16</td>
<td>1.20</td>
</tr>
<tr>
<td>6</td>
<td>1.24</td>
<td>1.28</td>
<td>1.32</td>
<td>1.36</td>
<td>1.40</td>
<td>1.44</td>
</tr>
<tr>
<td>7</td>
<td>1.48</td>
<td>1.52</td>
<td>1.56</td>
<td>1.60</td>
<td>1.64</td>
<td>1.68</td>
</tr>
<tr>
<td>8</td>
<td>1.72</td>
<td>1.76</td>
<td>1.80</td>
<td>1.84</td>
<td>1.88</td>
<td>1.92</td>
</tr>
</tbody>
</table>

**Key**
- Profound (<0.48)
- Severe (0.52 - 1.00)
- Moderate (1.04 - 1.48)
- and Normal > Age 60 (1.52 - 1.76)
- and Normal Middle/Young Adult (1.72 - 1.92)

Note: Expect 0.15 (\(\sqrt{2}\)) higher values for binocular testing when two monocular values have similar contrast sensitivity.

**Maintenance**

Charts should be stored in their portfolio case, to protect them from light, dust and physical damage. Do not place other objects on the chart surface that can scratch or dent the charts, and try to avoid touching their front surface, especially in the area where the letters are printed.
The Mars Numeral Contrast Sensitivity Test

Score Sheet

Patient ______________________ Administered by ______________________

Date ______________________ Correction __________ Test Distance __________

Comments ______________________

Quick Instructions: Instruct patient to read letters left to right for each line, from top to bottom of the chart. Mark misses with an “X”. Terminate test on 2 consecutive misses.

Important: Allow only the letters 0 1 2 3 4 5 6 7 8 9 as responses.

<table>
<thead>
<tr>
<th>Row</th>
<th>FORM 1</th>
<th>Left Eye □</th>
<th>Right Eye □</th>
<th>Binocular □</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.04</td>
<td>2</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0.28</td>
<td>7</td>
<td>0.32</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>0.52</td>
<td>1</td>
<td>0.56</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0.76</td>
<td>7</td>
<td>0.80</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>1.00</td>
<td>4</td>
<td>1.04</td>
</tr>
<tr>
<td>6</td>
<td>9</td>
<td>1.24</td>
<td>6</td>
<td>1.28</td>
</tr>
<tr>
<td>7</td>
<td>2</td>
<td>1.48</td>
<td>9</td>
<td>1.52</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>1.72</td>
<td>9</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Log CS value at final correct letter: ________

Number of errors prior to final correct letter____ x 0.04 = ________

Subtract

Log Contrast Sensitivity ________

<table>
<thead>
<tr>
<th>Row</th>
<th>FORM 2</th>
<th>Left Eye □</th>
<th>Right Eye □</th>
<th>Binocular □</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3</td>
<td>0.04</td>
<td>7</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>0.28</td>
<td>1</td>
<td>0.32</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0.52</td>
<td>3</td>
<td>0.56</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0.76</td>
<td>7</td>
<td>0.80</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>1.00</td>
<td>4</td>
<td>1.04</td>
</tr>
<tr>
<td>6</td>
<td>8</td>
<td>1.24</td>
<td>3</td>
<td>1.28</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>1.48</td>
<td>6</td>
<td>1.52</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>1.72</td>
<td>9</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Log CS value at final correct letter: ________

Number of errors prior to final correct letter____ x 0.04 = ________

Subtract

Log Contrast Sensitivity ________

<table>
<thead>
<tr>
<th>Row</th>
<th>FORM 3</th>
<th>Left Eye □</th>
<th>Right Eye □</th>
<th>Binocular □</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.04</td>
<td>6</td>
<td>0.08</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>0.28</td>
<td>5</td>
<td>0.32</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>0.52</td>
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<td>0.56</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>0.76</td>
<td>7</td>
<td>0.80</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1.00</td>
<td>2</td>
<td>1.04</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>1.24</td>
<td>6</td>
<td>1.28</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>1.48</td>
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<td>1.52</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>1.72</td>
<td>8</td>
<td>1.76</td>
</tr>
</tbody>
</table>

Log CS value at final correct letter: ________

Number of errors prior to final correct letter____ x 0.04 = ________

Subtract

Log Contrast Sensitivity ________

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Debriefing judo MIC study

In this research you have participated in several grip fighting matches. There were three conditions of simulated visual impairment. During the grip fighting video recordings have been made. Based on these videos and your personal ratings we will determine the way judo performance is affected by visual impairment. Based on previous research we expect that only the condition with the most visual impairment will significantly affect judo performance.

The recorded data, video material and self reported scores, will be processed anonymously. This means that no name or personal records are linked to this data. All digitally kept data will be password protected and the paper copies will be kept in a sealed cabinet. Conform common guidelines, the data has to be kept for 5 years after the publication date of the article. The data will not be shared with third parties (this means people outside of the research team) without permission and/or be used for purposes other than this research.

We expect to hereby have informed you sufficiently. If you have any further questions, or want to be kept informed about the results of this study, you can contact the research team: Arnt van Helden, a.d.van.helden@student.vu.nl; Youri Kalisvaart, y.kalisvaart@student.vu.nl.

In the case that you might have any complaints about this research, you can contact the project supervisor: Kai Krabben, k.j.krabben@vu.nl.

Thank you for your participation!

Kind regards,

Arnt van Helden, Youri Kalisvaart and Kai Krabben