Visual Daily Functioning of Chronic Stroke Patients Assessed by Goal Attainment Scaling After Visual Restorative Training: An Explorative Study

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Objective: To determine visual training effects on measures of daily life activities in cerebral blindness patients. **Method:** The study design was an explorative pre-post test design of patients in the chronic phase of stroke (>8 months) with visual field defects. Twelve hemianopic patients were trained by using visual restorative training, which is aimed at reducing the visual field defect. Goal attainment scaling (GAS) was applied to assess whether the functional impact of visual field defects on daily life activities was reduced after defects were reduced. **Results:** Visual field defect reduction was observed in all 12 patients to varying degrees. GAS score improvements were observed in 9 patients. In 5 of these 9 patients, all goals were attained or over-attained; in 2 of these patients, some goals were attained and other goals were not attained; and in 2 patients, goals were not attained. As a group, patients significantly improved their GAS scores (t test, $P < .005$). The correlation between GAS and defect reduction was not significant (Pearson's $r = 0.37$, $P > .01$). It is likely that this was due to the fact that the set goals were not tuned to the part of the visual field where defect reduction could be expected. This, in turn, may have led to slightly underestimated results. **Conclusions:** Visual restorative function training does not only lead to visual field enlargement, as assessed with dynamic Goldmann perimetry, but it may also lead to a subjective improvement of daily visual functioning as evaluated by means of GAS. **Key words:** *goal attainment scaling, quality of life, stroke, training, visual field defects*

Stroke leads to homonymous visual field defects in about one-quarter of all incidences.[1] These field defects can have far-reaching consequences for activities of daily life,[1-3] such as reading, driving, watching television, or using a computer, and in regard to navigation, orientation, and recognition of faces and objects. These activities can become problematic or even impossible to perform.

Thirty years ago, it was discovered that the size and depth of a visual field defect of cerebral origin could be reduced by means of visual training. In the mid-1990s, a training software program called Vision Restoration Therapy (VRT; NovaVision, Boca Raton, FL) became commercially available. During this training, a person is required to focus on a central fixation point while detecting peripherally presented stimuli by making a covert attention shift. Many studies have been performed in which training-induced visual field enlargement (VFE; ie, defect reduction) is reported using VRT.[1-20] Critical reviews that stated that the reduction may be a result of contaminating eye movements during perimetry[21-25] have been refuted.[5,7,14] In our studies, we use a custom-made training program that operates like VRT, which we call visual restorative function training (RFT). Using RFT, we found that defect reduction was accompanied by improvement of elementary visual functions

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(acuity, flicker fusion, color perception, simple pattern perception[6,9]) and visually guided behavior, such as reading,[3,6,7] and oculomotor strategies during driving.[8]

These improvements provide insight in the positive effects RFT has on daily life activities. However, only reading and driving have been studied, and these activities do not have the same relevance for everyone. For example, if a subject does not like to read and does not have a driver's license, the ability to read faster and have more effective eye-movement strategies while driving are not really going to be an improvement for the subject. It is therefore imperative that personal expectations and wishes are integrated into an assessment of training effects. One way to achieve this is to use goal attainment scaling (GAS).[26] GAS can be used to assess functional improvement by setting personal and realistic goals before training and evaluating to what extent these goals are achieved (attained) after training. In this way, GAS is used to measure the treatment outcome at the participation level. An additional benefit lies in the fact that the patients can associate the laborious training with personal goals, which motivates them to comply with the training requirements.

In this article, we describe a study in which we trained 12 participants with RFT and evaluated their progress toward individually set goals by applying GAS. The individual goals were specifically function and participation based. Moreover, we studied the relation between the degree of GAS progress and the amount of visual field defect reduction.

Methods

Subjects and design

The study design was a pre-post test. Subjects were chronic stroke patients who voluntarily applied to participate. Inclusion criteria were the presence of homonymous visual field defects as a consequence of postchiasmatic stroke, age between 18 and 75 years, a patient-signed consent form, and stroke occurrence more than 8 months previously (chronic phase of stroke). The presence of visual neglect served as an exclusion criterion (if suspected, this was tested by means of the character line bisection task). Subjects' ages ranged from 40 to 68 years (average, 57.8 years) and time after stroke onset ranged from 8 to 105 months (average, 32.6 months). **Table 1** lists subject characteristics. Subject P11 appeared to have problems in carrying out the training on a computer and dropped out from the study. Before and after training, the visual field defect was assessed and GAS was applied.

Anatomical scans of the 12 subjects in radiological convention (left = right; right = left) are shown in **Figure A1** in the Appendix.

Research process

Potential subjects were able to apply for participation on a Web site that was specifically designed for this purpose. After applying to participate in this study, subjects were invited for an intake interview. Applicants who were subsequently included in the study returned to the lab for baseline measurements

Assessment of the visual field defect and visual field enlargement

Dynamic Goldmann perimetry was used to identify the VFD. For a more elaborate description of the perimetry method that was used, see previous studies (Bergsma et al, 2008, 2010).[6,7] VFE can be described as the percentage of visual field that is regained or by the average number of degrees that the visual border shifts. However, this description does not take into account that a border shift in the central visual field cannot be compared with a border shift of the same magnitude in the peripheral visual field.

The cortical magnification factor (CMF)[27] describes the amount of cortical tissue in the visual cortex that is allocated to a particular part of the visual field. According to the CMF, the largest amount of cortex is allocated to the central visual field. As the part of visual field under consideration is located more peripherally, the amount of cortex that is allocated to it decreases. As a consequence, visual acuity in the central visual field is maximal, but it decreases as eccentricity increases. This explains why subjects notice a border shift of just a few degrees when it is located near the fovea,

Table 1. Profile of subjects

Subject	Gender	Age at start of training, years	Cerebral damage	Visual field defect	Time since stroke, months
P1	Male	62	Right occipital lobe complete	Hemianopia left	23
P2	Male	40	Left occipital lobe below calcarine sulcus	Quadrantanopia upper right	47
P3	Male	53	Right occipital lobe below calcarine sulcus	Quadrantanopia upper left	55
P4	Male	62	Right occipital lobe around calcarine sulcus	Incomplete hemianopia left	15
P5	Male	68	Right occipital lobe below calcarine sulcus	Quadrantanopia upper left	25
P6	Male	52	Right occipital lobe below calcarine sulcus	Quadrantanopia upper left	22
P7	Male	66	Right occipital lobe around calcarine sulcus	Incomplete hemianopia left	42
P8	Male	64	Right occipital lobe below calcarine sulcus	Quadrantanopia upper left	21
P9	Male	68	Right occipital lobe below calcarine sulcus	Quadrantanopia upper left	20
P10	Male	44	Right occipital lobe below calcarine sulcus	Quadrantanopia upper left	105
P12	Male	60	Right occipital lobe around calcarine sulcus	Incomplete hemianopia left	8
P13	Female	55	Left occipital lobe below calcarine sulcus	Quadrantanopia upper right	8
Average		57.8			32.6
Median		57.5			22.5

whereas a border shift in the periphery must be much larger for a subject to notice.

Changes in GAS scores after, for example, a 2° shift of the visual field border in the foveal field will likely differ from changes in GAS scores after a shift of the same magnitude in the peripheral field. We took this into account when we studied the relationship between changes in GAS scores and VFE. Thus, we calculated VFE as follows: the area of the visual field that was enlarged by training was divided in radial sections with a visual angle of 2.5°. For each radial section, the locations of the visual field border before and after training were established and given a CMF value, derived from the Cowey paper.[27] The difference between these values was weighted by the sine of the angle between the heading of the radial section and the pretraining visual field border in that section. The resulting values of all radial sections in the trained area were then averaged, yielding the VFE value for that subject. A more elaborate description of VFE calculation using the CMF can be found in Bergsma et al (2012).[9] In an earlier study, we showed that this method of calculating VFE correlates significantly with improvements on nontrained visual tasks after training ($r = .57$, $P = .01$), whereas the expression of VFE in number of degrees or percentage visual field does not correlate significantly with improvements on nontrained visual tasks after training ($r = .41$, $P = .08$).

Training

RFT is a custom-made training software program that works like VRT.[16] Patients are required to train 1 hour a day, 5 days a week, for a period of 13 weeks. In this study, subjects trained at home on their own computers that had our RFT software installed on them. The training was aimed at the border area between the blind field and the seeing field, therefore it was tailored to the defect shape of the individual subject. During training, subjects tried to detect simple light stimuli that were presented around the visual field border, thus including stimulus presentations *inside* the visual field defect. To enable the stimuli to be presented in the border area, subjects were required to direct their gaze on a central fixation point, just as with perimetry. To detect stimuli, subjects needed to use peripheral view or to make a *covert attention shift*. During training, more and more stimuli become detectable and visible. This shows up during perimetry after training, which is expressed as a reduction of the defect size or a shift of the visual field border. A more detailed description of the training can be found in Bergsma et al (2008, 2010).[6,7]

Goal attainment scaling

In GAS, a number of personal and realistic goals are set. Goals are set by the subject in cooperation with an occupational therapist (OT) to ensure that goals are attainable, that is, that they are set realistically. For example, goals that imply complete recovery of VFD are not realistic, because this rarely happens in the chronic phase of stroke. The personal character of the goals ensures that a goal, when achieved, reflects the actual benefit from VFE. In this study, the goals were set before training by the patient in cooperation with an OT in about 60 minutes. First, personal and realistic goals were chosen. Then, the pretraining level of a certain activity pertaining to a goal was assessed. These levels ranged from -2 to +2: level -2 = cannot perform worse; level -1 = performance is impaired but could be worse; level 0 = the expected outcome level of the set goal; level +1 = outcome better than expected; level +2 = outcome *much* better than expected. See **Table 2** for the values of the goals of all subjects. The pretraining level of each goal was evaluated by the subject and OT during a 30-minute session. In our study, 3 goals were set for all patients except patient 4, for whom only 1 goal was set.

To assess GAS improvement within a subject, a combined score was calculated for all 3 goals before and after training. These scores are called the before index and the after index and are shown in **Table 3**. The indices are calculated using the formula of Kiresuk and Sherman[26]:

$$GAS = 50 + \frac{10\sum_{i=1}^{n} W_i x_i}{\sqrt{(1-\rho)\sum_{i=1}^{n} W_i^2 + \rho\left(\sum_{i=1}^{n} W_i\right)^2}} \quad \text{Eq. 1}$$

where x_i = the score on the i^{th} goal (pretraining level and posttraining level in **Table 2**); W_i = the weight that was allocated to the i^{th} goal; ρ = weighted average correlation between the goals; and n = number of goals. For all subjects, $n = 3$ except P4 ($n = 1$). The weight of each goal, W_i , can be found in **Table A2** in the Appendix . ρ is standard set at .3 by the original introducers of GAS (Kiresuk and Sherman).

Statistical analyses

GAS improvement was assessed using the GAS index before and after training. A positive number indicates an improvement. Significance of GAS improvement of the whole patient sample was tested using a t test. The correlation between VFE and GAS improvement was tested using Pearson's r.

Results

Visual fields

The visual fields of the 12 subjects are shown in **Figure 1**. Eight patients showed a quadrantanopia and 4 patients had a hemianopia. Five patients had a macular sparing of 4° or more. In 7 patients, macular sparing ranged from 2° to 3°.

The first result is the change in visual field size (VFE). The black line depicts the visual field border before training. The black area is the VFD that remained. The area that lies between the black line and the black area is the VFE after training. All 12 subjects showed VFE after training, with large variation between subjects and also *within* some subjects (ie, differences between peripheral and central VFE).

Goal attainment scaling

All individual goals that were set before training are listed in **Appendix 2**. A few typical goals pertaining to RFT are to decrease the number of times that someone walks into branches while mowing the lawn, the ability to read most or all subtitles, the ability to increase the distance between golf ball and hole without losing 1 of the 2 out of sight, and the ability to read a sentence without too many regressions (back-saccades) and to increase the number of columns of a crossword puzzle that can be seen at one glance.

Table 2 sums up the level at which the subjects' goals could be executed before training, the expected level to be attained after training, and the level of goal attainment that was attained after training. Nine out of 12 subjects showed improvement regarding 1, 2, or 3 set goals. Subject P4 could produce only 1 goal but improved much and therefore over-attained the set goal. Three subjects did not show any change in the level of goal attainment. No deterioration was observed;

Table 2. Goal attainment scaling (GAS) level before training, expected goal level, and level after training

	GAS level[a]				
Subject /VFE	**Pre training**	**Expected**	**Post training**	**Improvement[b]**	**Less/same/more than expected[c]**
P1/VFE 6.80					
Goal 1	-2	0	0	++	0
Goal 2	-2	0	+1	+++	+
Goal 3	-2	0	+1	+++	+
P2/VFE 5.55					
Goal 1	-1	0	+1	++	+
Goal 2	-1	0	+2	+++	++
Goal 3	-1	0	0	+	0
P3/VFE 4.94					
Goal 1	-1	0	-1	0	-
Goal 2	-1	0	-1	0	-
Goal 3	-1	0	-1	0	-
P4/VFE 8.81					
Goal 1	-1	0	+2	+++	++
P5/VFE 9.49					
Goal 1	-1	0	+1	++	+
Goal 2	-1	0	0	+	0
Goal 3	-1	0	-1	0	-
P6/VFE 4.01					
Goal 1	-2	0	-2	0	-
Goal 2	-2	0	-1	+	-
Goal 3	-2	0	-2	0	-
P7/VFE 4.70					
Goal 1	-1	0	+1	++	+
Goal 2	-1	0	-1	0	-
Goal 3	-1	0	-1	0	-
P8/VFE 6.73					
Goal 1	-2	0	+1	++	+
Goal 2	-2	0	0	+	0
Goal 3	-2	0	0	+	0
P9/VFE 6.86					
Goal 1	-2	0	-2	0	-
Goal 2	-2	0	-2	0	-
Goal 3	-2	0	-2	0	-
P10/VFE 6.05					
Goal 1	-2	0	-2	0	-
Goal 2	-2	0	-2	0	-
Goal 3	-1	0	-1	0	-
P12/VFE 8.99					
Goal 1	-2	0	-1	+	-
Goal 2	-2	0	-1	+	-
Goal 3	-2	0	-1	+	-
Goal 4	-2	0	0	++	0
P13/VFE 4.17					
Goal 1	-1	0	+2	+++	++
Goal 2	-1	0	+1	++	++
Goal 3	-1	0	+1	++	++

Note: VFE = visual field enlargement.

[a]Rating of GAS levels: -2 = cannot get any worse; -1 = can even get worse; 0 = expected level after training; 1 = better than expected; 2 = much better than expected.

[b]Scale for degree of improvement: 0 = no change; + = 1 scale improvement; ++ = 2 scale improvement; +++ = 3 scale improvement.

[c]Scale for degree of attainment: - = goal not attained; 0 = goal attained; + or ++ = goal more than attained.

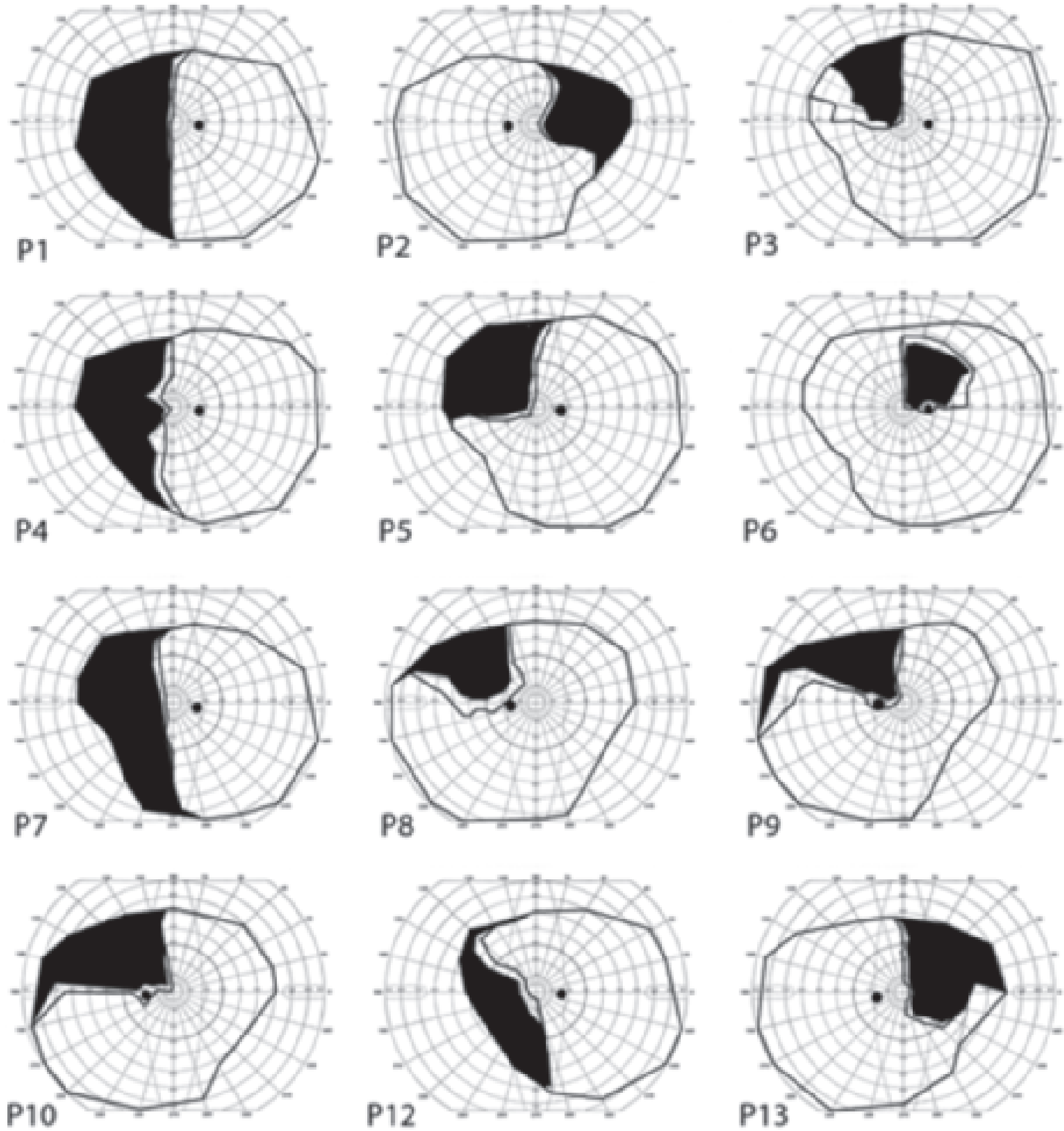

Figure 1. The visual fields of the subjects as measured with dynamic Goldmann perimetry. Only absolute defects are shown. The line near the visual field defect depicts the border between blind and seeing fields before training. The black areas denote the remaining defect after training.

an increase in VFD is never observed in the chronic phase of stroke (unless new brain damage occurs).

GAS improvement was determined by comparing the GAS indices before and after training. The indices of all patients were calculated using Equation 1 and are listed in **Table 3**. Nine out of 12 patient improved their GAS scores. Consequently, the patients as a group show significantly improved GAS scores (t = -3.6, $P < .005$, $\alpha = 0.05$). In the subjects who showed no improvement (n = 3), the average VFE was 5.95 mm. In the subjects who did showed improvement (n = 9), the average VFE was 6.58 mm. These averages roughly concur with earlier observations that (subjective) improvement is only to be expected if VFE >6 mm.[9] However, in individual subjects, sometimes VFE >6 mm does *not* lead to significant improvements (P9 and P10) and sometimes VFE <6 mm *does* lead to significant improvement (P2 and P13). This could mean that the criterion of 6 mm is not a hard divisor between subjects with and subjects without improvement. On the other hand, it could also mean that the goals in these cases were not set properly in relation to the visual field area where VFE was expected (see section below, Advantages and limitations of goal attainment scaling). The VFEs of P9 and P10 are only *slightly* larger than 6 mm and the VFE of P2 is only *slightly* smaller than 6 mm. In fact, P13 is the only true exception. We therefore think that the criterion of 6 mm is still a valid one.

We also studied the relation between improvement of GAS scores and VFE. The correlation between GAS improvement and the size of defect reduction was not significant: Pearson's r = 0.37 ($P > .1$). We discovered VFEs that were accompanied by improvements in GAS scores, but we also discovered a few larger VFEs that lacked improvement in GAS scores. For example, P1, P6, P7, and P13 showed improvements in GAS scores, whereas P9 and P10 had larger VFEs but did not show improvements in GAS scores.

Table 3. Before and after indices, index change, and VFE of all subjects

Subject	Before-index	After-index	Δ Index	VFE
P1	15.5	50.8	35.3	6.8
P2	32.7	52.1	19.4	5.55
P3	32.7	32.7	0	4.94
P4	48.9	52.3	3.4	8.81
P5	32.7	53.8	21.1	9.49
P6	15.5	21.2	5.7	4.01
P7	32.7	36.6	3.9	4.7
P8	15.5	42.3	26.8	6.73
P9	15.5	15.5	0	6.86
P10	17.4	17.4	0	6.05
P12	15.5	50.8	35.3	8.99
P13	32.7	52.1	19.4	4.17

Note: VFE = visual field enlargement.

We think this result is due to the fact that some of the chosen individual goals were not tuned to the part of the visual field where defect reduction could be expected.

For example, a goal may relate to peripheral view. Peripheral view is used to perceive visual information in the outer parts of the visual field, such as objects approaching from the left or right from the "corner of the eye." If there is defect reduction in the central visual field, however, it is not likely that this goal will be reached. Alternatively, if a goal relates specifically to central vision (eg, reading), a defect reduction outside the central visual field is not likely to have an effect on reading.

The following are some examples of this mismatch:

- P1 has a left-sided hemianopia and reported seeing only 50% of the visual information when in the front passenger seat of a moving car. A training goal was set at seeing 75% of that information. This means that the visual field border needs to shift with a magnitude of 25° to 30° toward the peripheral visual field. However, because training effect is only expected in the *central* visual field in the case of almost complete hemianopia (as we indeed observed), this goal could never be reached. It would have been more appropriate to set 60% as a goal. The other 2 goals of this subject concerned the central visual field. Because we *did* find training effects in the central visual field, these goals were attainable.
- P3, P9, and P10 chose goals that "belong" to VFE in the central visual field, but the training effect predominantly took place in the peripheral visual field. Consequently, the VFE did not change performance with regard to the set goals.
- The opposite also seems possible: P13 showed a rather low VFE after training. When

looking at the graph of P13's visual field, enlargement did *not* take place centrally, but more peripherally. Still, P13 was satisfied that the set goals were attained. This possibly is a result of the peripheral VFE, because P13's set goals were associated with general overview of a visual scene and thus with peripheral view.

- A special remark must be made about goals that are set properly (central or peripheral), but that are set at levels that are too high. P5 and P6 shared a common goal (the ability to see the golf ball near the hole) and showed the same amount of foveal sparing (the central visual field that is unaffected), but they differed in the desired output magnitude and VFE. P5 did not see the golf ball when the distance from the hole was more than 1 cm. The goal was set at seeing the ball at a distance of at least 3 cm. VFE was expected in the central visual field, so the goal was set properly. VFE appeared to be rather large and the goal was more than attained. For P6, on the other hand, the goal was set at seeing the ball at a distance of at least 50 cm. VFE was expected in the central visual field, so the goal was set properly. However, the desired magnitude of performance on the set goal was somewhat large: assuming a height of 1.80 m, 50 cm into the peripheral visual field corresponds to ±18°. VFE must be rather large to reach gains of that magnitude and the goal was therefore probably not attained. P12 may also have set the desired goal levels too high. So, although goals were properly set, the levels seem a little high. As a consequence, improvement was observed, but 2 of the 3 set goals were not attained.

Discussion

In this study, GAS was used as a method to evaluate the effects of RFT on daily activities, described as changes in subjectively experienced visual functioning of subjects with (cerebral) visual field defects. The results show that visual RFT leads to VFE, as assessed with dynamic Goldmann perimetry, and – if sufficiently large – also leads to a subjective improvement of daily visual functioning as evaluated by GAS. In the group of 12 chronic stroke patients, 9 had improved GAS scores, indicating that the (visual) goals that were set a priori were either attained or closely approached. This suggests that the area of VFE or defect reduction that was induced by this training is actually used for visual functioning, whereas the same visual field area was not used for visual functioning before training.

Advantages and limitations of goal attainment scaling

GAS has been successfully applied in several studies to evaluate functional outcome of stroke rehabilitation, mainly concerning motor rehabilitation.[28-35] A number of important advantages of GAS have been identified[36]: GAS is a very suitable instrument to measure functional improvement in heterogeneous patient groups with often complex disabilities. GAS also meets the expectations of patients and increases their ability to engage in activities that are meaningful to them. Less or more goals can be set because a general *T* score is calculated. This makes statistical comparisons possible.

Limitations of the GAS method have been identified as well[36]: The GAS version used in this study has 1 scale less than modern versions. Therefore, some cases of improvement could not be measured as such and the reported results are somewhat underestimated.

Deficits in visuo-spatial performance have been associated with underachievement of goals.[37] Our patients with VFD showed impaired visuo-spatial performance. Improving this performance, however, is precisely what our visual training aims for. GAS can therefore be used to evaluate improvement in visuo-spatial performance.

GAS levels that were set before and after training were confirmed by measurements when possible. In a few cases, the level was derived from the subjects' report. Because RFT takes a lot of effort, subjects may give desirable answers during the evaluation of the GAS levels as a result of cognitive consonance, thereby the actual level of GAS may be overestimated. There was suspicion of such bias in the case of P4 but not in others. We did not change the GAS score as reported by this patient, therefore the achieved GAS level may have been overestimated. At the same time, results may be somewhat underestimated, because the 5-scale GAS version was used instead of the more recent 6-scale versions.[35] In the 5-scale version, it is possible that an improvement is observed but it is too small to achieve the next GAS level. In our study, such improvements could not be scored as such and they may have been underestimated.

To our knowledge, this is the first time that GAS has been used to evaluate functional improvement in poststroke rehabilitation of partial cerebral blindness. A limitation emerged that is specific to this application: The correlation between the improvements in GAS scores (Δ Index) and defect reduction (VFE) was not significant. We think this is due to the fact that some of the individual goals were not tuned to the part of the visual field where defect reduction could be expected.

In summary, RFT led to significant improvement in daily functioning in 75% of the patients, as measured by means of GAS. Thus, in the case of training-induced visual field recovery from cerebral blindness, GAS proves to be a feasible method to chart subjectively experienced functional improvement of daily functioning after the intervention in an objective way. The results reported here might be improved, if all goals are set in accordance with the expected *location* of VFE. This is, of course, precisely what makes GAS with this type of intervention more difficult than with motor rehabilitation where goals may be more easily quantified. It is possible, however, to identify the part of the visual field where VFE is expected and adjust the goals to this specification as much as possible. This will increase the chance that a set goal is actually attained. For future studies, the setting of realistic individual goals must be based on the results of pre-intervention perimetry. In this way, the set goals will become more realistic and improvement will be detected more easily.

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Ethics: The study was approved by the Ethics Committee of the Radboud University Nijmegen, The Netherlands (registration NL38477.091.10). Written consent was obtained from all subjects.

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APPENDIX

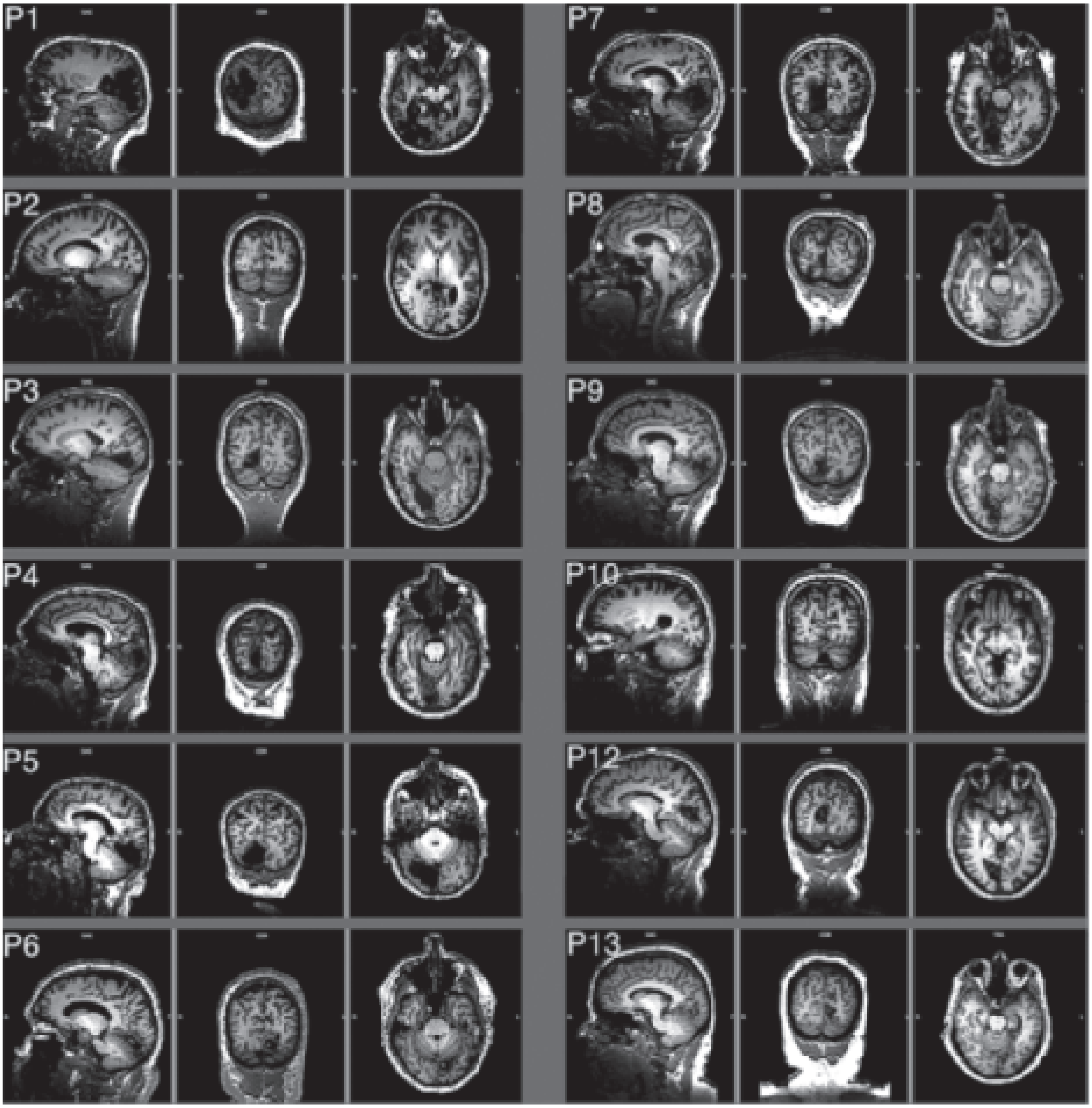

Figure A1. Anatomical scans of the 12 subjects in radiological convention (left = right; right = left).

Table A1. Visual field enlargement, individual goals and their weights, and pre- and posttraining levels

Subject/VFE	Goal level before training	Target goal level, set before training	Goal level, achieved after training	Improved ?	Goal attained ?
P1/VFE 6.80	1: Sees less than ±50% of visual information on left side when driving as passenger in a car (5) 2: Walks into branches >3 times when mowing the lawn (3) 3: Able to read <50% of subtitles on TV (1)	1: Wants to see ±75% of visual information 2: Walks into branches no more than once during lawnmowing 3: Able to read more than 50% of subtitles on TV	1: Sees ±60% visual information 2: Doesn't walk into branches anymore 3: Hardly misses subtitles anymore	1: Yes 2: Yes 3: Yes	1: No 2: Yes, attained *more* than set goal 3: Yes, attained *more* than set goal
P2/VFE 5.55	1: When driving, does not use/see through rear-view mirror (1) 2: Can't find tools in work-place, even when standing up and looking around (5) 3: Not able to navigate through (new) Web sites (3)	1: Able to see left side of mirror without moving his head 2: Able to find tools when searching from a seated position 3: Able to find items after spending some time searching a (new) Web site	1: Sees left side of mirror without moving his head 2: Able to see tools from seated position 3: Finds items without any effort	1: Yes 2: Yes 3: Yes	1: Yes 2: Yes, attained *more* than set goal 3: Yes, attained *much more* than set goal
P3/VFE 4.94	1: Not able to recognize >50% of faces that have been seen before (3) 2: Needs to ride on left side behind other cyclist in order to see him (5) 3: Misses cue to speak > twice during role play (1)	1: Able to recognize 70% to 80% of faces seen before 2: Able to ride straight behind other cyclist 3: Misses cue to speak not more than once during role play	1: Still not able to recognize >50% of faces seen before 2: Still needs to ride on left side behind other cyclist to see him 3: Still misses cue to speak > twice during role play	1: No 2: No 3: No	1: No 2: No 3: No
P4/VFE 8.81	1: Not able to find his way in new surroundings	1: Able to find way with some assistance	1: No problem finding way in new surroundings	1: Yes	1: Yes, attained *much more* than set goal
P5/VFE 9.49	1: Not able to see more than 1 column on the left of the column that is focused on in a crossword puzzle (5) 2: Not able to see the hole when golfball >1 cm away from the hole (3) 3: Needs to look at a persons' right eye to see the whole face (1)	1: Able to see 2 columns at the left of the column that is focused on 2: Able to see hole when ball and hole are 3 cm apart 3: Able to see the whole face when looking at a persons' nose	1: Sees almost 2 columns next to the column that is focused on 2: Able to see hole when ball and hole are 5 cm apart 3: Still needs to look at the right eye	1: Yes 2: Yes 3: No	1: Yes 2: Yes, attained *more* than set goal 3: No
P6/VFE 4.01	1: Able to see <25% of the pieces during a game of chess (3) 2: Not able to see the hole when putting ball >10 cm from hole (1) 3: Sees <50% of pop-ups when building a Web site (5)	1: Wants to see >50% of the chess pieces 2: Able to see hole when ball and hole are 50 cm apart 3: Able to see >50% of pop-ups when building a Web site	1: Able to see 25% to 50% of the pieces 2: Not able to see the hole when putting ball >10 cm from hole 3: Still sees <50% of pop-ups when building a Web site	1: Yes 2: No 3: No	1: No 2: No 3: No
P7/VFE 4.70	1: Not able to find the way in a new surroundings (5) 2: Not able to prune a hedge at all (3) 3: Not able to read a newspaper for >1 hour without getting tired (1)	1: Able to visualize or plan the way in a new surroundings 2: Able to prune the hedge using a leading rope 3: Able to read newspaper for 1.5 hours without getting tired	1: Still not able to find the way in a new surroundings 2: Still not able to prune a hedge 3: Able to read a newspaper for 2 hours without getting tired	1: No 2: No 3: Yes	1: No 2: No 3: Yes, attained *more* than set goal

(Continued)

Table A1. (*Continued*)

Subject/VFE	Goal level before training	Target goal level, set before training	Goal level, achieved after training	Improved ?	Goal attained ?
P8/VFE 6.73	1: Not able to read a sentence without <10 regressions (back-saccades) (5) 2: While looking at a group of 3 people, either recognizes just 1 or not 1 person (3) 3: Not able to follow the trajectory of a tennis ball, coming from an opponent (1)	1: Able to read a sentence without <10 regressions 2: Able to recognize 2 persons from a group of 3 3: Able to follow the first part of the trajectory of the tennis ball	1: Able to read a sentence without <3 regressions 2: While looking at a group of 3 people, recognizes 2 persons 3: Able to follow the first and the last part of the trajectory of the tennis ball	1: Yes 2: Yes 3: Yes	1: Yes, attained *more* than set goal 2: Yes 3: Yes
P9/VFE 6.86	1: Not able to see all items on a bathroom shelf at one glance (5) 2: Is intensely tired when driving an unfamiliar route (3) 3: Not able to find small items that have been dropped (1)	1: Able to see (almost) all items on a bathroom shelf at one glance 2: Able to drive an unfamiliar route only getting a little bit tired 3: Able to find small items that have been dropped	1: Still not able to see all items at one glance on bathroom shelf 2: Still intensely tired driving an unfamiliar route 3: Finds the items, but takes more time to search for them	1: No 2: No 3: No	1: No 2: No 3: No
P10/VFE 6.05	1: Misses dirt during vacuum-cleaning (1) 2: Needs too much time to find misplaced items (3) 3: Spots other cyclists on the road too late, so that an emergency stop has to be made (5)	1: Wants to miss less dirt during vacuum-cleaning 2: Needs 35% less time to find misplaced items 3: Does not need to make emergency stops anymore	1: Still misses the same amount of dirt during vacuum-cleaning 2: Still needs too much time to find misplaced items 3: Surgery on foot prevented subject from cycling after training, however, subject did not expect improvement.	1: No 2: No 3: No	1: No 2: No 3: No
P12/VFE 8.99	1: Needs to turn his head at least 180° and needs to dismount when turning left during cycling (1) 2: Not able to work on a computer for >1 hour without getting tired (5) 3: Visiting the city is intensely tiring (3)	1: Needs to turn his head only 120° and there is no need for dismounting when turning left during bicycling 2: Able to work on computer for at least 2 hours without getting tired 3: Visiting the city is somewhat tiring	1: Estimates that 140° is needed and that he dismounts the bike in only 10% of the cases 2: Can work for 1.5 hours without a break 3: Visiting the city is somewhat tiring	1: Yes 2: Yes 3: Yes	1: No 2: No 3: Yes
P13/VFE 4.17	1: Not able to work on a computer without asking for help at least 3 times (1) 2: Not able to find items/food in the kitchen (3) 3: When taking a 30-minute walk, needs to stop >3 times because of visual disorientation	1: Able to work on a computer with asking help <3 times 2: Finds items/food in the kitchen by turning around axis >3 times 3: Able to walk 30 minutes but with stopping 2 or 3 times because of visual disorientation	1: Works on computer without asking for help 2: Finds items/food in kitchen by turning around axis <3 times 3: Able to walk for 30 minutes with only 1 stop because of visual disorientation	1: Yes 2: Yes 3: Yes	1: Yes, attained *much more* than set goal 2: Yes, attained *more* than set goal 3: Yes, attained *more* than set goal