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Validation of the Hemianopia Reading Questionnaire

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Abstract

Homonymous Hemianopia (HH) can lead to reading difficulties and an associated lowered quality of life. The Hemianopia Reading Questionnaire (HRQ) was recently developed to assess reading behaviours and reading difficulties in people with HH to support reading rehabilitation and research. The goal of this study was to assess the factor structure as well as the convergent and divergent validity of the HRQ in a large community sample. For the analysis of the convergent validity, the HRQ was correlated with the attitude scale of a questionnaire by Stokmans and the Impact of Vision Impairment questionnaire (IVI). For the analysis of the divergent validity, the HRQ was correlated with the Depression Anxiety Stress Scale – 21 (DASS-21) and the Behavior Rating Inventory of Executive Function-A (BRIEF-A). The analyses were run with a sample of 1013 participants. The HRQ showed acceptable convergent (Stokmans‘ questionnaire: r = 0.553; IVI: r = -0.336) and divergent validity (DASS-21: r = -0.339; BRIEF-A: r = -0.331) with the convergent measures showing overall higher correlations with the HRQ than the divergent measures. The three factors extracted in the exploratory factor analysis were interpreted as *Reading ability*, *Reading objects*, and *Reading attitudes*. Based on these results, the HRQ seems to be a valid instrument for the assessment of reading attitude and reading difficulties in patients with HH.

Keywords: Homonymous Hemianopia, Reading, Questionnaire, Validation

Validation of the Hemianopia Reading Questionnaire

Homonymous visual field defects (HVFD) are the loss of processing visual information in the brain in certain areas of the visual field in both eyes. Homonymous Hemianopia is the most common form of HVFD and occurs in either the left or right half of the visual field in both eyes (Papageorgiou & Tsironi-Malizou, 2017; Zihl, 2010). HH can occur following post chiasmatic acquired brain injury, with stroke being the most common cause (Zhang et al., 2006a). Spontaneous recovery of HH after stroke was seen in 17% - 50% of the cases after the first month of acquiring it (Ali et al., 2013; Gray et al., 1989). The more time passes, the less likely an improvement of HH is and one may speak of chronic HH after the six-month mark (Zhang et al., 2006c). Strokes are especially common among older adults with an increase in incidents every 10 years after the age of 45 and more than two thirds of all stroke patients being people older than 65 (Kelly-Hayes, 2010; Lloyd-Jones et al., 2010). Moreover, the increase of people living with the consequences of a stroke is expected to rise by 27% from 2017 to 2047 in the European Union (Wafa et al., 2020). As the population of the Netherlands, on which this study is focusing, is aging and therefore the prevalence of suffering from a stroke is increasing, it is of importance to find effective treatments for HH (Em et al., 2011; Struijs et al., 2005). This is particularly important as the consequences of a HVFD might lead to a reduced quality of life (Papageorgiou et al., 2007). In persons affected by HH, the reason for this might be not being able to carry out certain tasks like one used to due to difficulties with visual exploration (Zihl, 1995b), driving (Alberti et al., 2014; Bowers et al., 2009; de Haan et al., 2014) as well as reading (Leff et al., 2000).

Reading is an omnipresent part of our daily lives. In most social and occupational settings reading skills are a requirement in order to function well, suggesting that impaired reading can lead to a limited independence in everyday life. Moreover, reading has many benefits beyond functional tasks, including educating oneself (Moyer, 2007) and reducing

psychological distress (Levine et al., 2022). In general, up to 80% of persons suffering from a HVFD may experience reading difficulties (Zihl, 2010). In persons with HH, reading might be impaired due to the reduction of the visual field. As the text that is to be read cannot be seen in its entirety, words and syllables located at the beginning or end of a line might be overlooked (Leff et al., 2001). This in turn reduces the reading speed due to longer fixations and increased searching time for finding the beginning or ending of a line (Papageorgiou et al., 2007; Schuett et al., 2008; Zihl, 1995a). Especially people with right HH who have been taught to read in a western world language are impaired in their reading due to an increase in necessary saccades (Leff et al., 2000). The reason for that being that information located in the right half of the visual field cannot be processed, which may lead to difficulties locating the following word and thus more saccades must be made to find these words. Also left-to-right readers with a left HH may experience specific reading difficulties, albeit not as severe. Their biggest difficulty lays in finding the beginning of the next line as their visual field is reduced on the left side (Zihl, 2010). Regarding the stated value of reading in daily life, it is of importance to find treatment to alleviate reading difficulties, possibly allowing people with HH to be more independent again.

Reading trainings may help persons with HH to improve their reading performance. Existing research evaluated the effects of interventions based on outcome measures like, for example, reading speed (words per minute) and eye movements (Hepworth et al., 2019; Kuester-Gruber et al., 2021; Lévy-Bencheton et al., 2016; Pambakian et al., 2004; Roth et al., 2009; Schuett et al., 2012; Spitzyna et al., 2007; Zihl, 1995a). It would be of great addition to incorporate a well validated questionnaire assessing reading attitudes and difficulties from the patient's point of view into reading training programs. This may not only help to evaluate the effectiveness of training programs but would also allow to individually tailor a reading training to the patient's needs. Subjective measures could help to see how important reading is

for the patient, how well they perceived their reading abilities to be prior to the visual field defect, and how the perceived reading abilities are rated before as well as after the training. Furthermore, as stated, reading difficulties due to HH can be manifested in different ways depending on what half of the visual field is affected. Therefore, a questionnaire assessing reading difficulties might help to identify what the reading training should focus on. Based on these goals, the Hemianopia Reading Questionnaire (HRQ) was developed (Schepers, 2021). This self-report questionnaire aims to assess attitudes on reading and reading behaviour of people with HH. This way, the patient's individual reading problems, reading difficulties before the visual field defect, and reading behaviour can be assessed to personalize the treatment. Furthermore, the HRQ might be included in further research for a uniform evidence-based reading training for patients with HH in the Netherlands. Existing questionnaires from the field of reading behaviour and difficulties were used as an inspiration for the development of the HRQ. Additionally, an expert panel supported the development by evaluating its face validity. The HRQ consists of a pre-intervention version as well as of a post-measurement assessment. In this manner, the effectiveness of the treatment can be evaluated by comparing scores of the pre-measurement and post-measurement assessment. The questions cover the domains of judging one's own reading skills, attitudes on reading, reading frequency, what kind of texts one is reading, reading performance and difficulties before acquiring HH, and expectations of the reading training. While developing the HRQ the psychometric properties of the post-measurement version of the HRQ were assessed in a small sample (n=159) (Schepers, 2021). Before the HRQ can be used in a clinical setting, the psychometric properties of factor structure as well as divergent and convergent validity should be investigated in a larger sample. The reason for this is that these analyses are shown to yield more accurate results when performed in larger samples (Charter, 1999; Comrey & Lee, 2013; Hair, 2009).

The aim of the present study is to assess the psychometric quality of the HRQ in a large community sample with the following sub questions: 1. What are the divergent and convergent validities? and 2. What is the factor structure of the HRQ? We expect the HRQ to show good convergent and divergent validity since it was developed based on existing instruments measuring the constructs of reading motivation, reading difficulties, and reading attitudes (Schepers, 2021).

Methods

Participants

The sample consisted of Dutch adults without a reported history of neurological history with ages ranging from 20 to 97. Participants took part in this study on a voluntarily basis via the online platform Panel Inzicht and therefore formed a quota sample. Moreover, participants received a monetary compensation for their participation. The exclusion criterium was reporting any history with neurological pathology. Participants were not included for the analysis in case of an incomplete survey, not mentioning their age, and not passing the validity scales that were used in this survey. The participants gave digital informed consent before taking part in this study and were informed that they could end the study at any point without providing a reason. This study received ethical approval from the Ethical Committee of Psychology of the University of Groningen.

Materials

Hemianopia Reading Questionnaire (HRQ). The HRQ has a pre-measurement version (see Appendix A for the Dutch version and Appendix C for the English version) containing 57 items as well as a post-measurement version (see Appendix B for the Dutch version and Appendix D for the English version) containing 26 items (Schepers, 2021). This study used the post-measurement version of the questionnaire as it does not contain questions regarding HH and the reading training and is therefore suitable for a sample consisting of

participants without HH. The post-measurement part consists of three subscales, namely *Appreciation of own reading* (items 1-12), *Reading time* (items 13-15), and *What do you read?* (items 16-26). Subscales *Appreciation of own reading* and *What do you read?* examine the previous two weeks, whereas the subscale *Reading time* examines the previous month. Item 1 to 5 of the first subscale assess judgement of the examined person's own reading skills and is scored on a 5-point Likert scale with the options 'Fully disagree', 'Disagree', 'Not agree or disagree', 'Agree', or 'Fully agree'. Items 6 to 12 of this subscale assess how successful certain reading-related tasks were going. These items can be answered on a 4-point Likert scale with the options 'Bad', 'Not good', 'Good', or 'Really good'. The topic of the subscale *Reading time* is the amount of time spent reading and has three open ended questions. Participants are asked to fill in the hours and minutes they have spent reading in the last month and for how many minutes they can read continuously without becoming tired. The subscale *What do you read?* assesses how well one succeeded to read different sources in their daily life. Some examples for these sources are paper books/magazines, subtitles, and traffic signs. For each of the 11 sources the participants can indicate whether they did or did not read this source. If they did read it, they can answer on a 4-point Likert scale how well it went with the options 'Bad', 'Not good', 'Good', or 'Really good'. In case they did not read a certain source, they can indicate this with the answer option 'Does not apply'. After these 11 items, additional sources can be added by the participant which are also being scored on the same 4-point Likert scale. The HRQ has a high total internal consistency (Cronbach's alpha of 0.96) together with a good face validity assessed by an expert group in a sample of adults without HH (N = 159) (Schepers, 2021). However, the small sample in Scheper's (2021) study should be considered when making claims regarding its psychometric properties.

Impact of Vision Impairment Questionnaire (IVI). The IVI is a 28-item questionnaire assessing the self-reported vision-related quality of life. In this study, the Dutch

version of the IVI was used (Rausch – Koster et al., 2021). The IVI consists of the three subscales *Reading and assessing information*, *Mobility and independence*, and *Emotional well-being*. We used the *Reading and accessing information* scale which is composed of 10 items. Each item is scored on a 4-point Likert scale with the options 'Not at all', 'A little', 'A fair amount', and 'A lot'. Additionally, each item had the response option 'Don't do this for other reasons'. The IVI was validated in a low-vision sample (Weih et al., 2002). The internal consistency (Cronbach's alpha ranging from 0.80 to 0.96) and test-retest reliability (Guttman split-half reliability coefficients ranging from 0.73 to 0.94) were found to be good.

Stokmans' questionnaire. This questionnaire was developed to evaluate the attitude towards reading and reading behaviour in Dutch pupils (Stokmans, 2007). There are two parts to this questionnaire: a pre-intervention part and a post-intervention part. The current study used the *Reading attitude* scale and *Reading intention* scale of the post-intervention part of the questionnaire which contain 35 and three items, respectively. The reason for this is that the pre-intervention part and the remaining scales of the post-intervention part focus on school-related questions which did not fit to our sample of adults. The first part of the *reading attitude* scale (items 1 – 21) is scored by indicating which of two opposing adjectives reflects the participant's opinion on reading. The items of the second part of this scale (items 22 – 35) are scored on a 5-likert scale with the options 'Strongly disagree', 'Disagree', 'Neither disagree nor agree', 'Agree', and 'Strongly agree'. Participants also have the option to choose 'I do not know'. In the three items of the *reading intention* scale, participants are asked to indicate their reading intentions for the short and long future. The internal consistency of the reading attitude scale was found to be good in a sample of pupils aged 11 to 15 (N = 505) with Cronbach's alpha ranging from 0.88 to 0.94. The same applies for the test-retest reliability (correlation coefficient ranging from 0.64 to 0.85).

Depression Anxiety Stress Scale – 21 (DASS-21). The DASS-21 is a self-report questionnaire composed of 21 items developed by Lovibond et al. (1995). In the current study the Dutch version of the DASS-21 was used (de Beurs, 2001). The DASS-21 aims to assess emotions related to depression, anxiety, and stress experienced over the past week with seven questions per subscale (Lovibond & Lovibond, 1995). Each question can be answered on a 4-point Likert scale with the options 'Did not apply to me at all (0)', 'Applied to me to some degree, or some of the time (1)', 'Applied to me to a considerable degree or a good part of time (2)' and 'Applied to me very much or most of the time' (3)'. The total score is the sum of all items where the higher the score the more severe symptoms a person has. The Dutch version of the DASS-21 has a good internal consistency (Cronbach's alphas of the three subscales ranging from 0.89 to 0.94) as well as a good convergent validity (correlation coefficients of the three subscales ranging from 0.70 to 0.82) in a sample of patients (N = 173) with different anxiety and mood disorders. Additionally, the test-retest reliability was also found to be good (correlation coefficients the three subscales ranging from 0.74 to 0.85) in the same sample.

Behaviour Rating Inventory of Executive Function – Adult (BRIEF-A). The BRIEF-A is a self-report questionnaire comprised of 75 items and developed to assess behavioural as well as emotional expressions of executive dysfunction in everyday life (Scholte & Noens, 2011; Roth et al., 2005). There are nine subscales which are scored on a 3-point Likert scale with the options 'Never' (1), 'Sometimes' (2), and 'Often' (3) as well as the two constructs behavioural regulation and metacognition. The sum of all scores represents the total score with a higher score meaning poorer executive functions in daily life. In this study, the subscales *inhibit*, *shift*, *emotional control*, *self-monitor*, *plan/organize*, and *organization of materials* subscales as well as the Behavioural regulation index (BRI) were used. Besides the clinical scales, the BRIEF-A also contains three validity scales of which two were used in this

study: negativity and infrequency scale. These scales can detect participants who answer items in an unusual negative way and participants whose answers deviate strongly from normative data in terms of probability. In this study, participants were excluded with scores higher than three on the negativity scale and scores higher than two on the infrequency scale, according to the manual, in order to ensure that all participants answered the survey truthfully. The Dutch version of the BRIEF-A has a good internal consistency (Cronbach's alphas of 0.96) in a sample of the Dutch general population aged 18 to 65 (n = 1600). In addition, the internal consistency is also good in the subscales used in this study (Cronbach's alpha ranging from 0.70 to 0.89). Moreover, the test-retest reliability of this questionnaire was also proven to be good (intraclass correlation coefficient ranging from 0.68 to 0.79) (Scholte & Noens, 2011).

Procedure

Members of Panel Inzicht were invited to take part in this online study using the software Qualtrics (Qualtrics, 2005). In total, the survey consisted of the five self-report questionnaires mentioned above (HRQ, IVI *reading and accessing information* subscale, Stokmans' *reading attitude* and *reading intention* subscales, BRIEF-A *inhibit*, *shift*, *emotional control*, *self-monitor*, *plan/organize*, and *organization of materials* subscales, DASS-21). Before each new questionnaire, instructions were given on how to respond to the following questions. The total estimated length of the survey was 19.6 minutes.

Analysis

In this study, a within-subject design was applied and SPSS Statistics version 28 (IBM Corp., 2021) was used for the statistical analysis. The alpha level was put at $p<0.05$. Only data from participants who completed the whole survey and passed the validity scales of the BRIEF-A were included in the analysis. The scores on the HRQ, IVI, and Stokmans' questionnaire of participants who chose the answer options 'Did not read' (HRQ), 'I do not

know' (Stokmans' questionnaire), or 'Don't do this for other reasons' (IVI) were deleted to ease the interpretation of these scores for the analysis of the convergent and divergent validity. These deletions of data led to different sample sizes in the correlational analyses. Additionally, only closed-ended questions of the HRQ were considered for the analyses (items 1-13 and 17-27).

The factor structure was evaluated by performing a principal component analysis (PCA). Factors with an eigenvalue higher than one were retained. A parallel analysis (O'Connor, 2000) was performed for further confirmation on how many factors to retain. In this factor retention method, random data matrices are generated of the same size as the original data set. Factors were retained when the eigenvalues of the randomly generated data sets were higher than the ones of the actual data set.

To assess the convergent and divergent validity, a correlation analysis was performed between the HRQ and other validated questionnaires. For the assessment of the convergent validity the HRQ was correlated with the *Reading and accessing information* subscale of the IVI and the *Reading attitude* and *Reading intention* subscale of the post-intervention part developed by Stokmans (2007). For the assessment of the divergent validity, the HRQ was correlated with the DASS-21 and its subscales depression, anxiety, and stress as well as with the BRIEF-A and its subscales *inhibit, shift, emotional control, self-monitor, plan/organize,* and *organization of materials* and the BRI. For the correlational analyses the sum scores of the different questionnaires were used. These were computed by summing the raw scores for each participant. Moreover, for the interpretation of the correlation coefficients the criteria of Cohen were used (Cohen, 2013) meaning that a correlation of 0.5 or higher was needed to declare it has good convergent validity, whereas a correlation of 0.3 or lower was needed to declare it as good divergent validity.

Results

Participants

Of the 1557 participants that were considered for this study, a total of 544 were excluded. 132 of the participants did not mention their age and it was therefore not possible to include them for further analysis. Additionally, participants were excluded for not completing the survey (n = 296). The two validity scales of the BRIEF-A that were used in this study revealed four participants who answered items in an unlikely negative manner and 84 participants who answered the items in an improbable way, which also led to exclusion. Furthermore, 28 participants were excluded based on the presence of history of self-reported neurological pathology. The exclusions led to a final sample of 1013 participants. Table 1 shows the demographic characteristics of the participants. The mean age was 65.28 years with a range from 20 years to 97 years.

Table 1.

Demographic characteristics of participants

	N	Percentage	Mean (SD)
N	1013		
Age, in years			65.28 (13.613)
Sex			
Female	457	45.1	
Male	554	54.7	
Other	2	0.2	
Educational level[a]			
Low	231	22.8	
Medium	409	40.4	
High	373	36.8	

[a]Categories based on the Dutch school system where low reflects ‘no primary education’, ‘primary education’, ‘primary education with unfinished secondary education’, ‘VMBO basis’, ‘MBO niveaus 1 or 2’, and ‘LTS’; medium reflects ‘VMBO kader or theoretisch’, ‘MBO niveaus 3 and 4’, ‘Mulo’, and ‘MAVO’; high reflects ‘HAVO’, ‘VWO’, ‘HBO bachelor’, ‘VHMO’, ‘HBO master’, ‘WO bachelor’, ‘WO master’, ‘PhD’.

Exploratory factor analysis

The factor analysis was performed on the subscales *Appreciation of own reading* and *What do you read?* of the HRQ. An oblique rotation method was used since correlation between the factors was expected (Costello & Osborne, 2005). The Kaiser-Meyer-Olkin test indicated that the data was adequate for performing an exploratory factor analysis with a by Kaiser as marvelous classified value of 0.936 (Kaiser, 1974). Additionally, a Bartlett's test of sphericity, which tests for enough correlation between items to run a factor analysis, showed a significant result (χ^2 (276) = 14399.383, p<.001), indicating that an exploratory factor analysis could be performed. Initially, the PCA identified four factors which fulfilled the requirement of an eigenvalue higher than 1. These factors accounted for 38.549, 12.121, 6.104, and 4.945 percent of the variance, respectively. It is advised to not rely on the eigenvalues alone when retaining factors as this can lead to an overestimation of factors (Zwick & Velicer, 1986). Additionally, the scree-plot showed a break after the third factor which also needed further inspection (see Appendix E). Therefore, a parallel analysis was performed which showed that three of the initial eigenvalues exceeded the values of the randomly generated ones. Thus, it was suggested to retain three factors. After careful assessment of the factor loadings, these three factors were interpreted as *Reading ability* (9 items), *Reading objects* (11 items), and *Reading attitudes* (4 items). Table 2 shows the factor loadings of the retained factors and the corresponding eigenvalues and explained variances.

Table 2.

Results From a Principal Component Factor Analysis of the HRQ

	Factor loading		
HRQ item	1	2	3
11. Perceiving a long word in its entirety	**.905**	-.002	-.043
10. Perceiving a word in its entirety	**.887**	.011	-.011
9. Read the line completely	**.863**	.042	-.010
8. Finding the next line	**.850**	.028	-.009
6. Understanding what I read	**.781**	-.033	.082
7. Reading fast	**.772**	-.057	.033
12. Read tirelessly	**.745**	.057	.027
13. Remember what I have read	**.714**	-.007	.052
4. I do not experience any difficulties reading	**.499**	.060	.185
25. Reading road signs	.006	**.723**	.075
27. Reading letters/mail	.105	**.689**	.075
26. Reading public transportation signs	-.078	**.686**	.048
23. Reading from a computer/laptop	-.026	**.678**	.071
20. Reading subtitles	.106	**.669**	.059
21. Reading from a phone	.015	**.638**	.071
22. Reading from a tablet/ e-reader	-.122	**.613**	-.027
19. Reading a paper magazine	.023	**.589**	-.065

Table 2.

Results From a Principal Component Factor Analysis of the HRQ

18. Reading a paper newspaper	.052	.**576**	-.056
24. Reading prescription/ packing	.052	.**574**	.010
17. Reading a paper book	.233	.**398**	-.314
5. I love reading	-.008	.106	.**876**
2. Reading is important to me	.066	.020	.**872**
3. My attitude regarding reading is positive	.192	.077	.**754**
1. I am a good reader	.322	.039	.**621**
Eigenvalue	9.25	2.90	1.47
Explained variance	38.6%	12.1%	6.1%

Note. N = 1013. Factors were extracted using principal component analysis with an oblique (Oblimin with Kaiser Normalization) rotation. Highest factor loadings per item are presented in bold.

Convergent validity

Table 3 shows all correlations between the HRQ and the IVI as well as the questionnaire by Stokmans (2007) and the corresponding subscales. The total score of the Stokmans' questionnaire showed strong correlations with the HRQ (r = .553) and the factor *Reading opinion* (r = .723). The factors *Reading ability* and *Reading objects* showed moderate correlations (r = .436; r = .393, respectively) with Stokmans' questionnaire. Additionally, also the subscales *Reading attitude* and *Reading intention* of Stokmans' questionnaire showed moderate to strong correlations with the HRQ and the corresponding factors. The IVI correlated moderately with the HRQ (r = -.336) and the factor *Reading*

Table 3.

Convergent validity of the HRQ (sample sizes are displayed in the table)

	HRQ total score	1. Reading ability	2. Reading objects	3. Reading opinion
Stokmans' Questionnaire[a] – total score *(n)*	.553 *(249)*	.436 *(669)*	.393 *(249)*	.723 *(669)*
Reading attitude scale *(n)*	.540 *(249)*	.422 *(669)*	392 *(249)*	.695 *(669)*
Reading intention scale *(n)*	.437 *(321)*	.364 *(1013)*	.304 *(321)*	.659 *(1013)*
IVI – total score *(n)*	-.336 (*219*)	-.276 *(902)*	-.379 *(291)*	-.116 *(902)*

Note. All of the correlations are significant with $p<0.01$.
[a] This score is made up from the subscales *Reading attention* and *Reading intention*

objects (r = -.379). The factors *Reading ability* (r = -.276) and *Reading attitudes* (r = -.116) showed weak correlation with the IVI.

Divergent validity

Table 4 displays all correlations between the HRQ and the DASS-21 as well as the BRIEF-A. The HRQ showed a moderate correlation with the total scores of the DASS-21 (r = -0.339) and the factor *Reading subjects* (r = -.350). The factors *Reading ability* (r = -.268) and *Reading opinion* (r = -.147) showed weak correlations with the HRQ. The BRIEF-A (r = -.331) and its subscale BRI (r = .324) showed moderate correlations with the HRQ. Both factors *Reading ability* and *Reading opinion* showed low correlations with all divergent measures whereas the factor *Reading objects* showed moderate correlations with all divergent measures.

Table 4.

Divergent validity of the HRQ (sample sizes are displayed in the table)

	HRQ total score	1. Reading ability	2. Reading objects	3. Reading opinion
DASS-21 – total sore (*n*)	-.339 (*321*)	-.268 (*1013*)	-.350 (*321*)	-.147 (*1013*)
Stress (*n*)	-.298 (*321*)	-.231 (*1013*)	-.310 (*321*)	-.111 (*1013*)
Anxiety (*n*)	-.330 (*321*)	-.258 (*1013*)	-.326 (*321*)	-.155 (*1013*)
Depression (*n*)	-.340 (*321*)	-.266 (*1013*)	-.336 (*321*)	-.171 (*1013*)
BRIEF-A – total score[a] (*n*)	-.331 (*321*)	-.269 (*1013*)	-.325 (*321*)	-.137 (*1013*)
BRI (*n*)	-.324 (*321*)	-.250 (*1013*)	-.320 (*321*)	-.135 (*1013*)

Note. All of the correlations are significant with $p<0.01$.
[a] This score is composed of the subscales *inhibit*, *shift*, *emotional control*, *self-monitor*, *plan/organize*, and *organization of materials*

Discussion

The HRQ was recently developed to measure reading habits and difficulties in patients with HH. The purpose of the current study was to evaluate the psychometric properties of the HRQ in a large sample of healthy adults. The aims were to investigate the factor structure and the convergent as well as divergent validities of the HRQ.

Factor analysis

The exploratory factor analysis suggested to retain three factors. These factors were interpreted as *Reading ability* (9 items), *Reading objects* (11 items), and *Reading attitudes* (4 items). The first factor, named *Reading ability*, explained 39% of the variance in item scores. It consists of nine items assessing one's own subjective reading ability in general. This includes, for example, reading speed, perceiving a word in its entirety, and finding the next line. These reading difficulties represent possible reading difficulties experienced by patients with HH (Leff et al., 2001; Papageorgiou et al., 2007; Schuett et al., 2008; Zihl, 1995b). The second factor was interpreted as *Reading objects* and explained 12% of the variance in item scores. It assesses how well reading of specific reading objects went in the last two weeks. In

total, 11 items assessing different objects like letters, information on one's phones, and written information in public transportations are included in this factor. The third factor, called *Reading attitude*, includes four items assessing the patient's attitude towards reading. It explained 6% of the variance in item scores.

This factor structure is partly different to the one indicated by previous research on the HRQ (Schepers, 2021). In their analysis, the research team retained a factor structure with two factors interpreted as *Appreciation of own reading* and *What do you read?*. The first factor was a combination of the first and third factor of the current study but additionally included the item *reading a paper book*. In the current study, this item is included in the second factor. This indicates that the general factor structures in both studies is roughly similar despite using different samples. The reason for the difference in factor structure could be the sample size. The study by Schepers (2021) had a total sample size of 159 participants opposite to the rather large sample of the current study (N=1013). Auerswald & Moshagen (2019) found that the performance of factor retention criteria is better with larger samples. Both Schepers (2021) and the current study used parallel analysis as a factor retention criterion. Thus, the reason for the different factors that were retained could be the different sample sizes. Furthermore, research on the relation between sample size and factor structure showed that the larger the sample size, the less errors occur in the factor analysis (Costello & Osborne, 2005; Goretzko et al., 2021; MacCallum et al., 2001). One specific mistake that can appear with too little participants is the wrong allocation of items to factors (Costello & Osborne, 2005). This could explain the different placement of the item *reading a paper book* which intuitively should be included in the factor *Reading objects* as the current factor analysis shows. In the study of Schepers (2021), however, it is placed in the factor *Appreciation of own reading*. It is important to note here that there are discrepancies on what exactly a 'large' sample size in factor analyses means. Comrey & Lee (2013) presented a categorization of sample sizes

where 100 is described as ‘poor’, 200 as ‘fair’, 300 as ‘good’, 500 as ‘very good’, and 1000 as ‘excellent’. Others, however, recommend a sample size of 20 times the number of scale items (Hair et al., 2009). For this study, this would suggest a sample size of 480. Based on these rules of thumb regarding sample sizes it cannot be clearly stated what the required minimum sample size is, but it seems like the sample gathered by Schepers (2021) might have been too small for an exploratory factor analysis. However, exploratory factor analyses in general have been shown to vary greatly in factor extraction and item allocation when replicated (Costello & Osborne, 2005; Osborne & Fitzpatrick, 2019). A confirmatory factor analysis could aid to overcome sampling errors and is therefore recommended for future research (MacCallum et al., 2001).

Convergent and divergent validity

As expected, the HRQ correlated highly with the questionnaire by Stokmans which suggests a satisfactory convergent validity. However, only the HRQ factor *Reading attitude* revealed a high correlation with Stokmans questionnaire and its subscales whereas the other two factors correlated moderately with these measures. This can be explained by the content of Stokmans’ questionnaire. Stokmans (2007) developed the questionnaire to assess the effectiveness of a reading attitude enhancing intervention. Therefore, all items cover topics of reading attitude and do not explore reading difficulties like the factors *Reading ability* and *Reading objects* of the HRQ do (Stokmans, 2007). This could imply that the different subscales explore specific reading domains and that the high correlation between Stokmans’ (2007) questionnaire and the HRQ suggests that the factor *Reading attitudes* may form a valid subscale based on its content. Contrary to our expectation, the IVI correlated moderately with the HRQ which at first glance advises against a sufficient convergent validity. The objectives of the IVI can help to explain these results. We used the *Reading and accessing information* subscale for the analysis of the convergent validity. This scale aims to identify difficulties in

reading and accessing information in people with visual impairments which most closely relates to the items of the HRQ factor *Reading objects* (Weih et al., 2002). The items of the reading and accessing information scale assess how the persons eyesight hinders them to access information in different settings, for example when recognizing people, operating household appliances, and opening packages. Even though none of the factors showed high correlation with the HRQ, the factor *Reading objects* was the only factor that showed a moderate correlation. However, a higher correlation towards the factor *Reading ability* was expected since being able to read certain texts also reflects reading ability. A reason for this low correlation could be that the IVI subscale *Reading and accessing information* not exclusively assesses reading but also accessing information in settings where reading abilities are not required. Only two out of the 10 items explicitly assess reading performance. The fact that the HRQ does not highly correlate with this subscale of the IVI shows that the HRQ measures reading alone without measuring other activities requiring vision. This implies that the HRQ may be used in clinical practice or research in order to identify HH-specific reading difficulties alone without focusing on any other vision-related areas.

The BRIEF-A (subscales *inhibit, shift, emotional control, self-monitoring, plan/organizing, organization of materials*) showed moderate correlations with the HRQ and the factor *Reading objects* which is not in accordance with our expectations. The factors *Reading ability* and *Reading attitudes*, however, showed weak correlations as expected. The BRIEF-A assesses behavioural and emotional expressions of executive dysfunction in everyday life (Scholte & Noens, 2011; Roth et al., 2005). Existing research shows that executive functions are positively related to reading. It was suggested that inhibition capacity increases reading speed (Johann et al., 2019) as well as reading comprehension (Butterfuss & Kendeou, 2018; Kieffer et al., 2013), and that planning (Georgiou & Das, 2016) and shifting (Butterfuss & Kendeou, 2018) aid reading comprehension. The moderate correlation between

the HRQ and the BRIEF-A might be due to this relationship between executive functions and reading performance. Moreover, it is plausible that reading performance declines in persons with HH who additionally show lowered executive functions. However, it can be said that the HRQ focuses mainly on the reading problems experienced by persons with visual deficiencies and a person's attitude towards reading and not on any deficits in executive functions that could lead to reading difficulties. This is reflected by the weak correlations between the BRIEF-A and the factors *Reading ability* and *Reading attitudes*. Similarly, also the DASS-21 and the corresponding three subscales, *stress*, *anxiety*, and *depression*, showed moderate correlation with the HRQ and the factor *Reading objects*. Only the factors *Reading ability* and *Reading attitudes* showed weak correlations with the DASS-21 and its subscales. The DASS-21 was developed and validated to assess the constructs of anxiety, depression, and stress (Henry & Crawford, 2005). The yielded correlations suggest that low reading performance might lead to emotions of depression, anxiety, and stress. It is reasonable that persons experiencing reading difficulties might feel negative emotions regarding reading. Moreover, Maughan et al. (2003) showed that boys with reading difficulties are more at risk for developing a depressed mood which supports this statement. The fact that the factors *Reading performance* and *Reading attitudes* showed weak correlations with all divergent measures suggests that these factors successfully reflect HH-related reading behaviour which is not related to other factors that might influence reading. This implies that the constructs measured in the BRIEF-21 and DASS-21 are mainly different from the ones measured in the HRQ which in turn suggests an adequate divergent validity of the HRQ.

Spector (1992) suggests that, in general, convergent validity means that constructs similar to each other will show more correlation than constructs dissimilar to each other. Overall, the correlations between the HRQ and other questionnaires assessing reading were higher (shared variance ranging 0.11 to 0.31) than the ones between the HRQ and

questionnaires unrelated to reading (shared variance ranging from 0.11 to 0.12). Thus, despite the fact that according to Cohens criteria (Cohen, 2013) the correlation between the HRQ and the IVI does not support convergent validity, it can be said that the construct validity of the HRQ appears sufficient. Nevertheless, the moderate correlations should be considered when making claims.

Clinical implications

The HRQ was developed to assess reading difficulties and behaviours in adult patients with HH. To the authors knowledge, it is the first questionnaire of this kind and therefore a valuable acquisition in the field of reading rehabilitation for patients with HH. Additionally, the structure of the HRQ is supporting the evaluation of the effectiveness of reading interventions. It is divided into two parts: the pre-measurement part and the post-measurement part. This two-part division can aid to individually interpret the effectiveness of the intervention for each patient. Furthermore, by comparing the scores of the first and second part of the HRQ, the patient's improvement can be evaluated. Here, a higher score on the post-measurement part of the HRQ would indicate an improvement in reading performance and a more positive attitude towards reading.

Reading ability in people with HH has often been measured before. One example is an instrument assessing reading performance in HH called Visual Skills for Reading Test (VSRT) (Blaylock et al., 2016). The VRST consists of a task the patients must perform rather than a self-report questionnaire like the HRQ. Additionally, the VRST only focuses on reading performance whereas the HRQ assesses reading attitudes and behaviours of the patient. This way, the clinicians have the possibility to see in what ways the subjective reading performance and attitudes change for the patient after the reading intervention. There are existing self-report questionnaires that assess reading attitudes and behaviours in populations without brain damage. Examples are the Adult Reading Motivation Scale

(ARMS) which assesses reading motivation (Schutte & Malouff, 2007), the Spanish questionnaire ATLAS which assesses reading abilities in adults (Giménez et al., 2015), and the Adult Reading History Questionnaire assessing reading attitude and history of reading difficulties (Lefly & Pennington, 2000). However, these questionnaires do not assess reading performance and difficulties and are also not designed for people with HH but for the general population. Therefore, the HRQ is unique in the way that it can be used by clinicians to assess reading difficulties that are typically experienced by persons with HH in connection with their general attitude towards reading.

Limitations and future directions

The current study does not come without limitations. Firstly, the used questionnaires in the analysis of the convergent validity were not completely investigating the constructs of the HRQ. As mentioned earlier, the questionnaire by Stokmans does only assess attitude towards reading and the IVI does assess reading performance, however, only to a certain extent. This means, that the constructs measured in the HRQ do not entirely correspond to the constructs measured by the convergent measures which is not the objective of an analysis of the convergent validity. Additionally, the Stokmans questionnaire was not sufficiently fitting for the target sample of this study. It was developed for pupils and was only tested in a sample of children aged 11 to 15 (Stokmans, 2007). Therefore, the wording of the items was done with children in mind and might therefore not be representative for adults. Nevertheless, we decided to include both questionnaires in the analysis since they were seen as the best available options due to the scarcity in Dutch self-report reading questionnaires for adults. To the best knowledge of the authors there are no better fitting questionnaires for assessing the constructs of the HRQ. Most Dutch questionnaires were developed for a school setting and therefore not validated nor worded appropriately for adults. A possible idea for future research would be the analysis of convergent validity of a translated version of the HRQ in an

English-speaking sample using English reading questionnaires for adults since these seem to be available in greater amount compared to Dutch ones. An example for measuring the construct of the factor *Reading objects* of the HRQ could be the Self-Report Assessment of Functional Visual Performance questionnaire which assesses the difficulty of performing certain reading related tasks (Mennem et al., 2012). Compared to the IVI, this instrument was developed for persons with HH and the *Reading* subscale only focuses on reading and no other activities related to vision. Moreover, the ATLAS (Giménez et al., 2015) and AMRS (Schutte & Malouff, 2007) might be a good instruments for assessing the convergent validity as they were developed for an adult sample unlike the questionnaire by Stokmans (2007) and assess only reading-related difficulties unlike the IVI.

A second limitation is the scoring of the answer options *'Did not read', 'I do not know'*, and *'Don't do this for other reasons'* of the HRQ, Stokmans, and IVI, respectively. One option was to score these answer options as 0. However, this might have led to a misinterpretation of the results as the concerned scales all measure reading performance or reading attitude with lower scores indicating a lower reading performance (HRQ and IVI) or more negative attitude towards reading (Stokmans' questionnaire). Scoring the answer options *'Did not read', 'I do not know'*, and *'Don't do this for other* reasons' as 0 would imply that not reading anything equals to a low reading performance (HRQ and IVI) and that not knowing the answer equals to having a negative attitude towards reading (Stokmans' questionnaire). Thus, we decided to delete the data of participants who chose any of these answer options to ease the interpretation of these scores for the analysis of the convergent and divergent validity. However, this also led to rather small sample sizes due to the deletion of cases (sample sizes for correlational analyses ranging from 219 to 1013). Therefore, we cannot assure if the sample characteristics in these smaller samples correspond to the ones found in the total sample. There is a possibility that the found correlations between the HRQ

and the convergent and divergent measures are due to the differences in age, gender, or educational level of the participants in the different samples. Additionally, this correlational analysis was also run scoring the mentioned answer options as 0. This analysis showed similar correlations between the HRQ and the convergent and divergent measures which suggests that the correlations of the HRQ with the Stokmans questionnaire and the IVI can be expected to reflect the whole sample.

The third limitation of the current study is the use of a community sample. The sample of the current study has a rather even distribution of gender and education levels. Furthermore, the age average of the sample (M = 65.28) is close to the one found in persons with HH (M=51.3) (Zhang et al., 2006b). However, only adults without HH were included in the current study. Therefore, we cannot confirm if the construct validity and factor structure of the HRQ in a clinical sample with patients with HH will reflect the results of this community sample. Additionally, the HRQ is structured into two parts, a pre-measurement questionnaire and a post-measurement questionnaire. The current study only evaluated the psychometric properties of the post-measurement questionnaire as the pre-measurement part includes questions regarding self-reported reading performance and difficulties prior to the acquisition of HH as well as expectations of the reading training in addition to the items that are part of the post-measurement questionnaire. Therefore, it is of importance for future research to investigate the psychometric properties of both parts of the HRQ in a clinical sample.

Lastly, it should be considered that this study used an online survey method. Thus, we cannot say where, when, and on what kind of advice the data collection took place. Existing literature identified a few disadvantages of the use of online surveys, including generalizability of sample and truthfulness of answers (Andrade, 2020; Evans & Mathur, 2005; Wright, 2005). In the current study, we tried to overcome these drawbacks by

implementing a quota sample with balanced gender ratio, educational level ratio, and age ratio. In addition, the use of the two validity scales gave more support towards a data set with truthful answers.

Conclusion

The current study investigated the psychometric properties of the recently developed HRQ. The results show that its items can be organized into three factors, namely *subjective reading performance*, *reading objects* and *attitude towards reading*. Furthermore, the HRQ showed good divergent and convergent validity. Designed for HH-related reading difficulties, the HRQ seems to be able to measure reading in a large sample of persons without HH. Further research in a clinical sample and on the reliability of the HRQ is needed before implementing it in a clinical setting. Additionally, a confirmatory analysis in both a healthy and clinical sample should be performed.

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Appendix A. *Hemianopia Reading Questionnaire pre-measurement in Dutch*

Available on request from the examiner

Appendix B. *Hemianopia Reading Questionnaire post-measurement in Dutch*

Available on request from the examiner

Appendix C. *Hemianopia Reading Questionnaire pre-measurement in English*

Available on request from the examiner

Appendix D. *Hemianopia Reading Questionnaire pre-measurement in English*

Available on request from the examiner

Appendix E.

Figure E1

Components and Corresponding Eigenvalues From Principal Component Factor Analysis of the HRQ