Article ▸ Press Lites – Procedures For Visual Field Awareness

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ABSTRACT

Patients who experience a loss of their visual field are usually unaware that their peripheral vision has been altered. The first distinction to be made when the periphery is altered is to differentiate traditional visual field defects from loss of peripheral awareness due to inattention or neglect. Within this population experiencing inattention/neglect, extinction is another property reflecting a de-sensitization of one side of visual space as compared to the contralateral side of space.

A set of therapeutic procedures is introduced based on components of higher order cerebral function that factor into visual field awareness. Stressing visual function in three dimensional space, a method of probing and improving sensitivity to peripheral stimuli is presented. A commercially available set of lights is used with suggested procedures that can be used individually or hierarchically. Emphasis is placed on developing awareness, attention, and divided attention in attempting to broaden, if not fully restore, visual field sensitivity and scanning.

Keywords: visual field, visual inattention, visual neglect, peripheral awareness, Press Lites

Introduction

One of the more difficult conditions to treat clinically occurs when patients lose awareness of a portion of their visual field. Even individuals with homonymous hemianopia may be unaware that half of their visual field is missing. This can be considered as an elaborated version of perceptual filling-in, a normal process which helps to explain why we are not aware of the physiological blind spot created where the optic nerve is situated within the retina.[1] The challenge for the clinician is to arrange conditions so that the patient develops more sensitivity regarding areas of field loss, and ultimately to cultivate prescriptive measures including therapy procedures that expand visual awareness into the areas of field loss or inattention. The term visual neglect is often used interchangeably with visual inattention, and represents a lack of awareness of visual space on one side of the visual field without overt visual pathway disease that would account for the deficit.[2] It is indicative of a cognitive change that may be more amenable to restoration with therapy as compared to a visual field defect. Homonymous visual field defects may occur with or without unilateral spatial inattention or neglect.[3]

Homonymous hemianopia is a common type of visual field loss occurring in patients with acquired brain injury.[4] The field loss may be complete or incomplete, and results in a variety of functional vision deficits.[5] The three primary areas of deficit are:

1) Orientation and mobility
2) Navigation while driving
3) Reading comprehension and fluency

The procedures reviewed here center on skills used for spatial orientation and navigation when walking or driving, more so than reading. These skills have been classified as restorative and compensatory therapy, the former involving visual field expansion procedures and the latter involving scanning strategies to improve visual search.[6] For a full discussion of field loss or inattention related to reading, see the detailed overviews provided by Schuett et al.[7] and Rowe et al.[8]

Patients with field loss or inattention/neglect often exhibit a midline shift favoring the side[9] of space on their seeing or more attentive side. For example, a patient with left homonymous hemianopia may veer toward the right side when walking a hallway, or position material when reading or writing on her right side. She may also exhibit postural skews with head and/or body shifted to maximize the useful field of view.

In some instances it is difficult to differentiate between visual neglect or inattention and visual field loss. More thorough investigation of this topic can be found elsewhere,[10] but for the purposes of this paper we will concentrate on the basic challenge of increasing the patient's sensitivity to areas of the visual field in which awareness is deficient or lacking. To set the stage for this, it is useful to re-visit the concept of visual field measurement distinct from but related to peripheral visual awareness, followed by considerations of visual inattention.

Visual Field vs. Peripheral Awareness

In traditional visual field measurements, the patient is asked to maintain steady central fixation while simultaneously judging when a single target has appeared in the periphery. The patient does not have to process any information about the central light, only to use it as a point of fixation. Automated visual field units have become the standard of care in which the patient has to respond with a hand-held device to indicate awareness of light presented sequentially in the periphery within a certain time interval.

Compare this to the concept of a traditional peripheral awareness chart (Figure 1), in which the patient is asked to

maintain central fixation on a spot while simultaneously identifying objects in the periphery.[11] While the response is verbal rather than motor, and the targets are simultaneously in view rather than presented sequentially, the cognitive functions are very similar. It is fair then to say that clinical profiles of visual fields are based in part on peripheral awareness. To the extent that this is true, any intervention that enhances peripheral awareness should result not only in better functional performance in activities of daily living, but in improved visual field measurements.

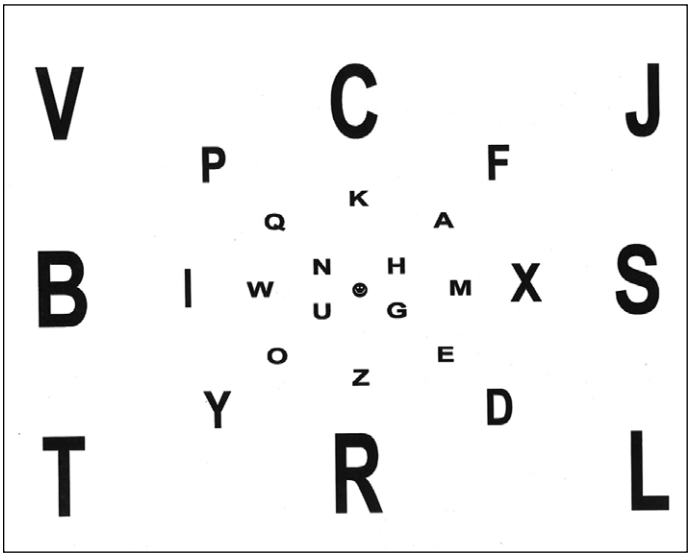

Figure 1: Peripheral Awareness Chart

Visual Field Loss Vs. Visual Inattention

There are certain visual field losses, rooted in disruption of the visual pathways, which will not recover significantly due to loss of neural function. However, the concept of visual neuroplasticity challenges the notion that visual field loss is absolute and inalterable. Visual inattention or neglect may occur independent of absolute visual field loss and may be more amenable to therapeutic or rehabilitative procedures.

There are several grades of visual inattention or neglect. The most severe form is when the patient is simply unaware of objects in one region of space. Classical examples are the patient who shaves one side of his face and leaves the other unshaven, thinking that the task has been completed, or the patient who draws a clock and squeezes all the numbers in so that 1 – 12 occurs in the region of 1 – 6. A less pronounced form of neglect is extinction, wherein the patient responds to all regions of space, but not when events are occurring in multiple regions simultaneously. An example is the patient who eats and leaves food on one side of the plate unattended. However, if food were presented on only one side of the plate, the patient would locate it. It is as if the presence of items in one field dampens or inhibits awareness of items in the inattentive or neglected field.

As a general rule, making the target in the unresponsive or insensitive field more striking will help the patient become aware of its presence. Examples include increasing the brightness, using color, or flickering the stimulus. To combat extinction, one can load the stimuli so that at the outset of therapy there are minimally competing stimuli in the good or responsive field, and strong stimuli in the inattentive field.

At the outset of therapy, the patient should be asked to maintain fixation on the midline while a target is introduced into the inattentive field very close to the midline. If these procedures are being done to try to enhance awareness in the presence of field loss, and there is incongruous or incomplete field loss on one side, begin with the patient's seeing field and slowly progress toward the non-seeing field.

There are several computer-driven approaches to increasing visual field awareness or expansion including Vision Restoration Therapy (VRT) and the Sanet Vision Integrator (SVI). They work on principles similar to what we are presenting here. In particular, the SVI is very versatile in terms of quadrant loading, cognitive loading, and building perceptual speed in the eye-hand coordination responses involved.

It is highly probable that the patient with field loss or inattention has developed a midline shift in which the egocenter of the body is now linked with visual guidance opposite to the side of loss or inattention. Patients experiencing midline shift will be observed to drift or veer to one side when walking. They may bump into objects, people, or walls, and they may be surprised that the object was present when it appears in their unseeing field. In other instances, they have consciously or subconsciously learned to scan toward their side of loss or inattention.

Yoked prisms are sometimes used to shift the useful field of view so that objects normally falling in the non-seeing field are re-positioned into the seeing field.[12] The bases of the prisms are generally positioned in the same direction as the field loss. For example, with a right homonymous hemianopia, or right field neglect, the prisms are placed with both bases right, moving objects in the patient's non-seeing field to where they can be seen. The procedures suggested here are not intended to displace the application of yoked prisms, as reviewed in detail by Harris.[13] Instead, yoked prisms can be used in conjunction with many of these procedures.

Divided Attention

Strictly speaking, any test of visual field awareness requires divided attention. The patient's gaze must be directed toward a specific region of space, while we are probing or measuring awareness in another region of space. Even a basic automated visual field test is only valid when the patient can maintain fixation on a central target while simultaneously being aware of stimuli in the periphery.

Extinction can be considered a more complex failure of divided attention when the patient maintains central gaze while processing what is occurring on both sides of the field simultaneously. This is done when, for example, a clinician conducts confrontation visual fields using fingers during a

chairside examination. If two fingers are extended on one hand, and one finger is extended on the other hand, the patient is expected to report awareness of three fingers being extended. Motion may be required by wiggling the fingers in order to aid divided attention and offset extinction of one of the fields.

Patients with field loss, neglect, or compromised peripheral awareness may have their difficulties compounded by a fundamental deficit in divided attention. This may be due to alterations in executive function, but irrespective of the anatomical locus, the challenge remains the same. Successful treatment reflects improvement in divided attention at a basic level.

Procedural Stimuli: The Press Lites

I am using the name "Press Lites" to designate procedures, although the lights are not proprietary. They are Life Gear Glow Sticks available commercially through www.lifegear.com (Figure 2). The sticks are produced as roadside safety hazard devices. A button activates multiple settings, from a flashlight beam to a solid colored light within the stick, which can also flash on and off.

The lights are available in a number of different colors, but for our purposes two colors suffice. Since the red and green colors cancel well with anaglyphic filters, we typically use those two colors. There may be applications for and implications of using specific colors of light, but that is in the realm of syntonics and colored fields which is beyond the scope of our discussion. Good insights on the application of color in rehabilitation can be obtained in the overview by Stern.[14] The procedures introduced here primarily address awareness of the two lights and whether each is on continuously or flashing.

Figure 2:
Press Lites – Life Gear Glow Sticks

If we want the patient to have a cue that the light is changing, pressing the button is audible. There are other models of glow sticks available with no auditory cue, for which the light can be changed by rotating the bottom of the stick. If the patient has difficulty maintaining steady fixation on the midline, holding the target can aid fixation through kinesthetic feedback. As a general rule, we begin rehabilitative procedures in the patient's intact visual field, and move toward the field of inattention/neglect or loss. Unless otherwise specified, both eyes are open for all of the procedures.

Figure 3: Press Lites separated laterally on midline, fixation light on and peripheral light off.

The progression we follow is generally to work from the midline slowly into the non-seeing or inattentive field. Once there is evidence of some field expansion or awareness, the light is brought inward from non-seeing field toward the midline until it is reliably perceived. Although we are ultimately working toward increasing the useful field of visual awareness, these procedures can be beneficial in priming the patient to scan or search the neglected field even if the measured visual field is not expanding. Lastly, we are listing these activities as procedures, but they may also be viewed as phases in a sequence of progressions.

Press Lite Procedures

Procedure One: Basic Fixation and Awareness

The red light is positioned on the midline to establish that the patient can maintain steady fixation. Press the button so that the light is flashing and ask the patient to confirm awareness of the change by saying "now."

Procedure Two: Simultaneous Awareness

Position the red light on the midline and hold the green light slightly off the midline in the patient's seeing field, or the side of attention, with the light off (Figure 3). As the patient maintains central fixation, ask the patient to say "now" when the light is turned on (Figure 4). Repeat the procedure with the light on and ask the patient to say "now" when the light begins flashing.

Procedure Three: Simultaneous Awareness with Movement

When the patient is able to complete procedure two, repeat the process with one light as the fixation target on the midline and the other slightly off the midline, now into the non-seeing or inattentive field. When working on this side,

Figure 4: Press Lites separated laterally on midline both lights on.

Figure 5: Press Lites separated sufficiently on the z-axis to generate physiological diplopia of the light not being fixated.

you may need to begin with the light flashing in order for it to be perceived. Probe different sectors of the field.

Procedure Four: Physiological Diplopia

We are going to take advantage of the principle that physiological diplopia is an example of divided visual attention.[15] Begin working in the patient's preferred field. For example, if the patient has a right homonymous defect, begin by having her look slightly to the left of midline. Position the green light about 20 centimeters beyond the red light, directly along the line of sight. When the patient fixates the red light, there should appear to be two green lights in the background, and when the patient fixates the green light, there should appear to be two red lights in the foreground. If the patient has difficulty registering physiological diplopia, leave the light being fixated in the "on" position, and have the other light flashing. It is more difficult to suppress the lights in physiological diplopia when they are flashing.

As the patient is able to perceive physiological diplopia in near and/or far space, gradually move the lights laterally in tandem until they are close to or at the anatomical midline, midway between the two eyes. When the lights are on the midline, have the patient fixate the front red light and be aware of two green lights beyond it. If the patient is able to do this, she is now aware of simultaneous stimuli, on one in the preferred field and one in the formerly neglected, inattentive field. By definition, they split the midline in equal degrees.

If the patient is experiencing a midline shift, and reports the lights being perceived as straight ahead when they are to the right or left of midline, the lights should initially be placed along the perceived midline. As physiological diplopia is perceived, the lights can slowly be moved toward the anatomical midline while the patient is asked to maintain physiological diplopia (Figure 5).

Some patients may only be able to perceive the proximal or distal lights in physiological diplopia when the light is flashing. It is possible that flicker detection channels tap into visual field regionalization.[16] First try having the patient fixate the proximal light when the light source is continuous, while having the distal light flashing. When the patient can maintain awareness of physiological diplopia this way, try having the proximal fixation light flashing and the distal light seen in physiological diplopia continuous.

Procedure Five: Reducing Extinction

Once the patient is able to appreciate targets on both sides of midline simultaneously through physiological diplopia, it should be easier to combat extinction. The patient should now be ready to have one of the lights placed slightly off the midline to the left while one is slightly off the midline to the right. Begin with both lights off and illuminate one, asking the patient to identify which of the colors is on. When both lights are on, ask the patient to identify when the light begins flashing. Once this is done accurately, ask the patient to report when the light stops flashing. When the patient needs an auditory cue to aid sensory integration, use the Glow Stick

with a button so that the patient is cued that something is changing. Once this is achieved, Glow Sticks with a twist bottom rather than a button can be used so that there is no auditory cue.

As previously noted, the distinctions between visual-spatial neglect, visual hemi-inattention, and visual field loss can be subtle. Margolis[17] presented an excellent overview of the subject in the context of therapeutic strategies for vision rehabilitation. It is important to note that extinction can occur with two simultaneous stimuli from different sensory modalities, one visual and the other one tactile.[18] We therefore engage the patient in simultaneous touch and vision procedures. For example, have the patient reach for an object in the seeing field while reporting awareness of the color of the light that you will introduce into the non-seeing field.

Procedure Six: Processing Synchronously

The lights have a flash rate that occurs at slightly differing peak cycles. This results in the lights flashing so that at one point they are perfectly in sync blinking together, and approximately seven flashes later they have moved 180 degrees out of phase so that they flash alternately. Any of the preceding five procedures can be done so that the patient has to say "now" when the lights are flashing synchronously. This represents a higher level cognitive task, and is an important cognitive load in dividing attention equally between the two fields.

Discussion

The procedures presented here fall within the category of perceptual learning as applied to vision rehabilitation.[19] By the nature of the stimuli in Press Lites as a threshold detection task, we are applying the principle that perceptual learning is based on sufficient numbers of repeated trials designed to improve one's ability to detect a target in a complex environment.[20]

As a general principle, one begins working with patients in a quiet environment, where both visual and auditory distractions are kept to a minimum.[21] The procedures have been presented as phased sequences, from lower order thinking to higher order cognition. Although perceptual learning is not predicated on feedback, and theoretically does not transfer to tasks that are not practiced, the utility of these procedures is enhanced when the therapist is able to guide the patient on making changes from what is initially perceived.

Patients with rehabilitative needs vary widely regarding their initial capabilities and cognitive capacities. At the outset, the patient may need to work at a basic level of visual awareness, detecting when a single fixation light is on or off in the seeing field. We then progress to whether the light is flashing on and off or is on continuously. Intersensory integration can aid peripheral localization by adding a tone or a click to the target, or by touch. However, neglect or inattention can exist in all sensorimotor domains, and some patients may therefore be confused or conflicted by the addition of non-visual cues rather than be aided by them.

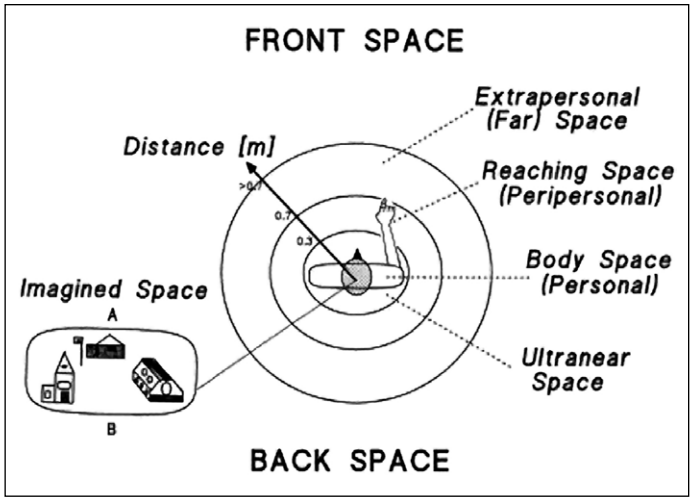

Figure 6: The Neuropsychology of Visual Space

We have emphasized the role of divided attention and that inattention or neglect reflects a limitation in the patient's ability to divide attention. Although the Press Lites Procedures have greatest utility in aiding restoration of visual field awareness, they may be used to accentuate peripheral awareness even when there are no visual field abnormalities per se. This dovetails with the concept of useful field of view.

When a patient has intact binocular vision without suppression, we utilize awareness of physiological diplopia as a strong stimulus that bisects visual space symmetrically. There is less likelihood of extinction because the simultaneity of the two lights splitting the midline is generated by the patient's internal projection of a single stimulus on the midline, not two physical objects in space competing for attention presented by the therapist. The awareness of physiological diplopia in the background or foreground of the fixation light can be accentuated by leaving the non-fixated light on the flashing mode.

All of these procedures may have differential effects based on the location of the targets within the sphere of the patient's neuropsychological visual space (Figure 6). This is where the results of a visual field conducted in a two dimensional plane within an instrument, with visual fixation at one fixed distance, may not be indicative of how the patient functions out of the instrument. It also explains why chairside confrontation visual fields may be more indicative of visual function regarding peripheral awareness, as there are more stimuli competing for visual attention. For some patients, neglect or inattention may be accentuated in near or personal space, for others in intermediate or peripersonal space, and for still others in far or extrapersonal space. By varying location of the targets, the therapist will find the area of space within which the patient can best perform initially, and work toward extending that region within three-dimensional space.

Conclusion

Press Lites are commercially available road hazard lights adapted for use as versatile stimuli for vision rehabilitation and therapy procedures. They provide the advantage of being used under natural conditions in three-dimensional visual space, and the fixation distance in various visual planes can be easily adjusted. Awareness of a stimulus peripherally when a central light is fixated can expand the useful field of view. Inattention or neglect can be combatted when the non-fixated light is set to the flash mode. Physiological diplopia can be used to overcome extinction, a feature unavailable in current computerized technologies which operate within two-dimensional planes rather than on the z-axis of open visual space.

These procedures are used to complement rather than displace existing technologies. They have the added advantage of being readily available, inexpensive, and easily dispensed for reinforcement outside of the office. They may be used in conjunction with lens and prism procedures synergistically, and the cognitive load can be varied by using the lights in various visual environments progressing from quiet to cluttered. Given the complexity of the visual and cognitive processes involved, their use should be closely monitored by the optometrist prescribing the procedures.

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