Insight
Research and Practice in Visual Impairment and Blindness

ISSN 2157-037X
Insight: Research and Practice in Visual Impairment and Blindness

ABBREVIATED INSTRUCTIONS FOR CONTRIBUTORS

Authors should refer to full instructions at www.aerbvi.org.

Insight is a peer-reviewed member journal that is focused on excellent research that can be applied in a practical setting. Insight publishes material of interest to people concerned with services to individuals of all ages with visual disabilities, including those who are multiply disabled and/or deafblind. Published submissions include Original Research, Practice Report, Book Review, Professional Corner, and Conference Proceedings papers.

Original Research papers reflect the latest scientific discoveries in the fields of education and rehabilitation in vision impairment and blindness (maximum length: 4,000 words).

Practice Report papers reflect examples of best practice in the fields of education and rehabilitation of persons with visual impairments or who are blind. We expect not only academics but also practitioners to benefit from the contents (maximum length: 3,000 words).

Book Review papers are brief reviews of recently published books which will include a review of both the content and structure of the book (maximum length: 1,500 words).

Professional Corner papers are guest articles submitted by an AER member about a recent professional experience or set of experiences (maximum length: 1,500 words).

Conference Proceedings are intended to reflect the main topics of interest from your presentation or poster given at the biennial AER International Conference (maximum length: 1,000 words).

Theory Papers/Thought Pieces are papers that have been developed based on historical or content analysis, research evidence or literature, or evidence-based review (maximum length: 3,000 words).

Online Submission: Submit manuscripts online at www.editorialmanager.com/aerjournal; cover letter, title page and abstract, manuscript text, tables, and figures must be submitted as separate files. If your manuscript is accepted, you will need to submit an Insight Author Agreement found on the Insight Web site which consists of a copyright license for articles in AER publications.

For more information about the manual, visit www.apastyle.org.

Author Fees: Once a manuscript is accepted for publication and sent in for typesetting, it is expected to be in its final form. If excessive revisions (more than 5) are made at the proof stage, the corresponding author will be billed $5.00 (USD) per revision. Figure remakes (replacement figures or minor figure editing) will be billed as follows: $20.00 (USD) per halftone (grayscale) figure remake, $15.00 (USD) per line art (black/white) figure remake.
Call for Manuscripts
Special Theme Issue:
Vision Rehabilitation with Children and Adolescents, Including Those with Multiple Impairments

In the general literature on visual impairment, there has been less attention paid to children than to adults. This may be because of the lower prevalence among this age group. In North America, the prevalence of low vision and blindness in 0- to 19-year olds is a fraction of overall prevalence. However, the life expectancy of a 65-year old Canadian in 1997, for example, was 17.7 years compared to a newborn’s, which was 76.5 years in the same year. So when considered in terms of visual impairment years, the need for rehabilitation and accommodative services is much greater. Low vision statistics on children have often not included children with multiple impairments and yet approximately half to two-thirds of children with low vision also have other impairments.

So *Insight* is planning a special issue devoted to issues of vision rehabilitation surrounding children and young people of school and university/college age with visual impairment and blindness. We are interested in papers describing new research on educational issues and challenges at home for this age group. These could include, but are not limited to:

- access to print and school materials
- assistive technologies
- approaches to training
- new or improved interventions
- reading research
- O and M studies
- studies on encouraging independence and educational and home challenges

**Guest Editor:** Prof. Susan Leat

**Manuscripts can be:** Original Research; Practice Reports; Book, Film, or Literature Reviews; or Theory Pieces

**Manuscript submission deadline:** October 1, 2011

**Publication date:** May 2012

**Visit:** [www.editorialmanager.com/insight](http://www.editorialmanager.com/insight) for all submission information or contact eic@aerbvi.org
Insight: Research and Practice in Visual Impairment and Blindness

We are pleased to announce Prof. Susan Leat, PhD, as Guest Editor for the upcoming Special Theme Issue: Vision Rehabilitation with Children and Adolescents, Including Those with Multiple Impairments, to be published in the Spring, 2012 issue.

Prof. Leat graduated in Optometry from the University of Manchester (formerly UMIST), England. She obtained her PhD and undertook post-doctoral studies at Cardiff University (formerly UWCC), Great Britain. She founded the UWCC Low Vision Clinic and was instrumental in establishing the Special Assessment Clinic in UWCC. In 1991, she took up a faculty position at the University of Waterloo, Canada, where she is now a professor and a clinician in the Low Vision Clinic and the Paediatric and Special Needs Clinic. She teaches and conducts research in psychophysics, low vision, pediatrics, visual development, special needs, and gerontology. She also publishes in international optometric and ophthalmology journals and presents at international conferences.

Prof. Leat is a Fellow of the College of Optometrists (UK), a member of the College of Optometrists of Ontario, a Fellow of the American Academy of Optometry, and a member of the editorial board for the Journal of Optometry. She has co-authored a book on pediatric optometry entitled Assessing Children’s Vision—A Handbook, published by Butterworth-Heinemann in 1999. She is Past Head of the Paediatric and Special Needs Clinic and is currently the Head of Residencies at the University of Waterloo.

Submission Deadline for the Special Issue on Vision Rehabilitation with Children and Adolescents is October 1, 2011.

www.editorialmanager.com/insight
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SAVE THE DATE!
AER International Conference 2012
JULY 17–22, 2012
Hyatt Regency Bellevue on Seattle’s Eastside
Bellevue, Washington

Insight: Research and Practice in Visual
Impairment and Blindness

Upcoming Submission Deadlines
Spring 2012: Vision Rehabilitation with Children and Youth
Submission Deadline: October 1, 2011

Summer 2012
Submission Deadline: January 1, 2012

Fall 2012
Submission Deadline: April 1, 2012

Winter 2013
Submission Deadline: July 1, 2012

Spring 2013: Early Intervention and Habilitation with Infants and Toddlers
Submission Deadline: October 1, 2012

Go to www.editorialmanager.com/insight to submit your paper today!
In April 2011, I provided a report to the Board of Directors of AER that was created to show the progress of our journal in the calendar year 2010, compared with 2009. In this editorial, I’d like to share the essentials of that report with you, our readers, and let you know that you can find the full report at www.aerbvi.org.

**Manuscripts**

Table 1 compares 2009 and 2010 data about manuscripts received. Please note that not everything received in a given year would have been reviewed in that year.

What do these statistics in Table 1 mean?

1. We have more than doubled our manuscript submissions in the year 2010.
2. In each of these years, only one manuscript was deemed unqualified to continue on for review. This is one indicator of an increase in the quality of what we have been receiving.
3. In 2009, 64 percent of submissions required revisions, while in 2010, 54 percent required revisions, another indication of an increase in quality as well as quantity.
4. In 2009, 95 percent of those requiring revisions returned their revised manuscripts to us, while in 2010, only 80 percent of these were revised for us. This may be a sign that our reviewers’ requirements have become more stringent, although that is only an inference at this point.

**Theme Issues**

AER members and, in particular, contributors to the journal, will be pleased to learn that we have shown progress on almost every metric, which is evidence that the fledgling journal is growing in attractiveness and marketability. We attribute this success to the strategy of introducing two theme issues per year, and to the marketing strategies of Allen Press and AER. A few advantages of the theme issue approach include the following:

1. We have been able to target invitations to authors we know are conducting research and practice in the specific theme area.
2. We have selected themes that are under-published in our field. Specifically, the two issues on persons who are deaf-blind in different age groups were highly successful—so successful that we needed to publish some submissions in the “open call” issues of the year. The quality of manuscripts has been influenced positively by personal invitations provided through theme issues, and by guest editors with specific expertise. For example, the issue on Falls and Falls Prevention invited submissions by optometrists and physical therapists, as well as by orientation and mobility instructors. The issue on children who are deaf-blind permitted submissions by a number of authors and reviewers who were not previously connected to AER.
3. The introduction of theme issues has generated a substantial increase in our reviewer base. Each guest editor has had a good reputation in their specialization, and the theme issues have attracted new reviewers from outside the typical sphere of vision rehabilitation, which has enhanced the quality of the reviews.

**Table 1. 2009 and 2010 Submission Data**

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<th>2009</th>
<th>%</th>
<th>2010</th>
<th>%</th>
</tr>
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<tr>
<td>All manuscripts received</td>
<td>33</td>
<td>100</td>
<td>74</td>
<td>100</td>
</tr>
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<td>Removed by office</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
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<tr>
<td>Revisions required</td>
<td>21</td>
<td>64</td>
<td>40</td>
<td>54</td>
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<tr>
<td>Revisions returned</td>
<td>20</td>
<td>95% of requested; 61% of total</td>
<td>32</td>
<td>80% of requested; 43% of total</td>
</tr>
</tbody>
</table>
Reviewers

The number of reviewers for our journal grew from 58 in 2009 to 139 in 2010. We can expect the range of expertise areas to grow as well, permitting an ever-wider number of manuscripts that will benefit from expert review. It is interesting to note that the average number of days to complete a review has not changed from 2009 to 2010; thus, we can plan for future issues knowing that it takes an average of 2.5 weeks for a reviewer to complete a review from the time of invitation. We are also seeing a steady-state number of reviews per reviewer, even with the 39 percent increase in the number of reviewers in the system. Again, this statistic permits us to tell potential reviewers that they should not expect to be asked to complete more than two reviews per year. Finally, our number of reviews turned in late dropped by 9 percent, a very healthy trend.

Table 2 indicates our acceptance rates compared between the two years. While we rejected 16 percent of submissions in 2009, 36 percent were rejected in 2010.

It should be noted that “revise” includes both minor and major revisions; “reject” includes both reject outright and reject with the possibility to resubmit for a review by new reviewers. It is interesting to note that the frequency of the recommendation “accept” has not changed substantially in the two years (12 percent in 2009 and 11 percent in 2010).

The year 2010 was extremely successful for the flagship publication of AER. I have been proud to oversee this success, and to manage as best I could the changes brought about by enacting the old adage, “if you build it, they will come!” I thank the Board for the ongoing support provided to the journal.

Finally, this issue contains articles we had received for the special issue on Falls and Falls Prevention, and therefore I would like to thank Dr. J. Vernon Odom again for serving as Guest Editor and for his excellent work with these articles.

Until next time,

Deborah Gold, PhD
Editor-in-Chief

Table 2. 2009 and 2010 Acceptance Rates

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<th>%</th>
<th>2010</th>
<th>%</th>
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<td>Accept/revise</td>
<td>42</td>
<td>84</td>
<td>87</td>
<td>74</td>
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<tr>
<td>Reject (all)</td>
<td>8</td>
<td>16</td>
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<td>36</td>
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<td>Total</td>
<td>50</td>
<td>100</td>
<td>118</td>
<td>100</td>
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Editorial
Abstract

The ability to spatially navigate relies on the efficient updating of multisensory spatial information with observer motion. Here we tested the role of visual information in spatial navigation in older adults by measuring distance error-to-target and gait parameters in a triangular walk task. In each trial, either participants could view their surroundings or vision was reduced using blurring goggles. Our results suggest that reduced visual information incurred a cost on efficient updating in younger and older adults relative to when visual information was fully available. However, this cost was particularly profound in older persons with a recent history of falling. Moreover, reduced vision was associated with a compensatory change in gait velocity for all participant groups except for fall-prone older adults. Our results suggest that the mechanism for updating spatial information with observer motion is particularly compromised in older adults who fall, in that they not only show an overreliance on visuo-spatial information for spatial cognition but also fail to adjust their behavior adequately when this spatial information is unreliable.

Keywords: ageing, spatial updating, multisensory processing, falls, simulated vision

Introduction

Our phenomenological experience as we move around the environment is that information from all the senses is coherently updated: Spatial cues across the senses do not disengage as we move but are integrated into a single spatial percept. Yet despite an accumulation of research on the processes involved in visual spatial updating (or remapping) during eye or head movements in both animals (e.g., Andersen, Essick, & Siegel, 1985; Duhamel, Colby, & Goldberg, 1992; Nakamura & Colby, 2002; Poucet, Lenck-Santini, Paz-Villagrán, &
Visuo-Spatial Cognition in Older Adults

Save, 2003) and humans (e.g., Pasqualotto, Finucane, & Newell, 2005; Simons & Wang, 1998), relatively little is known about how spatial updating across the human senses is affected by the ageing process. Moreover, epidemiological studies show that falls are a very common problem in the older population with 30% of community dwelling older people older than 65 years of age falling each year and 12% of these falling at least twice (Kenny, Dishongh, Newell, & Ni Scanail, 2009). Currently there is no comprehensive method to diagnose and prevent frailty and falls; current falls intervention strategies prevent less than 30% of events (Parry et al., 2008). However, one cognitive ability that may affect falling in older adults is the ability to update spatial representations of the surrounding environment during self-motion and navigation. Here we describe an exploratory study on spatial cognition in older adults, with a particular emphasis on the role of visual information in efficient spatial updating during self-motion in older adults with a history of falling.

Although some studies have provided evidence that extraretinal cues such as vestibular, proprioception, and corollary discharge are implicated in updating both visual and auditory spatial information (e.g., Andersen, Snyder, Bradley, & Xing, 1997; Crowell, Banks, Shenoy, & Andersen, 1998), others have suggested that self-motion from optic flow information represents an important cue for the subsequent updating of spatial representations in memory (Cohen & Andersen, 2004). Moreover, other findings lead to the speculation that vision plays an orchestrating role in the process of integrating spatial information across the senses, possibly underpinned by spatial processing in the posterior parietal cortex in humans (Merriam, Genovese, & Colby, 2003). This speculation arises chiefly from a growing literature on the role of visual experience in crossmodal spatial perception and updating (Pasqualotto & Newell, 2007; Röder, Rösler, & Spence, 2004; Wallace, Perrault, Hairston, & Stein, 2004). By integrating the encoded spatial information into a functionally multisensory representation in memory, spatial updating across all the sensory modalities can be achieved rapidly and efficiently, that is, in a single shot (Kardar & Zee, 2002).

In the following experiment, we investigated whether the efficiency of these processes, involved in updating information represented in spatial memory, are generally affected by ageing and whether such processes are less efficient in older persons with a history of falls. Several previous studies have found differences in spatial abilities dependent on the availability of visual information across different age groups (see e.g., Moffat, 2009, and Wolbers & Hegarty, 2010, for reviews). In particular, performance in older adults is generally found to be less than younger adults in tasks involving spatial memory (e.g., Iachini, Ruggiero, & Ruotolo, 2009) and also the manipulation of spatial information for navigation purposes (e.g., Mahmood, Adamo, Briceno, & Moffat, 2009). We therefore expected that performance in spatial updating while walking in a room would be worse in an older adult group (without a history of falls) than in a younger adult population. In the present study, we were also specifically interested in the role of vision on spatial cognition in older persons with a history of falls and whether this group was selectively more reliant on precise spatial information encoded through vision for navigation purposes. If so, we expected spatial updating performance to be worse in the older adult group who were fall-prone, particularly when visual information was reduced, than either an age-matched group without a history of falls or a younger adult group.

Method

Participants

Six young adults ($M = 32.5$ years, $SD = 4.3$ years, 3 were woman) and 11 older adults ($M = 69$ years, $SD = 7$ years, 5 were woman) took part in the study as volunteers. Younger adults were students from Trinity College Dublin or employees from St. James’s Hospital Dublin and were recruited through advertisement. The older adults were recruited as part of a larger study on ageing, namely the Technology Research for Independent Living project (http://www.trilcentre.org). All older participants had normal or corrected to normal vision for their age group (binocular LogMar $M = 0.037$, $SD = 0.09$; Pelli-Robson Contrast Sensitivity, $M = 1.72$, $SD = 0.11$) and were cognitively healthy (Mini Mental State Exam, $M = 27.3$, $SD = 0.3$, no history of psychiatric or neurological illness). Five of the older participants were fallers (four women) and six were non-fallers (three women). Fallers were defined as persons who had fallen at least once in the recent
past (i.e., around 12 months) and required medical attention as a consequence of the fall.

The study was approved by the School of Psychology Ethics Committee and by the St. James’s Hospital Ethics Committee and conformed to the Declaration of Helsinki. Accordingly, all participants gave informed, written consent to take part in the experiment.

**Apparatus**

Testing took part in a large laboratory at St. James’s Hospital, Dublin. The laboratory was approximately 7 m × 5 m in length and width dimensions and contained two windows along one wall and a door on the opposite wall. The room was illuminated by fluorescent lighting located on the ceiling. We made efforts to render the ambient light conditions constant across participants by covering both windows with blinds, which filtered the external light to reduce any potential glare. The room was sparsely furnished and had minimal decorations on the walls.

The testing apparatus consisted of a triangular pathway on the floor of this testing laboratory. The triangular path was equilateral, with each side measuring 3m long. Each end-point of this pathway was indicated on the floor by marks that were invisible to the participants but used as a guide for the experimenter. One of the sides of this pathway was indicated by a 5 m long GaitRite mat (http://www.gaitrite.com), which comprised embedded sensors to record the gait parameters of the participants’ walks. Consequently, the other two sides of this pathway lay off the mat. Each walk started and finished on the mat, in order to be able to record gait parameters on the final, unguided, walk and the exact starting point was randomized across trials (although the dimensions of the triangular pathway remained constant).

For half of the trials, spatial visual information was reduced by a set of blurring goggles. These goggles were composed of standard safety goggles, which were wrapped in masking tape. The tape effectively blurred the visuo-spatial information available in the room but allowed for the perception of light. Peripheral vision from the side of the goggles was masked using foam and tape on the edges of the goggles. For each participant, the experimenter fitted the goggles such that they were worn comfortably while ensuring that no visual information was available from the side of the goggles.

Gait parameters were acquired using the GaitRite pressure sensor walkway. The sensors embedded in the walkway provide spatial information on foot placement during walking at a resolution of 1.25 cm between sensors. Data was captured at a rate of 80 samples per second. Gait parameters (e.g., stride velocity) were computed by the GaitRite software (version 3.4) based on algorithms that automatically identified the spatial location and timing of each footfall. Data for each participant were exported in spreadsheet format for further analysis. The walkway was positioned so that gait parameters were recorded on the unguided return to the starting position (see Figure 1); thus, the gait velocity achieved by each participant while navigating the unguided portion of the triangular path could be determined. The first and last strides of the return walk were not included in the calculation of the mean stride velocity.

**Design**

We tested three different groups of individuals (young, older non-fallers, and older fallers) on our spatial updating task. Each group was tested twice in two different visuo-spatial conditions: full or reduced vision. Trials were blocked into “vision” and “reduced vision” blocks and block order was counterbalanced across all participants.

The dependent variables were the XY distance error to the target destination point (i.e., the original starting point) and gait velocity as measured by the GaitRite walkway. Distance error measurements was composed of the square root of the sum of the square of the orthogonal X and Y errors (as shown in Figure 1b) of the distance along the X and Y axes between the position of the destination point and the starting point.

For each trial, there were four possible starting points to each walk in order to minimize familiarization effects: two on one end of the GaitRite mat and two on the other end. The two starting points on the same end of the mat were located at 30 cm distance from each other. In effect, there were two triangular paths that participants could walk along for each of two possible path directions. All participants were tested on all four permutations of starting points and path directions.
Procedure

At the beginning of each trial, the participant was guided by the experimenter to the designated starting point (e.g., Point a in Figure 1). They were instructed that their task was to walk along two sides of an invisible triangular pathway on the floor of the laboratory, which was indicated by the experimenter, and to walk to the final apex of this triangular pathway on their own. They were instructed to walk at a speed that was comfortable to them and that the task was to return to the precise location of the original starting point. Before embarking on the final unguided walk, the experimenter reoriented the participant toward the starting point.

Participants were guided by the experimenter along two of the three sides of the triangle as well as verbally instructed on the direction in which to turn their bodies. During the unguided walk, the experimenter remained at the side of the participant while he or she walked but did not provide instructions or feedback on the direction or duration of the walk. When the participant finally reached their perceived destination point (i.e., the original starting point) at the end of the unguided walk, the participant remained in place until the experimenter measured the distance between this point and the actual starting point. Measurements were taken both from the toe (on the y axis) and from the arch of the foot (on the x axis) to the starting point.

In the full vision condition, participants had full view of the room while walking, whereas in the reduced vision condition their vision was substantially impoverished by the goggles. There were eight trials in each of the visual conditions. The experiment took approximately 30 min for each participant to complete.

Results

The spatial error between the final stopping point and the original start position (see Figure 1b) was calculated and averaged across individuals in each participant group (older adult fallers and non-fallers and young adults) for each of the visual conditions (vision and reduced vision). The distributions of distance errors across participant groups and visual condition are shown in Figure 2a.

We conducted a $3 \times 2$ mixed measures analysis of variance (ANOVA) on the distance error with participant groups (older adults: fallers or non-fallers, and young adults) as a between-subject factor and visual-spatial conditions (full vision or reduced vision) as a within-subjects factor. The interaction between group and visual condition failed to reach significance, $F(2, 14) < 1$. The mean distance error was smaller in the full vision than in the reduced visual condition, $F(1, 14) = 15.8, p = .001$. There was also a main effect of participant group, $F(2, 14) = 3.6, p = .05$. A Fisher least significant difference (LSD) post hoc analysis on this main effect revealed a greater spatial error in older adults with a history of falling relative to younger adults ($p < .02$) but not to older adults with no history of falling ($p = .15$). The specific effect of age on performance in this task was assessed by comparing error distance between the young and older adults without a history of falling using a Fisher LSD post hoc analysis. The difference

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Figure 1. (a) A schematic illustration of the two-dimensional, triangular pathway used in the study. The pathway was not visible to the participants, but subtle markers guided the experimenter to the angular corners. Each participant was guided, from the starting point, along two of the three sides of the triangle (a to b and b to c) and were then expected to walk unguided back to the starting Point a. (b) The spatial distance error was calculated using the following formula: $\sqrt{x^2 + y^2}$, which represented the distances between the final destination position and the starting Point a along both the x and y axes, as illustrated.
Due to a technical error, the gait velocity of one of the participants in the group of older adults with a history of falling was not recorded. The mean gait velocity for the remaining participants in each group across each of the visual conditions is shown in Figure 2b. We conducted a 3 × 2 mixed measures ANOVA on gait velocity and found a main effect of visual condition, F(1, 12) = 35.09, p = .001, with significantly reduced gait velocity when visual information was reduced than when visual information about the surroundings was available. There was

Figure 2. Plots showing results of each of the tested groups on (a) the mean distance error made between the destination point and the actual position of the starting point and (b) the mean gait velocity of the unguided walk as a function of the availability of visual information (full or reduced). Error bars represent ± 1 SE of the mean.
no main effect of participant group, $F(2, 12) < 1$, nor an interaction between the factors, $F(2, 12) < 1$.

In order to explore further the relationship between stride velocity and spatial error we conducted correlations between these two variables. Figure 3 shows the correlations between the mean gait velocity and spatial error plotted for each group in the reduced vision trials. These correlations were conducted to allow us to examine the extent to which groups might adjust their gait speed when returning, unguided, to the starting point. There are marked differences in the relationship between gait velocity and spatial error.
and distance error across the participant groups. First, this correlation was negative ($r = -0.821, p < .05$) in the younger adult group indicating that a reduction in gait velocity was associated with increasing distance error. In contrast for the older adult groups, the correlation between these variables was positive in the older adult group with a history of falling, ($r = 0.978, p < .05$) and there was no correlation found in the older adults not prone to falls ($r = 0.105$, n.s.). Although these results should be considered with caution due to the relatively small number of data points available for each group, they may nevertheless constitute a preliminary indication of an important difference between younger adults and older fallers in the compensatory mechanisms involved in changing gait velocity when visual information is reduced and spatial precision is lost.

Discussion

Although an increasing number of studies have investigated the role of ageing on spatial abilities, particularly spatial navigation (see e.g., Moffat, 2009), very little is known about the role of visual information on efficient spatial cognition in older persons. Furthermore, falling is often a debilitating event for an older adult and although several factors seem to contribute to falls (Davies & Kenny, 1996), the precise role of spatial cognition on incidence of falls has not previously been investigated. In the present study, we asked three different groups of participants to walk, unguided, along one side of a triangular pathway following a guided walk along the other two sides. Their task was to walk to the original starting point of this triangle, under two visual conditions: full vision or reduced vision. We found that older adults (fallers and non-fallers) performed relatively poorly on this task, with greater spatial distance errors relative to younger adults. Moreover, the mean spatial error for each participant group was smaller in the trials in which full visual information about the surrounding environment was available relative to when visuo-spatial information was not available. Although the distance error was greater for all groups in the trials with reduced vision, there was a greater difference in the magnitude of the error across visual conditions for the older adults with a history of falling (average of 38 cm) relative to older adults without a history of falling (19 cm) or younger adults (23 cm), although the interaction failed to reach significance. Furthermore, although fall-prone older adults made greater spatial errors when visual information was reduced by blurring goggles, they appeared not to compensate for this reduction in spatial precision with a change in their gait velocity. Our data therefore suggest not only that ageing affects spatial cognition but that efficient spatial updating and spatial navigation in older persons who fall is particularly dependent on visual information.

Although there may be several reasons why older persons with a history of falling have impaired spatial cognition relative to their age-matched, healthy counterparts, with regard to the mechanisms involved in spatial cognition two possible reasons can be suggested. First, consistent with previous studies the data suggest that spatial updating in older adults is particularly dependent on the presence of visual information (see e.g., Pasqualotto & Newell, 2007), particularly in older, fall-prone adults. By reducing the visual input during self-motion, optic flow information is disrupted. Several studies have found evidence that motion information from optic flow is important for spatial updating (Macuga, Loomis, Beall, & Kelly, 2006; Wolbers, Hegarty, Büchel, & Loomis, 2008; Yamamoto & Shelton, 2005); therefore, it is possible that thresholds for this visual motion information differ across the older groups (e.g., Duffy, 2009). As such, the information required to update the spatial representation of the environment is not sufficiently precise resulting in greater spatial errors during navigation. Furthermore, for fall-prone older adults in particular, the cost in spatial precision was not compensated by an appropriate change in gait velocity, which may allow for other sensory modalities, such as auditory, tactile, or vestibular inputs, to provide a better spatial update of the surrounding environment (Klatzky, Lippa, Loomis, & Golledge, 2003; Loomis, Lippa, Klatzky, & Golledge, 2002; Pasqualotto et al., 2005).

Second, the finding that in older, fall-prone adults, greater spatial error is associated with increased stride velocity suggests a role for executive processes in spatial awareness. In particular, because the younger adult group reduced their stride velocity with increasing spatial uncertainty (i.e., error), this indicates an awareness of their spatial errors. In contrast, the data suggest that older adults with a history of falls do not compensate for
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increased uncertainty in spatial information with a change in gait velocity, suggesting that executive function involved in error awareness may be impaired in this group. Although there has been some previous evidence for a role of executive function in spatial navigation in older adults (e.g., Monacelli, Cushman, Kavic, & Duffy, 2003; Moffat & Resnick, 2002), prior testing of the participants in our task did not suggest general cognitive differences across the older groups, including in executive functioning (i.e., in the Mini Mental State Examination). Nevertheless, our cognitive task may not have been sufficiently sensitive to reveal such differences; therefore, the exact role of higher level cognition, using more sensitive measures such as the Montreal Cognitive Assessment (Nasreddine et al., 2005), on spatial abilities in older adults prone to falling requires further investigation.

Conclusion

We investigated the role of vision on spatial cognition across three adult groups, two of which were older and one younger. In the older adults, those with a history of falling made greater spatial errors in determining the location of the starting point of a triangular pathway than their age-matched control group. Moreover, these errors were greater when visual information was reduced, particularly in the falls group. Despite this spatial uncertainty, fall-prone older adults did not adjust their gait velocity to compensate for spatial errors: There was no difference across groups in gait velocity. Rather, when visual information was reduced, an increase in gait velocity appeared to be associated with a larger spatial error in the fall-prone adults only, but not in the age-matched healthy older or younger adults. Our findings suggest that spatial cognition, which relies on a complex integration between the spatial information encoded through the sensory modalities and the temporal parameters associated with self-motion, may be particularly compromised in older adults with a history of falling. Furthermore, visuo-spatial information seems to play a key role in orchestrating this integration process and renders fall-prone older adults particularly dependent on visual input for precise spatial awareness. Future research on spatial abilities in individuals with visual impairment, particularly age-related visual loss over a long term, would provide further insight into the role of vision on spatial cognition and the associated effect on falls.

Acknowledgments

This research was completed as part of a wider program of research within the Technology Research for Independent Living (TRIL) Centre. The TRIL Centre is a multidisciplinary research center, bringing together researchers from Trinity College Dublin, University College Dublin, National University of Ireland Galway, and Intel, funded by Intel and the Industrial Development Agency, Ireland. www.trilcentre.org

References


Balance in Adolescents with and without Visual Impairments

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Abstract

Research has found balance to be significantly delayed in children and adolescents with visual impairments in comparison to their sighted peers, but the relationship between balance self-efficacy and actual balance is unknown. This study examined dynamic and static balance and balance self-efficacy in adolescents who are blind (B) and have low vision (LV); the role of visual experience upon balance, sighted (S) and sighted blindfolded (SB); and the relationship between perceived and actual balance. The results revealed that the degree of impairment (LV compared to B) and experience with vision (SB compared to LV and B) were significant factors in many of the balance assessments, but not the balance self-efficacy ratings. Main effects for self-efficacy ratings and significant correlations for self-efficacy and balance measurements were only found for a few of the more difficult tasks. In conclusion, it is important to examine both motor performance and self-efficacy in adolescents with visual impairments on a variety of familiar tasks and contexts to gain a thorough understanding of the individual’s balance. This information is essential when developing appropriate and effective balance interventions for adolescents with visual impairments.

Keywords: balance, visual impairments, adolescents, posture, physical activity

Introduction

Children rely more heavily upon vision for balance than any other sensory information (Casselbrant, Mandel, Sparto, Redfern, & Furman, 2007; Foster, Sveistrup, & Woollacott, 1996). This information is important as balance is a critical component in the performance of all motor activities, both functional and sport related (Ferdjallah, Harris, & Wertsch, 2002). For example, young children use vision to make quick postural compensations to maintain their body position when acquiring new fundamental locomotor skills, such as walking with and without support (Delorme, Frigon, & Lagace, 1989). Around the age of 7 to 8 years, children exhibit significantly improved postural control through a reduction in the magnitude and velocity of their center of pressure (COP) motion (Kirshenbaum, Riach, & Starkes, 2001). It has been suggested that these postural improvements are a result of improved use of sensory feedback from proprioceptive, visual, and vestibular inputs.

Children of the same age with reduced or no vision have been found to have significant delays in postural control in comparison with age-matched controls (Bouchard & Tetartult, 2000; Navarro,
Significant differences begin to be apparent in toddlers (Brambring, 2006). These delays are particularly striking in dynamic balance tasks (i.e., walking along a line, hopping, and walking on tip toes), in comparison to static balance tasks (i.e., quiet standing), with developmental divergences as large as 21 months or more during dynamic balance tasks, as opposed to 2.7 months during static balance tasks in toddlers with visual impairments. This divergence between static and dynamic balance is likely due to an increased contribution of other sensory systems (i.e., the vestibular and proprioceptive systems) during static postural control, whereas dynamic postural control requires a higher reliance upon visual control (Brambring, 2006). It is not known whether this divergence in balance in children with and without visual impairments continues beyond childhood.

Although there is clear evidence that individuals with visual impairments experience reduced balance, there is no clear relationship in regard to the degree of visual impairment with static balance (Houwen et al., 2007; Houwen et al., 2008), and only weak evidence has been found for dynamic balance and the degree of visual impairment (Ribadi et al., 1987; Wyver & Livesey, 2003). Further research needs to be conducted on the relationship between individuals with low vision and blindness upon both static and dynamic balance to better understand the extent and type of postural control and balance delays between these two groups. To further examine this issue, an assessment of sighted blindfolded adolescents, in addition to adolescents with and without visual impairments, would allow an investigation of the role of postural control experience without visual feedback, because the sighted adolescents will have had minimal experiences with adapting their postural control to a sudden loss of vision. Adolescents with sight have minimal balance experience without visual feedback. By wearing blindfolds, sighted individuals are forced to reweight their sensory information from a heavy emphasis upon vision to proprioception and vestibular information (Ribadi et al., 1987).

In addition to these assessments, it is important to assess the self-esteem of adolescents with visual impairments. Motor performance has been linked to self-esteem in that individuals with lower self-esteem are less likely to fully develop fundamental motor skills (Losse et al., 1991; Shaw, Levin, & Belfer, 1982), and self-esteem in adolescents with visual impairments has been found to be lower than that of their sighted peers (Shapiro, Moffett, Lieberman, & Dummer, 2008). Children and adolescents who do not acquire fundamental motor skills tend to experience social problems and perform more poorly academically (Brown & Brown, 1996; Lieberman, Volding, & Winnick, 2004). In recognizing that children with visual impairments often have lower self-esteem, efforts to improve self-esteem or related factors may have beneficial effects upon motor performance, beyond directly targeting motor performance alone. Interventions that only focus upon motor performance may also improve self-esteem; however, targeting both may have a greater impact than performance or self-esteem, or related factors, individually.

A factor that is related to self-esteem is self-efficacy, that is, an individual's perceived ability to perform a task. There has been a strong relationship found between self-efficacy and motor performance (Holbrook & Koenig, 2007; Willoughby & Polatajko, 1995). Self-efficacy and sense of competence is reduced in individuals who perform more poorly than their peers (Harter, 1989). Individuals with impaired postural control and balance often have lower balance self-efficacy, which may be due to intentionally reducing participation in physical activity on the part of individuals with lower self-efficacy (Ray, Horvat, Williams, & Blasch, 2007; Stuart, Lieberman, & Hand, 2006; Vellas, Wayne, Romero, Baumgartner, & Garry, 1997). A decline in physical activity, as well, has been linked to reductions in balance, which can lead to difficulty in the maintenance of balance during even simple activities. Furthermore, it has been suggested that self-reports of an individual's own abilities can provide reliable data on their functional abilities as well as increase their involvement in their treatments and improve the effectiveness of the treatment (Berry & West, 1993). The present study sought to expand the knowledge of static and dynamic balance in adolescents with low vision and blindness and determine how balance abilities affect adolescent's self-efficacy related to balance.
In summary, there is little research examining static and dynamic balance in adolescents with visual impairments (Häkkinnen, Holopainen, Kautianinen, Sillanpää, & Häkkinnen, 2006; Leonard, 1969; Ribadi et al., 1987) and no research correlating balance measures with self-efficacy related to balance in adolescents. The purpose of this study was to determine whether perceived confidence (self-efficacy) related to balance is related to actual balance in adolescents with visual impairments (blind and low vision). More specifically, the purposes of this study were to (a) examine and compare static and dynamic balance in adolescents across four groups, blind (B), low vision (LV), sighted (S), and sighted blindfolded (SB); (b) compare the perceived self-efficacy of balance across each group; and (c) examine the correlations between static and dynamic balance and self-efficacy of balance within each group.

Methods

Participants

A group of 44 adolescents (boys, n = 24; girls, n = 20) with and without visual impairments between the ages of 12 and 17 years (M = 14.05 years, SD = 1.63) participated in this study. The adolescents with visual impairments were categorized (total or legal blindness) according to the United States Association for Blind Athletes (USABA) sport classifications: Blind (B1s; 3 girls and 8 boys; M = 13.27 years, SD = 1.42 years) and low vision (B3s; 6 girls and 5 boys; M = 13.73 years, SD = 1.56 years). Nineteen of the 22 adolescents were congenitally blind. The onsets of the visual impairments for the other three participants were ages 4 months (LV), 16 months (B), and 5 years (LV). The sighted adolescents included 11 girls and 11 boys (M = 14.55 years, SD = 1.6 years) randomly broken into two groups, sighted (S) and sighted blindfolded (SB). These participants and their parents signed informed consent forms reviewed by the college’s institutional review board committee.

The participants with visual impairments in this study were recruited from a 1-week sports camp for children and adolescents with visual impairments, blindness, or deaf-blindness. Although they are not all on sports teams and do not typically participate in weekly sports, this is a limitation. The participants may perceive themselves to be “athletes” and therefore display better balance than a child who does not attend a sports camp and consider themselves athletes. The reason the researchers went to the sports camp for the study was to increase the sample size because children with visual impairments are considered a low-incidence population.

Equipment

An AMTI AccuGait Portable force platform (AMTI, Newton, MA) was used to measure the amount of postural motion in both the mediolateral (side to side) and anteroposterior (front to back) directions during the static conditions. Force plates are a common method of measuring postural stability (Cheng, Lee, & Su, 2003; Haibach, Slobounov, & Newell, 2008; Haibach, Slobounov, Slobounova, & Newell, 2007a, 2007b) and are a valid and reliable measure of balance (Cheng et al., 2003; Haibach et al., 2008). The force platform records the postural dynamics with three force components: the mediolateral force (Fx), anteroposterior force (Fy), and the vertical force (Fz). The force platform data were sampled at a rate of 100 Hz and the excitation voltage was set to 5 V. The raw data were filtered at a cutoff frequency of 20 Hz to reduce noise. The AMTI force platform was connected to a personal computer via a 16 bit analog-digital (A/D) conversion board.

A Lafayette Stability platform with digital control, model 16030 (refer to Figure 1), was used for two additional dynamic balance conditions. The stability platform has been found to be a reliable and valid measure of dynamic balance (J.F. Murray, 1982; Nashner, 1982). The stability platform has an angle measurement resolution of 1 degree and a platform tilt range of + 30 degrees. The output voltage was set at 5 volts and the analog output rate was 25 samples per second. The stability platform measured the movement time and provided an angle measurement of the platform tilt from a parallel position to the ground.

Procedures

The participants were tested during a 1-week sports camp for children with visual impairments. Before testing, a 17-question balance self-efficacy survey was read to each participant. The survey was adapted from two validated questionnaires, the Powell and Myers (1995) Balance Confidence Scale (ABC) and the Falls Efficacy Scale (FES). In this survey, participants rated their self-efficacy of...
balance using a Likert scale from 0 (no confidence) to 5 (complete confidence) on activities such as walking around the house, getting dressed, and walking on icy sidewalks. The self-efficacy questionnaire used in this study has been validated in older adults and for face and content validity by three professionals in the field for adolescents with visual impairments. The experts reviewing the items for this questionnaire were an adapted physical education specialist with expertise in visual impairment and two experts in motor control specializing in balance and postural control. Further validation is currently being conducted.

Participants completed four tasks on the force platform. The five COP measures were used for Conditions 1 to 4. For Condition 1, participants rotated their body in a circular direction leaning as far as possible by bending at the hip. If a step was initiated, the trial was aborted. This condition was performed to obtain the maximum stability boundary of each participant. The other three conditions measured static balance at various levels of difficulty. For Condition 2, low difficulty, participants were instructed to stand as still as possible on the force platform. Participants stood with a tandem stance, one foot in front of the other for Condition 3, moderate difficulty. For Condition 4, high difficulty, participants stood with one foot. The duration of each trial was 20 sec.

Participants completed two tasks on the Lafayette stability platform to assess dynamic stability. Verbal instruction and tactile modeling were used to help the participants with visual impairments understand the procedures for the stability platform. The tactile modeling allowed the participants to feel others completing the movement (O’Connell, Lieberman, & Petersen, 2006). All participants were instructed to hold the bar when stepping onto the stability platform and continue holding the bar until they felt comfortable with the apparatus and understood all movements. Participants with visual impairments were also physically assisted onto the stability platform. Prior to testing, all participants were given an opportunity to become comfortable with the task by moving the platform laterally with and without holding onto the bar. It was important for the participants to fully understand the protocol for reliable testing of their total balance capabilities.

For Condition 5, participants began with the stability platform tilted to one side such that the platform was touching the floor to their right side. At the onset of the beep, they were to move the platform to an angle of 0 degrees (parallel to the floor) as quickly as they could and hold it there for the duration of 30 sec. For Condition 6, participants began with the stability platform at 0 degrees. Following the beep, participants were instructed to tilt the platform to each side by leaning in each direction, continuously moving back and forth as quickly as possible for trial durations of 30 sec. Conditions 5 and 6 were completed three times each.

Data Analysis

Static and dynamic balance have often been assessed by reference to properties of the amount of motion of the COP (amplitude, velocity, acceleration properties), such that the degree of motion away from the equilibrium point is reflective of the degree of postural instability (Goldie, Bach, & Evans, 1989; M.P. Murray, Seirewg, & Sepic, 1975). COP represents the point of application of the ground reaction force (Enoka, 1988). Comparisons of COP measures were examined across each of the groups. The total deviation of COP and the COP area recorded by the force platform provide measures of the amount of postural motion (Benvenuti et al., 1999; Winter, 1987). Measures of COP included the COP area (total area of the COP), COP length (the total displacement of the COP in both x and y directions), COPy (COP in the anteroposterior direction), COPx (COP in the mediolateral direction), and COP velocity (the second derivative of COP position).

The amount of time required to bring the platform to zero degrees was analyzed during Condition 5.
Balance in Adolescents

from the stability platform and comparisons were made across groups. For the maximum motion condition (Condition 6), the number of lateral movements, individually and jointly, and the maximum and minimum angular excursions were analyzed.

Descriptive statistics (including means and standard deviations) and analysis of variance (ANOVA) of COP and the stability platform measures were computed. The dependent variables derived from these time series were placed independently in a two-way, Group 4 × Condition 4 ANOVA. Spearman’s correlation was used to examine the correlations between the balance measures and the balance self-efficacy scores. The statistical tests were set at a level of .05.

Results

Static and Dynamic Balance

The results of Condition 1, stability boundaries, the area of the stability region as indexed by the motion of the COP, revealed that LV and B had significantly smaller stability boundaries (refer to Figure 2b) than their age-matched controls, S and SB (ps < .05). For the stability boundary condition, significant main effects were found across groups for COPx, F(3, 84) = 4.37, p < .05; COP area, F(3, 84) = 10.15, p < .05; and COP velocity, F(3, 8) = 5.00, p < .05, but not for COPy or COP length (ps < .05). All of the COP measures were highly correlated (ps = .00) with one another, so only a few of the COP measures are discussed in detail. Tukey’s post hoc analyses revealed that both control groups had significantly greater COP area (ps > .05) in their stability boundary than LV and B. The majority of this additional COP area was in the mediolateral direction revealing that LV and B were much less able to lean in the sideways directions in comparison to the sighted participants.

During Conditions 2 to 4, where decreased motion reveals better balance, LV and B had significantly more postural motion (refer to Figure 2a) indicating that they are much less stable than their sighted peers. An interaction was found for COPy and COP length, F(9, 336) = 2.15, p < .05, and F(9, 336) = 2.15, p < .05, respectively. A main effect was also found for group and condition (ps < 0.05) for COPy and COP length. Tukey’s post hoc analyses revealed group differences. S exhibited the least amount of COP motion, and B exhibited the greatest amount of postural motion for both COPy and COP length (ps < 0.05), significantly more than LV, SB, and S. COPy ranged from a mean of 5.58 cm (B) to a mean of 1.55 cm (S) for the standing still with a comfortable stance condition. The differences were even greater for the tandem stance. Similar effects were found for the COP velocity, group effect, F(3, 335) = 2.83, p < .05, and group by condition interaction, F(9, 335) = 1.99, p < .05. There were no significant effects for COPx.

Dynamic balance was further assessed using a stability platform. There was a significant main effect for time to stabilize (refer to Figure 3a), with decreased time to stabilize indicating better postural control, across groups during the stability platform Condition 5, F(3, 126) = 4.13, p < .05. B and LV required significantly more time to stabilize the platform than either of the control groups. SB required significantly more time than S (ps < .05) to stabilize the platform with mean times of 3.7 sec and 2.3 sec, respectively. There was no significant difference between the B and LV requiring 5.65 sec and 5.19 sec, respectively. Participants did not improve across trials (ps > .05).

During Condition 6, maximum motion, S and SB displayed significantly more motion in both the left and right directions (refer to Figure 3b) than LV and B, F(3, 126) = 5.16, p < .05, F(3, 126) = 9.29, p < .05, respectively. Interestingly, there was no significant difference (ps > .05) for the number of lateral excursions from left to right across groups. Rather than move at a higher frequency, S and SB performed at a similar speed but produced larger amplitudes in both the left and right directions (refer to Figure 4).

Self-Efficacy of Balance

Prior to testing, balance self-efficacy assessments were conducted to compare each group’s perceived balance. It was expected that adolescents with visual impairments (both blind and low vision) would score lower on the balance self-efficacy questionnaire than the sighted adolescents. Although there was a trend for the sighted participants to rate themselves higher, there was no significant difference when all of the questions were averaged, F(3, 67) = 1.11, p = .351. B did, however, have much greater variability than the sighted participants. A couple of the participants in the B group gave two ratings for more difficult
tasks such as climbing stairs, one rating for with a guide and another rating for without a guide. The rating for without the guide was generally one to two points lower than with a guide.

Table 1 displays the descriptive statistics for the self-efficacy survey. A main effect was found for the questions, $F(16, 67) = 9.16, p < .05$. When all groups were averaged, self-efficacy scores were

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**Figure 2.** (A) COP motion in the anteroposterior direction for Conditions 2 to 4. (B) COP area for the stability boundaries for each group: blind, low vision, sighted, and sighted blindfolded (BF).
Figure 3. (A) Time to stabilize on the stability platform during Condition 5. (B) Maximum and minimum excursions during Condition 6.
lowest for walking on icy sidewalks ($M = 3.3$) and the most confident for walking around the house ($M = 5$). There were significant differences across groups for some of the questions on the more challenging tasks. B rated themselves lowest for the walk in crowd/bumped ($M = 3.09$), stand on chair to reach ($M = 3.18$), and walk on icy sidewalks ($M = 3.18$) questions, with several individual participants rating themselves as a zero. S rated themselves as a mean of 4.81 for walk in crowd/bumped, 3.72 for stand on chair to reach, and 3.55 for walk on icy sidewalks.

Correlations
The third purpose of this investigation was to examine the correlations between static and dynamic balance and self-efficacy of balance within each group. Although no significant correlations were found for the mean scores on the self-efficacy questionnaire ($ps > .05$), there were significant correlations for some of the questions regarding more challenging activities. Some of these findings include, walking in a crowd/bumped was negatively correlated ($r = -0.394, p < .01$) for COP area and near significance for COPy ($p = .053$) for the standing still condition, and standing on a chair was negatively correlated with COP length ($r = -0.359, p < .05$) and COPy ($r = -0.354, p < .05$) for the tandem stance, and walking on icy sidewalks was positively correlated with maximum motion on the stability platform ($r = 0.342, p < .05$). These results indicate that the participants are better able to perceive their balance capabilities during more challenging tasks, but may overestimate their abilities during tasks that appear less challenging.

Discussion
This study aimed to expand upon existing research on static and dynamic postural control in...
adolescents with and without visual impairments using a force platform and a stability platform. In addition to these assessments, this study examined balance self-efficacy in these participants and correlated this data with their balance performance. The results of the study support previous research on adolescents with and without visual impairments in that sighted adolescents exhibit better balance than adolescents who are blind or have low vision (Bouchard & Tetrault, 2000; Sparto et al., 2006); however, it did not support the findings that sighted blindfolded adolescents performed worse than the adolescents with visual impairments (Ribadi et al., 1987).

Adolescents with visual impairments produced smaller stability boundaries and displayed increased postural motion during quiet stance, tandem stance, and one-legged stance. To obtain stability boundaries, participants were instructed to lean as far as possible in all directions of the horizontal plane without losing stability. Reduced COP area during the stability boundary condition is an indication of reduced postural control. The results of this study found that the stability boundaries were significantly increased with vision and the experience of normal vision, as found by comparing SB with LV and B. The sighted groups were also better able to reduce their postural motion during the standing still conditions under various levels of difficulty, also indicating that the experience of vision assisted the participants in adapting to the challenging tasks when blindfolded. In addition to increased COP motion during Conditions 2 to 4, many of the participants with visual impairments heavily relied upon the use of the upper body in an effort to maintain stability.

Like previous research findings, clear and conclusive differences between the varying levels of visual impairments on static (Houwen et al., 2007; Houwen et al., 2008) and dynamic balance (Ribadi et al., 1987; Wyver & Livsey, 2003) were not found in the present study. When comparing the two groups of adolescents with visual impairments, low vision and blind, there were trends toward LV performing better than B, but significant differences were only found for some of the COP measures. No significant differences were found between the two groups with visual impairments for any of the stability platform measures.

For the dynamic balance tasks, both groups of adolescents with visual impairments required more time to reach a stable position (Condition 5) and did not produce as much angular platform tilt (Condition

Table 1. Descriptive Statistics for the Self-Efficacy Balance Ratings

<table>
<thead>
<tr>
<th>Activity</th>
<th>Sighted Mean</th>
<th>Sighted SD</th>
<th>Low Vision Mean</th>
<th>Low Vision SD</th>
<th>Blind Mean</th>
<th>Blind SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Walking around the house</td>
<td>5.00</td>
<td>0.00</td>
<td>5.00</td>
<td>0.00</td>
<td>5.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2. Up and down stairs</td>
<td>4.55</td>
<td>0.69</td>
<td>4.73</td>
<td>0.65</td>
<td>4.82</td>
<td>0.60</td>
</tr>
<tr>
<td>3. Pick up pencil from floor</td>
<td>4.55</td>
<td>0.93</td>
<td>4.23</td>
<td>0.88</td>
<td>4.73</td>
<td>0.90</td>
</tr>
<tr>
<td>4. Reach at eye level</td>
<td>4.55</td>
<td>0.69</td>
<td>4.64</td>
<td>0.36</td>
<td>4.45</td>
<td>1.03</td>
</tr>
<tr>
<td>5. Reach on tiptoes</td>
<td>4.64</td>
<td>0.50</td>
<td>4.36</td>
<td>0.92</td>
<td>3.82</td>
<td>1.83</td>
</tr>
<tr>
<td>6. Stand on chair to reach</td>
<td>4.82</td>
<td>0.40</td>
<td>3.64</td>
<td>1.75</td>
<td>3.18</td>
<td>2.22</td>
</tr>
<tr>
<td>7. Sweep the floor</td>
<td>4.55</td>
<td>0.82</td>
<td>3.55</td>
<td>1.81</td>
<td>4.09</td>
<td>1.51</td>
</tr>
<tr>
<td>8. Walk outside to nearby car</td>
<td>4.73</td>
<td>0.47</td>
<td>4.64</td>
<td>0.67</td>
<td>4.82</td>
<td>0.40</td>
</tr>
<tr>
<td>9. Get in/out of car</td>
<td>4.82</td>
<td>0.40</td>
<td>4.91</td>
<td>0.30</td>
<td>4.82</td>
<td>0.60</td>
</tr>
<tr>
<td>10. Walk across parking lot</td>
<td>4.82</td>
<td>0.40</td>
<td>4.41</td>
<td>0.86</td>
<td>3.73</td>
<td>1.95</td>
</tr>
<tr>
<td>11. Up and down ramp</td>
<td>4.82</td>
<td>0.40</td>
<td>4.82</td>
<td>0.60</td>
<td>4.73</td>
<td>0.90</td>
</tr>
<tr>
<td>12. Walk in crowd/bumped</td>
<td>3.73</td>
<td>1.01</td>
<td>3.82</td>
<td>0.98</td>
<td>3.09</td>
<td>2.02</td>
</tr>
<tr>
<td>13. Escalator holding rail</td>
<td>4.64</td>
<td>0.81</td>
<td>4.27</td>
<td>1.49</td>
<td>4.18</td>
<td>1.60</td>
</tr>
<tr>
<td>14. Escalator not holding rail</td>
<td>4.09</td>
<td>0.70</td>
<td>3.91</td>
<td>1.64</td>
<td>3.55</td>
<td>2.16</td>
</tr>
<tr>
<td>15. Walk on icy sidewalks</td>
<td>3.55</td>
<td>1.44</td>
<td>3.45</td>
<td>1.21</td>
<td>3.18</td>
<td>1.99</td>
</tr>
<tr>
<td>16. Dressing</td>
<td>4.91</td>
<td>0.30</td>
<td>5.00</td>
<td>0.00</td>
<td>4.82</td>
<td>0.60</td>
</tr>
<tr>
<td>17. Take a bath or shower</td>
<td>4.91</td>
<td>0.30</td>
<td>4.91</td>
<td>0.30</td>
<td>4.82</td>
<td>0.40</td>
</tr>
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</table>
6) while on the dynamic platform than adolescents with sight but did not significantly differ between one another. Of particular interest, the groups did not significantly differ on the frequency of lateral movements during the maximum motion condition but did significantly differ on the amplitude of motion. Through observation of the adolescents completing the dynamic stability tasks, it appeared that the adolescents with visual impairments were freezing their degrees of freedom (constraining their joints and limiting their movement) while oscillating on the stability platform in an effort to simplify the challenging task. The sighted adolescents likely utilized more degrees of freedom allowing for better postural control as exhibited by large platform tilts and high lateral oscillation frequency. Vereijken, van Emmerik, Whiting, and Newell (1992) found that when placing novices on a ski simulator, they initially oscillated with low amplitude and high frequency. After much practice, performers were able to increase their amplitude of motion while maintaining high frequency of oscillations. It is probable that with additional practice, the adolescents with visual impairments would release their degrees of freedom enabling them to increase their magnitude of motion, which would further indicate improvement in both balance and postural control.

Although a strong relationship between self-esteem and motor performance has been found (Holbrook & Koenig, 2007; Willoughby & Polatajko, 1995), in these investigations there were only a few significant correlations found for some of the self-efficacy questions and the balance measures. In general, adolescents have fairly accurate when rating their capability to perform an activity (Damon & Hart, 1982), but it is possible that the participants in this study had a higher self-efficacy related to balance due to their participation in a sports camp. These participants may have considered themselves as athletes, which could have caused them to increase their self-efficacy ratings. These results indicate that LV and B were quite confident in their balance, rating themselves at a 4 or 5 level on many of the less challenging activities. It is important to note, however, that there was greater variability in the balance self-efficacy responses for B than S or SB, revealing that more of the adolescents who were blind were less confident than the sighted adolescents. Significant differences were found depending on the types of questions, indicating that many participants were aware of reduced balance abilities during more challenging tasks. All groups rated their stability highest while walking around the house and lowest while riding an escalator not holding onto the rail and while walking on icy sidewalks.

In summary, vision and experience with vision were significant factors in all of the balance assessments but not the self-efficacy ratings. Vision conferred an advantage for the balance measures, as expected, but sighted blindfolded adolescents also performed better, an unexpected finding. It was expected that the experience without vision would provide the adolescents with low vision and blindness an advantage in performing the activities over the sighted blindfolded participants. The results, however, indicate the opposite, that the experience of vision assisted the participants in adapting to the challenging tasks when blindfolded. Although there were no significant effects for the self-efficacy ratings, it is important to evaluate individuals with visual impairments on a variety of tasks and in a variety of contexts, examining both motor performance and self-efficacy. A high self-efficacy of performance is an important indicator of an individual’s eagerness to engage in physical activities, both functionally and recreationally (Ray et al., 2007; Stuart et al., 2006; Vellas et al., 1997). Inactive adolescents are more likely to experience reductions in the maintenance of balance, which can make even functional activities difficult to perform. Self-reports of an individual’s own abilities in addition to movement assessments have been reported to increase the involvement of an individual’s treatments, which have been suggested to improve the effectiveness of the treatment (Berry & West, 1993). When evaluating overall motor function and competence, the most effective intervention is one in which involves the child or adolescent such as examining both balance self-efficacy and actual balance ability.

Acknowledgments

The authors would like to thank Dr. Leigh Little for his assistance with Matlab programming and all the children who participated in this study.

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Physical Therapy Approach to Falls in Adults with Visual Impairment

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Ralph R. Utzman, PhD
West Virginia University
Morgantown, WV

Abstract

Falls are multifactoral and identification of risk factors is crucial for successful management or prevention of future falls. A good patient interview, assessment of fear of falling, and evidence and performance-based measures can help identify individuals at risk and guide intervention strategies. This article presents known falls risks, the physiologic control mechanisms that allow one to maintain balance or postural stability, the clinical assessment of balance, and physical therapy interventions used to treat balance impairment and prevent future falls. An argument is made that multiple disciplines should share tools and expertise in order to address the problem of falls in older adults.

Keywords: functional assessment, balance interventions

Background and Clinical Significance

Falls are the leading cause of injury-related visits to emergency departments of hospitals in the United States and the primary etiology of accidental deaths in persons older than 65 years (Fuller, 2000). More than a third of adults aged 65 years or older fall each year (Hausdorff, Rios, & Edelber, 2001) with costly and devastating physical, psychological, and social consequences (Stevens, Corso, Finkelstein, & Miller, 2006). For many older adults, falls are the primary cause for loss of independent living and development of fear that then results in limitation of physical activity or loss of social contact (Cumming, Salkeld, Thomas, & Szonyi, 2000).

Falls Risks

The cause of falling is multifactorial and consists of both intrinsic and extrinsic risk factors. Intrinsic risk factors include age-related or disease-induced physiologic impairments including visual loss and perceptual/cognitive impairments. Extrinsic risk factors include the use of multiple medications and environmental hazards (Rao, 2005; Tinetti, Speechley, & Ginter, 1988). Tinetti et al. reported an increase in falls risk from 8 percent to 78 percent when the number of preexisting risk factors increased from zero to four or more. The risk of being seriously injured in a fall increases with age (Stevens et al., 2006). Rates of falls injuries for adults 85 and older are four to five times that of adults aged 65 to 74. Furthermore, nearly 85 percent of deaths from falls are among those 75 years of age or older. Individuals 75 or older who fall are four to five times more likely to be admitted to a long-term care facility for a year or longer (Donald & Bulpitt, 1999; Stevens, Ryan, & Kresnow, 2006). Previous falls (Shumway-Cook, Baldwin, Polissar, & Gruber, 1997; Sai, Gallagher, Smith, & Logsdon,
and fear of falling (Boyd & Stevens, 2009) are strong predictors of subsequent falls. Also, a decrease in physical activity is associated with an increased falls risk (Deshpande et al. 2008; Kruger, Ham, & Sanker, 2008), and, conversely, an increase in physical activity is associated with a decreased falls risk (Ekwall, Lindberg, & Magnusson, 2009; Stevens, Powell, Smith, Wingo, & Sattin, 1997). Therefore, it is imperative to include an assessment of fear of falling when addressing physical activity in older adults.

Impaired vision is a significant and independent risk factor for falls. Reduced ability to detect low contrast hazards, judge distances, and perceive spatial relationships appear to be important for maintaining balance and detecting and avoiding hazards in the environment (Lord & Dayhew, 2001). Multifocal glasses may add to the risk of falls because in older people near-vision lenses impair distance contrast sensitivity and depth perception in the lower visual field, reducing their ability to detect environmental hazards (Lord, Dayhew, & Howland, 2002). Because the ophthalmologist or optometrist is likely to be the health care provider who first obtains information about visual function, these professionals should be aware of association with falls risk and be able to perform further assessment or refer to a physical therapist. Alternatively, orientation and mobility specialists (O&Ms) or certified vision rehabilitation therapists (cVRTs) may serve as valuable members of the team in assimilation of information about vision and falls risk and be able to perform further assessment or refer to a physical therapist. Approximately half of all falls happen at home and are related to home hazards. Home hazard assessments need to be accompanied by education, facilitation of modifications, and follow-up or they are doomed to fail (Nikolaus & Bauch, 2003; Sleet, Moffett, & Stevens, 2008). Older adults are often resistant to changes made in their home, but simple techniques like using liquid soap and a shower seat can help prevent falls. Poor lighting, sidewalk conditions, traffic, and adverse weather are risk factors outside the home. Use of antislip devices on shoes may be recommended as well as longer crosswalk times (Berggard & Johansson, 2010). Older adults should be made aware of who to contact in the local public works department to have their sidewalks and crosswalks updated and maintained. Once the older adult with heightened falls risk is identified, health care providers and public health officials and city or county infrastructure staff have to be ready to intervene. External and internal risk factors that are modifiable need to be addressed (Tables 1 and 2).

Balance and Postural Control

The science of motor control has been defined as the study of postures, movements, and the mind–body functions that govern them (Brooks, 1986). Shumway-Cook and Woollacott (1995) define postural control as the ability to maintain the body’s position in space for orientation and stability. These authors define postural orientation as the ability to sustain body part alignment sufficient for interaction with the environment and postural stability, equated with the terms balance or equilibrium, as the ability to maintain position of the body’s center of mass over the base of support. Motor control science views postural control as the product of integration of many neural components, including sensory and motor processes, internal representations of sensory maps, and high-level processes that allow for anticipatory and adaptive adjustments (Shumway-Cook & Woollacott, 1995). We use the term balance when specifically referring to the ability to maintain the body over the base of support and postural control when referring to the complex processes that interact to allow for function in orientation and stability.
Much of the programming involved in the postural task system is believed to be carried out at the middle level of the central nervous system, which includes the motor cortex, brain stem, and putamen circuit of the basal ganglia. Contribution of these areas to postural control is largely known from studies of individuals with damage to these areas, such as in the case of basal ganglia damage in Parkinson’s disease. It is hypothesized that the middle level of the motor system is involved with tactical planning of movements, giving particular specifications in space and time for practical execution with kinematic output (Brooks, 1986).

In all models of postural control, the role of sensory input is considered to be integrally linked to the production of motor output through complex programs that underlie the simple act of quiet standing (Peterka, 2002). Sensory inputs that are key contributors to the postural task system are well known through studies of individuals with system dysfunction as well as through studies involving manipulation or distortion of sensory inputs. The sensory systems thus identified are the vestibular system, joint proprioceptors sensitive to joint torque and angle, plantar pressure sensors, and vision (Maurer, Mergner, & Peterka, 2006). In addition to processing sensory input, the nervous system is capable of reweighting input over various sensory channels when stimulus amplitude is altered over any given channel (Peterka, 2002). This process of adaptation allows the individual to maintain balance even when sensory input is diminished, absent, or altered.

It is well known that vision plays an important role in postural stability. Sozzi, Monti, De Nunzio, Do, and Schieppati (2010) referred to a “necessary coupling” between vision, postural reference, and postural muscle activity. Furthermore, there are developmental changes in this relationship across the lifespan. Evidence from moving room experiments suggests that vision plays a particularly important role in the development of postural strategies, perhaps because visual inputs map muscular actions in the central nervous system earlier than the other sensory systems (Shumway-Cook & Woollacott, 1995). When sighted children younger than the age of 7 were deprived of both visual and somatosensory inputs, therefore relying on vestibular input alone, they were

<table>
<thead>
<tr>
<th>Table 1. Addressing Modifiable Extrinsic Fall Risk Factors</th>
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<tbody>
<tr>
<td>All rooms, hallways: Remove clutter, throw rugs, and potentially dangerous extension cords; install adequate lighting</td>
</tr>
<tr>
<td>Stairs: Secure handrails and mark steps edges with tape</td>
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<tr>
<td>Bedroom and hallways: Install night and motion sensor lights</td>
</tr>
<tr>
<td>Bath: Install grab bars and nonslip materials in bathroom shower or tub; use shower seat</td>
</tr>
<tr>
<td>Kitchen: Rearrange kitchen shelves; use low gloss wax on floors</td>
</tr>
<tr>
<td>Outdoors: Use motion sensor lighting; keep sidewalks clean; solicit public works as needed for repair of sidewalks, crosswalks, and so forth</td>
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<tr>
<td>Monitor location of pets</td>
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<tr>
<td>Encourage use of chairs with arm rests</td>
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<tr>
<td>Avoid clothing hazards such as pants that are too long or unsafe shoes</td>
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<tr>
<td>Engage in frequent checks of medicines to avoid polypharmacy</td>
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<tr>
<th>Table 2. Addressing Modifiable Intrinsic Fall Risk Factors</th>
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<tr>
<td>Monitor blood pressure and blood glucose</td>
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<tr>
<td>Maximize treatment for degenerative joint disease and neuropathy</td>
</tr>
<tr>
<td>Maximize vision including frequent exams and maintaining clean eyeglasses</td>
</tr>
<tr>
<td>Maximize ear health—hearing aids, removal of excess ear wax</td>
</tr>
<tr>
<td>Avoid abrupt changes in position, allow for extra time when changing positions</td>
</tr>
<tr>
<td>Use appropriate assistive device for ambulation</td>
</tr>
<tr>
<td>Use adaptive equipment for activities of daily living</td>
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</table>

Physical Therapy Prevention of Falls

1. Addressing Modifiable Extrinsic Fall Risk Factors

2. Addressing Modifiable Intrinsic Fall Risk Factors
unable to maintain balance (Woollacott & Shumway-Cook, 1990). With aging, there are many changes in the sensory systems underlying balance, such as loss of vestibular neurons. Like young children, healthy older adults seem to be able to compensate for sensory loss over one channel of input but cannot compensate effectively when two sensory inputs are lost or distorted (Woollacott & Shumway-Cook, 1990). There are many conditions that affect vision in the relatively healthy older adult due to changes in the structure and reactivity of the eye. These conditions affect the postural task program. Paulus, Straube, and Brandt (1984) found that when visual acuity was decreased logarithmically, a linearly increased postural instability was evident, especially in forward/backward displacement. Even in the absence of disease, age-related changes in sensory systems may cause disruptions to the postural task program that result in falls.

**Evidence- and Performance-Based Measures of Balance and Postural Control**

The clinical assessment of balance is used to measure the integrity of the postural stability system. The goals of testing are to identify individuals who are at risk for falling, assess the deficient components of the system, and develop interventions based on the findings. Assessments utilizing a task oriented approach can examine postural control at three levels including functional skills; sensory and motor strategies; and underlying sensory, motor, and cognitive impairments (Shumway-Cook & Woollacott, 1995).

Some of the functional tests are relatively simple. For example, assessing the number of seconds that an individual can maintain single leg or tandem stance is a quick check of ability to maintain postural stability when the base of support is narrow. The Functional Reach Test is a quick screen for balance problems in older adults (Duncan, Weiner, Chandler, & Stidenski, 1990). To perform this test, a yardstick is placed horizontally at shoulder height. Without taking a step, the individual is asked to reach forward as far as possible with the shoulder flexed to 90 degrees. Scores of 10 in. or more are associated with adequate functional balance and scores less than 6 or 7 indicate limited balance. Muir, Berg, Chasworth, Klar, and Speechley (2010) found that self-report of balance problems, forward reach, and single limb support were independent predictors of any fall in the 12 months after the older individuals in their study were tested.

The Timed Up and Go (TUG) test (Podsiadlo & Richardson, 1991) involves measuring the time in seconds it takes an individual to stand from a chair with arm rests, walk 3 m, turn around, return to the chair, and sit down again. Bohannon (2006) reported meta-analyses of 21 studies concluding that TUG scores were indicative of balance problems if they exceeded 9 sec for people in their 60s, 10.2 sec for people in their 70s, and 12.7 sec for individuals 80 to 89 years of age. Shumway-Cook, Brauer, and Woollacott (2000) reported that the TUG demonstrated sensitivity and specificity in identifying community-dwelling adults at risk for falls.

One of the most widely used tests of balance is the Berg Balance Scale (Berg, Wood-Dauphinee, Williams, & Maki, 1992). The scale consists of 14 items or tasks that are scored on a scale from 0 to 4 for a maximum score of 56 points. Examples of task items range from sitting unsupported to picking something up from the floor to taking a step. Scores of less than 46 indicate a significant falls risk. The Berg Balance Scale has been shown to have good predictive validity, particularly for multiple falls in community-dwelling older individuals (Muir, Berg, Chasworth, & Speechley, 2008).

The Activities-Specific Balance Confidence (ABC) scale is a 16-item questionnaire developed to assess an older individual’s fear of falling with 100 percent score indicating the most confident while performing activities of daily living (ADLs; Powell & Myers, 1995). Lajoie and Gallagher (2004) found an ABC cut-off score of 67 percent was a reliable means of predicting a future fall, with specificity and sensitivity of 87.5 percent and 84 percent, respectively.

Analysis of walking, or gait, has long been viewed as lending insight into balance. A simple analysis of gait commonly used by therapists is a 6-min walk test (6MW), in which the individual is instructed to walk for 6 min and the therapist records the distance walked. The 6MW test has been found to show high test–retest reliability (.95–.97) and to reflect age related decline in walking, as did tests of balance, such as the Berg and TUG (Steffan, Hacker, &
Mollinger, 2002). The Functional Gait Assessment (FGA) is a second-generation assessment built from its precursor, the Dynamic Gait Index (DGI), which eliminates the ceiling effect seen in the DGI (Wrisley & Kumar, 2010). The FGA consists of 10 items scored from 0 to 3, with a possible total score of 30. A cut-off score of 22 is considered to identify individuals at risk for falls. The items include walking under normal, fast, and slow conditions; walking backward; and stepping over obstacles. It has been found to have interrater reliability of 86.6 and to correlate with other tests such as the Berg and TUG (Wrisley & Kumar, 2010).

The tests discussed to this point assess only the functional “product” of central processing known as “balance,” without specific attention to input (sensory) or output (neuromusculoskeletal response). They have been normed on population samples without specific visual impairment; however, as mentioned throughout this article, any tests normed on older adults are likely to capture those with deficits in visual acuity and contrast sensitivity, without a specific diagnosis of visual impairment. Tests that target sensory-motor strategies underlying balance can be conceptually summarized by the Clinical Test of Sensory Interaction and Balance (CTSIB). Shumway-Cook and Horak (1986) described the CTSIB as an assessment of the individual's ability to generate effective balance strategies for 30 sec in the presence of varying visual and surface conditions. Visual conditions include eyes open, eyes closed, and visual distortion using a “dome” or Japanese lantern painted inside with vertical stripes. Surface conditions include standing on a normal firm surface and standing on a piece of medium-density foam. Individuals who demonstrate increased postural sway or fall when on a foam surface are said to be surface dependent. Individuals who sway or fall in the visual distortion or occlusion conditions are said to be visually dependent. Individuals who have difficulty balancing when on the foam surface or when vision is distorted on a firm surface are said to have a sensory selection deficit, demonstrating inability to adapt to distorted or diminished sensory input (Shumway-Cook & Woollacott, 1995). The CTSIB was the basis for the development of computerized dynamic posturography. In dynamic posturography, the individual stands on a fixed or tilted force plate, comprising the surface conditions. Visual conditions for distortion are created mechanically through a panel that surrounds the individual. This assessment tool is expensive and available in clinics that treat a large number of patients with balance impairment. Computerized dynamic posturography permits extensive assessment of balance, including not only sensory organization but also limits of stability. Buatois, Gueguen, Gauchard, Benetos, and Perrin (2006) found posturography, especially the Sensory Organization Test (SOT) in conflicting conditions, was better than other clinical measures in predicting recurrent falls in noninstitutionalized elders older than the age of 65.

All of the tests discussed previously have been shown to have utility in identifying individuals at risk for falls. It is important to include tasks of sufficient complexity so that a ceiling effect is limited and the probability of finding subtle indicators of falls is enhanced. However, some of the tests discussed are extremely simple and quick to administer and could easily be performed by O&M or cVRT professionals. For example, in the study by Muir et al. (2010), the three tests found to be reliable predictors of falls (self-report, forward reach, and time in single limb stance) could be easily administered by vision experts without need for additional training. A high falls risk could be an indicator for referral to physical therapy. Conversely, physical therapists assessing balance should arguably include a quick assessment of visual acuity using a Snellen chart (Abdelhafiz & Austin, 2003). This would encourage referral to vision specialists for intervention for problems with reversible causes, such as correctable refractive errors and cataracts. The Activities of Daily Vision Scale (ADVS) is a 20-item, 5-dimension questionnaire that has been shown to be a useful tool to assess falls risk in the outpatient setting (Kamel, Guro-Razuman, & Shareeff, 2000). It has been criticized for primary focus on cataract outcomes; however, because cataracts are a reversible and common factor related to falls (Black & Wood, 2005), this scale or others like it may be a useful addition to the assessment of falls risk by physical therapists.

Physical Therapy Interventions

It has been well documented that physical therapy interventions can positively influence several modifiable risk factors for falls, including impairments in...
balance, gait, and muscle strength (Miller, Magel, & Hayes, 2010). When initiating care for an older adult with a history or risk of falls, a physical therapist will perform a detailed history and examination. The history should include detailed information on the frequency and circumstances of falls as well as the intrinsic and extrinsic risk factors. The physical therapist will then select and administer performance-based functional measures of the patient’s gait and balance, such as those outlined previously. The physical therapist will also test for impairments in strength, flexibility, and endurance as indicated.

From the findings of the history and examination, the physical therapist develops an evidence-based plan of care to reduce the patient’s risk of falling. The plan of care will be individualized to the patient’s impairments, environment, goals, and level of activity and participation. Common interventions used for patients at risk for falls include functional training (including environmental assessment and modification), fitting for adaptive equipment (such as walking aids or orthotic devices), and therapeutic exercise (American Physical Therapy Association, 2003). Therapeutic exercise includes activities aimed at improving balance, gait, strength, flexibility, and endurance.

Exercise has been found to be beneficial for reducing falls risks in community-dwelling older adults. In a randomized trial by Steadman, Donaldson, and Karla (2003), participants who participated in a gait training program improved their falls risk. Participants who participated in gait training plus additional balance exercises not only had reduced falls risk but also improved in their confidence in walking indoors and out. Beling and Roller (2009) enrolled participants in a 12-week therapy program that included balance, gait, strengthening, and flexibility exercises in addition to home assessment and modification. Participants improved in their gait pattern, gait speed, TUG scores, and risk of falls.

Hess and Woollacott (2005) found that participants who participated in a 10-week strength training program improved their ABC, TUG, and Berg scores compared with a control group. Other studies have supported the inclusion of strengthening and flexibility exercises to improve functional performance and reduce falls risks (Means, Rodell, & O’Sullivan, 2005; Miller et al., 2010).

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Evidence suggests that exercise programs tailored to the patient’s specific impairments are more effective than general exercise approaches (Brown, 1999; Nitz & Choy, 2004). Shimada, Uchiyama, and Kakurai (2003) found that frail older adults who performed exercise focused on balance tended to improve in static postural control, while participants who performed gait exercises improved in their performance of dynamic gait tasks.

Compliance and participation in the prescribed exercise program is important for success. Shumway-Cook, Gruber, Baldwin, and Liao (1997) studied participants who participated regularly in a physical therapist–prescribed exercise program for 10 to 12 weeks. Compared with participants who participated sporadically for 4 weeks or less, participants who completed the program of strengthening, gait, and balance exercises had significantly improved scores on the Tinetti Performance-Oriented Mobility Assessment and DGI.

The intervention studies cited above included community-dwelling older adults; studies specifically addressing physical therapy interventions for falls in older adults with visual impairment are scarce. A study by Campbell et al. (2005) compared the effects of a standardized exercise program to home safety assessment and modification for adults 75 and older with severe visual impairments. The exercise program consisted of five visits from a physical therapist who taught the standardized exercises consisting of strengthening and walking. The participants were instructed to continue the exercises at home independently three times weekly for 1 year with periodic follow-up from the physical therapist by phone. The group who received home safety assessment and modification had a reduced frequency of falls, while the exercise group had more falls. The authors reported, however, that adherence to the exercise program was poor. Among those who participated regularly in the exercise program, falls rates were reduced by 77 percent. The authors concluded that the standardized exercise program may have been too difficult for this group of relatively frail older adults. Therefore, more study is necessary to identify ways to improve exercise adherence in this population. Physical therapists should collaborate with patients, their families, and other members of the health care team to develop safe, effective interventions for patients who are at risk for falls.
Physical Therapy Prevention of Falls

Summary

This article summarizes falls risks, postural control needed for the prevention of loss of balance, the clinical assessment of balance, and physical therapy interventions used to prevent falls. Given the personal pain and suffering and societal cost associated with falls, it is extremely important that a multidisciplinary perspective be applied to the problem so that identification of individuals at risk for falls may occur at diverse points of contact with health care providers. Such an approach ensures that individuals have access to appropriate cost-effective interventions that can reduce falls and minimize their devastating impact.

References


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Focus on Falls Prevention: A Quality Improvement Initiative

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Abstract

Vision loss is known to be directly related to the ageing process and has profound consequences for the independence of seniors. Causes of vision deficits in seniors, such as cataracts and refractive errors, are correctable and have been found to be associated with falls and fractures. Yet, minimal attention has been directed toward developing policy and services to address any possible association between vision and mobility. A falls prevention pilot initiative was undertaken over a 4-year period to provide vision care services to residents in long term care facilities in a major Canadian city. Vision care services included: vision screening, on-site optometry services, appropriate eye care referrals; facilitation of vision intervention(s); vision education; and vision intervention follow-up. Available data revealed substantial reductions in the number of falls and fractures in the participating facilities. In 2010, the project became a permanent program, making vision screening part of the falls prevention policy in a major regional health authority.

Keywords: residents, long term care, ageing, visual deficits, falls, fractures

Introduction

Decline in visual acuity is a progressive change that occurs with age (Houde & Huff, 2003). Muzychka (2009) indicates that vision loss triples after 75 years of age. Visual deficits contributing to vision loss in seniors include cataracts, refractive errors, macular degeneration, glaucoma, and diabetic retinopathy (Stuen & Faye, 2003). The prevalence of vision loss is expected to increase substantially as the population ages. Residents of long-term care (LTC) facilities are particularly vulnerable to visual deficits and lack access to vision care services. This population group has a substantially higher prevalence of blindness and vision impairment, ranging from 3 to 15 times greater than their community-dwelling counterparts (DeWinter, Honyng, Froeling, Meulendijks, & Van der Wilt, 2004; Evans & Rowlands, 2004). Seniors with vision loss enter LTC facilities 3 years earlier than those with normal vision.

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vision, have twice as many falls, and are four times more likely to fracture a hip (Canadian Association of Optometrists, 2007; Ham, Sloane, Warshaw, Bernard, & Flaherty, 2007).

Vision deficits can have profound consequences for seniors who may already be experiencing the effects of other chronic illnesses and aging changes. Falls, fractures, depression, social isolation, behavioral changes, and cognitive impairment are a few of the serious outcomes of uncorrected visual impairment (Berger & Porell, 2008; La Grow, Robertson, Campbell, Clarke, & Kerse, 2006; Rogers & Langa, 2010). Falls and fractures are of particular concern because of their severe impact on the individual’s independence and long-term health. Research, policy, and clinical intervention initiatives have tended not to link vision with falls, associated fractures, and other injuries.

Background

The lack of vision care services in the LTC setting is a global issue. Research conducted in Australia (Carnicelli, 2001), Iran (Ghodsi, Roudsari, Abdollahi, & Shadman, 2003), Great Britain (Ivers, Cumming, Mitchell, & Peduto, 2002), United States (Harwood, 2001), China (Ip, Leung, & Mak, 2000), and Canada (Johnson, 2000), indicate this lack of attention to vision care. Hawranik and Bell (2007) surveyed 28 nursing homes in Winnipeg, Manitoba and 45 in Aberdeen, Scotland to determine the nature of their vision care services and fall and fracture data collection methodologies. Only six facilities in Winnipeg and one in Aberdeen indicated they had either a policy or procedure on vision care services. In terms of falls and fracture data, medical records revealed inconsistent recording and different methods of reporting the information, despite reporting standards.

Vision loss is among the most costly of chronic diseases in Canada. Ranking fourth in prevalence among diagnostic categories, it poses a greater burden in direct and indirect costs than respiratory diseases, diabetes, and mental disorders. In terms of direct health-related costs, vision loss ranks higher than any disease category in Canada (Muzychka, 2009). Falls-related hip fractures in seniors are higher in persons with visual impairment (American Geriatrics Society, British Geriatrics Society, & American Academy of Orthopaedic Surgeons Panel on Falls, Prevention, 2001; Brannan et al. 2003). Hip fractures can have devastating effects on the individual’s quality of life, length of survival, and costs to the health care system (Canadian National Institute for the Blind, 2006; Ioannidis et al., 2009; Kannus & Khan, 2001; Muzychka, 2009). Falls are the leading cause of injury-related hospitalizations among seniors. They are also the cause of most hip fractures among seniors, with 20 percent of those who sustained a hip fracture dying within a year of the fracture (Public Health Agency of Canada, 2005). Within Manitoba, falls among seniors accounted for more than $164 million in health care spending (Manitoba Health and Healthy Living, 2007).

Remarkably, a number of visual deficits in seniors are correctable and treatable. In developed countries, between 7 and 34 percent of seniors have vision impairment that could be treated by corrective lenses (Evans & Rowlands, 2004; Wang, Foran, & Mitchell, 2000). A randomized control trial found that expedited cataract surgery was instrumental in preventing falls and fractures in women 70 years and older (Harwood et al. 2005).

Despite the knowledge that many visual deficits can be corrected and treated, that vision is a key factor affecting independence, and that visual deficits may be responsible for a substantial number of falls and fractures, minimal attention has been paid to addressing an association between vision impairment and falls and fractures. The findings from the National Coalition for Vision Health (Muzychka, 2009) illustrated a lack of national standards, an inconsistency in available services, a lack of awareness of vision-care issues, and a continuing fragmentation of vision care from policy to delivery. The report emphasized that greater research and clinical initiatives are needed to provide evidence on the impact of visual impairment on falls and fractures, and on the costs associated with hospitalization and morbidity.

This paper describes a vision care project implemented in a number of long-term care facilities in one major Canadian city. Data on the prevalence of falls and fractures and a number of quality of life indicators were collected during the project and are reported.

Current Situation

Canada does not have any national policy standards to govern vision care, except for cataract
surgery wait times. Clinical guidelines exist nationally, but there are no national or provincial standards. The Canadian Association for Optometrists recommends yearly eye examinations for persons over the age of 65. However, the College of Physicians and Surgeons of Manitoba does not provide specific guidelines to physicians with respect to vision examinations of residents who reside in the LTC setting (Canadian Association of Optometrists, 2007).

Currently, individuals over the age of 65 in the Province of Manitoba are entitled to biannual vision examinations by an optometrist with costs of the examination and prescription lenses partially covered by provincial health insurance (Province of Manitoba, 2003). Vision care services are usually located outside the LTC facility; visiting optometrists in facilities are a rarity. The resident in the facility must initiate the appointment themselves or rely on a family member or friend to make an appointment, obtain transportation, and arrange for the necessary treatment and follow up. In the majority of cases, the resident does not have the physical or cognitive capacity or ability to perform these activities.

**The Focus on Falls Prevention Project: 2006–2010**

The Focus on Falls Prevention Project (FOF) was initiated in 2006 at Misericordia Health Centre (MHC), a facility housing the Eye Care Centre of Excellence, the largest comprehensive surgical and treatment eye care centre in Western Canada. The ophthalmology program has over 20 surgical ophthalmologists who assess and treat 24,000 patients and perform more than 8,000 surgeries annually, 500 on an emergency basis. MHC also has a LTC program with 145 Geriatric Interim beds and 100 personal care home beds. It is important to note that, at the inception of FOF in 2006, residents in the LTC program at MHC did not have access to the Eye Care Centre of Excellence vision care services.

**Year I: 2006**

In collaboration with Manitoba Health, MHC developed the FOF project to address the lack of vision care services in LTC and support one of the strategies for the provincial falls prevention plan. The primary goal in 2006 was to provide on-site vision care services to residents who resided in the LTC program at MHC.

The purposes of the project were to: (a) address the lack of access to vision care services in LTC; (b) improve the quality of life and safety for residents; and (c) provide preliminary evidence that improving vision in this population group may have a positive impact on the prevalence of falls and fractures.

For this project “vision care services” was defined as: on-site vision screening with a reliable vision-screening tool; on-site optometry services; referral to eye care specialists if indicated; facilitation of residents to receive the recommended vision intervention(s); vision education for residents, families and staff; and vision intervention follow-up.

**Vision Screening**

The vision screening kit was adapted with permission from the Centre of Eye Research Australia (CERA), to meet North American vision assessment conversions. Carnicelli (2001), project coordinator for the Australian study, found the vision-screening tool to be highly reliable. The vision screening kit includes an instruction booklet with a referral algorithm, vision test and history forms, a pinhole mask, and vision cards for matching purposes and distance- and near-vision testing. The referral algorithm provides direction for referral to: an optometrist, ophthalmologist, or general practitioner, or for vision screening in 1 year. The tool is useful for seniors with speech, cognitive and motor impairments, those who are not fluent in English, and in some cases, those who have advanced levels of dementia.

An executive lead (0.1 FTE), a vision screening nurse (0.4 FTE) and optometrist (0.15 FTE) positions were established to implement FOF. Portable optometry equipment was obtained to provide on-site optometry services.

The 10-minute vision screening was conducted by the nurse in the resident’s room. The on-site optometrist then examined the resident and, if warranted, referred appropriately. The purpose of having both the nurse and the optometrist independently test the resident’s vision was to determine the reliability of the tool by comparing the results of the nurse’s screening with the results of the optometrist. A research study accompanied this project, in which the reliability and validity of the tool was measured, as well as pre- and post-effects of the vision care
services on quality of life indicators and falls and fractures prevalence (Hawranik & Bell, 2009).

All residents in the LTC program at the facility had equal opportunity to participate in FOF due to two criteria: being 65 years or older and being a resident at the facility. FOF staff arranged for referrals; provided education to staff, residents, and families on the specific visual deficit; arranged transportation to the eye care specialist; and scheduled recommended interventions with appropriate follow-up.

Interventions were conducted in a timely manner and included: cataract surgery, new eyeglass prescriptions, prescription eye drops, photodynamic therapy, Avastin or Lucentis therapy, and referrals to the Canadian National Institute for the Blind (CNIB) for magnifiers and lighting devices. Residents participated in the provincial cataract wait-list strategy, and all vision interventions were performed prior to the end of the first year of the project. Costs for optometry assessments, drops, transportation and follow-up were included in the project. Cataract surgery is covered by Manitoba Health and new prescription lenses are the responsibility of the resident, using the Manitoba Health vision care exemption. Some residents were on a limited budget and costs for interventions were accommodated by the project when necessary.

Education of staff, residents, and families was on an as-needed basis. Due to time restrictions, budget restraints, and deliverables set out by government, extensive education needs were not met in the first year of the project.

**Outcomes**

Several health professionals were trained on the use of the vision-screening tool and over 200 residents were vision screened. While over 50 percent of participants were referred for some form of vision intervention, not all followed through with the intervention due to various factors, such as fear, cost, and not believing it would be beneficial. Residents who were not referred either refused the recommended referral or their vision loss was too advanced to correct or treat. Further, a small number of residents were already being assessed and followed up by their eye care specialist in the community. In Manitoba, falls are measured per 1,000 resident days. The following graph demonstrates the decrease in falls during the study period of the project (Figure 1).

Injuries from falls decreased during the first year of the project from 72 minor injuries (consisting of bruises and skin lacerations) and 19 major injuries (including fractures), to 52 minor injuries and 10 major injuries at the end of the first year. Quality of life indicators were measured by pre- and post-vision intervention survey discussions with the residents and families. Post intervention participant comments included the following:

I’ve had macular degeneration for years and they told me that nothing could be done. This program referred me to the CNIB and now I have a lit magnifier and I can at least see some things. All I wanted was to see a little more light before I died. Thank you.

One resident who received new prescription glasses commented to the health care aide when he first put them on, “so, that’s what you look like.” Another participant who received bilateral cataract surgery began making sandwiches for an inner city community near MHC. His family was astounded at how he went from sitting in his room in his wheelchair to walking with his walker to attend recreation events on the unit. Comments from other participants included simple messages of “thank you for taking care of my eyesight,” “I feel so good that someone is thinking about my vision,” and “I haven’t had my eyes checked in years!”

**Year II: 2007–2008**

Year II included continuing vision care services at MHC and expanding to nine other LTC facilities in the Winnipeg Regional Health Authority (WRHA). Resident inclusion criteria remained the same, as well as

![Figure 1. Falls per 1,000 resident days at the main facility during 3 years.](image-url)
reasons for referrals. Over 200 residents were screened, with over half of these residents referred for some type of eye intervention. Follow-up of the residents became the responsibility of the staff in the individual facility rather than by the original FOF staff.

Statistics were difficult to obtain due to the lack of resources associated with the funding of FOF. Some of the LTC facilities built vision screening into their admission assessments, while others stopped using the vision-screening tool after scheduled clinics stopped. The mandate from government was to move into as many LTC facilities in the province as possible in order to have more residents assessed. Sites that adopted vision screening in their admission process displayed a decrease in falls and associated fractures, and obtained similar quality of life comments from residents and families as in year 1 of the project.

Year III: 2008–2009

Funding allowed vision care services to become available in an additional ten LTC facilities in the WRHA, and to train staff in other health regions in Manitoba. FOF also trained professionals in another province to introduce vision screening into their falls prevention initiative. FOF hired an assistant for a term position to perform a retrospective chart review at the LTC facilities who participated in 2007–2008. Findings indicated that facilities that maintained vision screening and record keeping demonstrated a decrease in falls and fractures and an increase in quality of life for residents. One facility in another region in Manitoba saw a 76 percent decrease in falls since implementing the FOF vision-screening tool and referral mechanism.

Years IV and V: 2009–2010

Funding allowed for the expansion of FOF into other regions in Manitoba and enhancement of the educational component. In 2010, FOF became a fully funded program, highlighting vision screening as a recommendation in the Falls Prevention Clinical Practice Guidelines developed by the regional health authority for LTC, acute care, and community sectors. Permanent funding has contributed to an additional 0.2 FTE nurse position and the development of a strategic plan, which includes a data collection and analysis system.

Discussion

Over each of the years and in each of the participating facilities, a trend of decreasing falls and fractures was observed and/or documented by the facilities. A causal relationship between FOF and falls and fractures cannot be concluded; however, the consistent reduction in falls and fractures that accompanied FOF has provided promising evidence to explore in greater depth whether or not a relationship exists. The tool and the screening process proved to be a positive and practical approach. To date, over 900 residents have received on-site vision care services. After the first year, interest in FOF increased substantially, resulting in Manitoba Health committing continuing funding as well as a number of the health regions in Manitoba requesting involvement. Interest was also garnered from educational programs for health professionals. University of Manitoba nursing students participated in FOF by vision screening and developing educational pamphlets as both a project and curriculum requirement.

One of the major limitations was the year-to-year funding model. There were 2 months at the beginning of each fiscal year when funding was in jeopardy and vision screening and optometry clinics had to halt. Permanent funding now allows FOF to move in a solid strategic direction and to plan an efficient and effective methodology to expand the program throughout the province. Lack of resources was a barrier to the collection of sufficient data on falls, fractures, and visual deficits at the participating sites. Although the retrospective chart review provided some preliminary positive data on the effectiveness of the project, a greater amount of information in a more systematic manner was needed.

FOF allowed opportunities for health professional students to participate in the assessment and promotion of health of seniors in LTC facilities. Conducting vision care services allowed a multidisciplinary approach to the care of seniors, resulting in greater interaction and consultation between the health disciplines. The inclusion of the CNIB in the referrals helped to increase staff awareness of their services.

Implications for the Vision Care Professional

The vision-screening tool is efficient and easy to use, and training is straightforward. These factors make it appealing for professional staff to use at the time of resident admission and on a regular basis. The tool is suitable to vision screen persons over the age of 65 in LTC, acute, and community settings. It is available for instruction and purchase through FOF (www.misericordia.mb.ca). Policies and procedures
Vision and Falls Prevention

need to be developed to allow staff to facilitate vision care services. Administrators and stakeholders need to be made aware of the relationship between visual deficits and falls, fractures, and quality of life indicators, and to be committed to support vision care services to provide the resources required for implementation.

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Implications of Parent–Child Interaction for Early Language Development of Young Children with Visual Impairments

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Abstract

This review of the extant research literature examines the relationship between characteristics of parent–child interactions and the language development of young children with visual impairments. A transactional model of the child’s ecology is used to conceptualize the relationship between factors internal to the child and those in the proximal environment. The special importance of language for young children with visual impairments as a means to initiate and sustain communicative exchanges is highlighted. Despite early research findings that parental input may not match the child’s unique language needs, recent research has failed to detect such a discrepancy. Hypotheses to account for this discrepancy are described, including a new hypothesis with a focus on family-centered early intervention. Implications for early language intervention for young children with visual impairments are outlined. Finally, the limitations of the research cited in the review are discussed.

Keywords: early intervention, parent–child interaction, language development, early childhood

Editor’s Note

This paper is the Second Place Winner of the 2010 AER Graduate Student Essay Contest. It underwent peer review and was accepted for publication in Insight.

Much of the extant research literature surrounding the early development of young children with visual impairments has focused on the developmental influence of factors internal to the child (e.g., temperament, motor ability; Dote-Kwan & Hughes, 1994). Dote-Kwan and Hughes note that very little research has been devoted to the impact of environmental factors on the early development of children with visual impairments. These findings imply the need for a theoretical conceptualization of the relationship between the child and his or her environment, if the influences of proximal factors are to be adequately understood (Sameroff & Fiese, 2000). For the purpose of this review, the “proximal environment” includes factors such as the people, objects, and locations that shape the child’s experience of his world.

A Transactional Model of Child Ecology

One of the most prevalent conceptualizations of the relationship between the child and his or her environment is the transactional model of child ecology, first described by Sameroff (1975). This transactional model asserts that developmental outcomes are not solely a function of individual factors nor are they solely a function of environmental factors (Sameroff & MacKenzie, 2003). Child development is viewed as “a product of the continuous dynamic interactions of the child and...
the experience provided by his or her family and social context” (Sameroff & MacKenzie, 2003, p. 614). Thus, behavior is seen as the property of a system, rather than as a characteristic inherent to the child.

The transactional model of child ecology is of great practical interest to early interventionists working with families of young children with visual impairments (Chen, 1999). Working within the transactional model, a young child’s disability constrains the “shaping force” of contextual factors (Sameroff & Fiese, 2000, p. 156). Thus, parents and other caregivers of young children with visual impairments may interpret child behavior in a manner that is less consistent with the early language needs of the child (Andersen, Dunlea, & Kekelis, 1993). Instead, parents may respond in a compensatory manner, one that is determined by the perceived constraints on language acquisition imposed by the visual impairment (Conti-Ramsden & Perez-Pereira, 1999). The sections that follow outline research examining the special importance of early language development for young children with visual impairments. Although the term visual impairment can entail myriad visual conditions and levels of functioning, for the purposes of this review visual impairment refers to congenital blindness with no functional use of vision, unless otherwise stated. Consistent with the transactional model, studies of the quality of parents’ child-directed speech is examined. Implications for early language intervention will be drawn from the conclusions of this research.

Early Language Development and Young Children with Visual Impairments

Because their experience of the visual world is significantly restricted, young children with visual impairments are thought to place a greater emphasis than sighted children on language as a means of promoting and sustaining relationships with individuals in their environment (Peters, 1994). Vision is often seen as the initial integrating force in a communicative exchange (Rattray & Zeedyk, 2005). Among young sighted children, following an adult’s eye gaze is an important early precursor to verbal exchange and later positive language outcomes (Brooks & Meltzoff, 2005). Visual contact between sighted infants and caregivers has been shown to increase infants’ visual attention and engagement in infant–caregiver interactions (Hains & Muir, 1996). Thus, young children with visual impairments are at a disadvantage when initiating interactions with a caregiver (Urwin, 1979). Unlike sighted children, young children with visual impairments cannot be sure that a caregiver is present to respond to their attempts to initiate communication (Tait, 1972). Early research indicated that young children with visual impairments initiate far fewer conversations than age-matched sighted children (Burlingham, 1965; Fraiberg, 1974). Recent research confirms this disadvantage. In a case study of two congenitally blind infants with no additional disabilities, Bigelow (2003) noted that, although the young children with visual impairments could sustain joint attention with caregivers, both were dependent on adults to initiate joint attention episodes. Therefore, these children may rely on knowledgeable adults to alert the child to his or her presence and to initiate conversation.

Language and Communication with Caregivers in the Proximal Environment

Vision is not likely to be a viable channel through which young children with visual impairments can initiate interactions with others in the proximal environment. Therefore, children and caregivers must identify alternate channels through which communication can be initiated. Language would appear to be the intuitive choice for young children with visual impairments to accomplish this communicative end (see Dunlea, 1989; Peters, 1994). Peters suggests that young children with visual impairments are more dependent on language to initiate and sustain communicative interactions. Peters conducted a case study of Seth, a toddler with optic nerve hypoplasia and no additional disabilities. Observations were recorded when Seth was between 15 and 48 months of age. Analyses of observational data revealed that Seth was extremely eager to enter into social interactions with caregivers and that he used formulaic expressions to promote and prolong these interactions. Formulaic utterances, such as the expression “on the other hand,” are “multi-word units of language stored in long-term
memory as if they were single lexical units” (Wood, 2002, p. 2). Thus, Seth essentially used imitation to simultaneously enhance language use and social interaction, despite a lack of comprehension of the meaning of these formulaic expressions (Peters, 1994). Peters hypothesized that young children have a strong motivation to adopt a formulaic approach to language learning—a sort of “pick it up and use it before you have had time to analyze it” approach (Peters, 1994, p. 200). This motivation likely results from the effectiveness of these formulaic expressions in initiating and sustaining linguistic exchanges in the absence of visual contact with the intended communicative partner.

Research by McConachie (1990) confirms the existence of this phenomenon. Developmental records from 60 children enrolled at a center for young children with visual impairments were examined. Of these children, 20 were considered blind because they had no functional vision. Raw scores from assessments of verbal comprehension and expressive language were compared to age-equivalents for sighted children. Most of the 20 blind children demonstrated a significant gap between expressive language and comprehension scores. According to McConachie, the development of expressive language tends to outpace language comprehension among blind children at a far greater rate than would be present among age-matched sighted children. This provides evidence for the same phenomenon described by Peters (1994), in that advanced expressive language among young children with visual impairments can be used to initiate and sustain early communicative exchanges between the child and caregiver—a role typically fulfilled by visual contact. These children’s use of language as an adaptive tool to initiate and sustain social contact has been confirmed through more recent research. Dote-Kwan (1995) used the Mother-Child Interaction Rating Scale to assess the quality of verbal interactions between mothers and young children (20 to 36 months of age) with visual impairments. Results indicated that children who demonstrate more initiating behaviors had higher scores on developmental measures (i.e., Reynell-Zinkin scales) than children who relied on their mothers to initiate interactions. Thus, the ability to initiate and sustain interaction with adults in the proximal environment is associated with positive developmental outcomes for young children with visual impairments, and language is an optimal means of accomplishing this end.

**Peters’ (1994) Hypothesis and the “Verbalism Issue”**

The importance of early language to the young child’s interactions with the environment is further underscored by its implications for the so-called verbalism issue (Perez-Pereira & Conti-Ramsden, 1999; Warren, 1984). Beginning with early work done by Cutsforth (1951), some researchers have proposed that blind children’s speech often contains words for which the child has no underlying conceptual understanding. Cutsforth labeled this speech as verbalism. Burlingham (1965) noted that young children with visual impairments tend to develop a mixture of words, some that refer to concepts within the realm of their sensory experience and some that are simply imitations of adult language. The notion that the speech of children with visual impairments is “meaningless” has been largely rebuked by later research (i.e., Civelli, 1983; Landau, 1983). However, younger children with visual impairments have been found to make greater use of imitation and formulaic expressions than would be noted among sighted children at the same point in development (Andersen, Dunlea, & Kekelis, 1984). Andersen, Dunlea, and Kekelis conclude that “behavioral and linguistic evidence are consistent in suggesting that the process which enables young sighted children to abstract critical features of a referent…is not functioning at the same level for blind children at the onset of language” (quoted in Warren, 1984, p. 209).

Expressive language development may exceed concept development among young children with visual impairments. Peters’ (1994) hypothesis may account for this gap, in that these young children use language as a means of initiating and sustaining social interaction prior to attaining the conceptual understandings which underlie their utterances. As such, early verbalisms may be adaptive at this point in the child’s language development—the products of a strategic shift to a viable channel (i.e., language) through which the child can initiate and maintain communicative exchanges with adults. Although this hypothesis has yet to be empirically validated, it does lend credence to the notion that language is of special importance to young children with visual impairments.

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For these children, language represents the primary channel through which social interaction occurs. In this sense, language takes on an augmented role. Apart from serving as a communicative device and a system of symbolic representation, language functions as a tool that young children with visual impairments use to connect with their proximal environment (Urwin, 1983).

Parents’ Input and the Child’s Transaction with His or Her Language Environment

The previous section established the special importance of language for young children with visual impairments. According to a transactional model of the child’s ecology, the emphasis placed on language by these children will, in turn, elicit a corresponding reaction from what Warren (1984) refers to as the child’s “language environment” (p. 211). Ideally, the input from the child’s language environment will be congruent with the child’s special emphasis on language—providing the child with contingent information about the proximal environment otherwise inaccessible without visual contact. This section outlines research into conversations between young children with visual impairments and a parent. Of specific interest are the form and function of the linguistic input received by these young children.

Kekelis and Andersen (1984) examined videotaped communicative exchanges between four young children and their parents. Two age-matched sighted dyads were included as a comparison group. Two of the children with visual impairments had a diagnosis of Leber’s congenital amaurosis, one child was diagnosed with optic nerve hypoplasia, and the remaining child was diagnosed with microphthalmia. Degrees of vision ranged from none to shadow and basic form perception. All interactions were recorded over two periods, when the children were 16 to 18 months of age (Period 1) and 19 to 22 months of age (Period 2).

Results indicated that young children with visual impairments heard fewer declarative sentences (e.g., “Here is a cat”) than sighted children at Period 2. The exposure to declarative sentences increased across this period for sighted children, while the rate of exposure to declarative language remained constant for young children with visual impairments. The use of imperative (e.g., “Pick up the cup”) was found to differ in frequency between parents of sighted children and parents of young children with visual impairments. Imperatives were the most frequent sentence type that the latter group received. Despite a drop during Period 2, 31% of the utterances directed toward young children with visual impairments were imperatives, compared to 15% directed toward sighted children. Thus, the language environments of children with visual impairments in this sample contained fewer informative utterances and more demands/requests for action than did the language environments of sighted children. The authors conclude that this was somewhat counterintuitive, noting that one would expect that young children with visual impairments would derive greater benefit from information about their environment, rather than from demands focused on behaviors directly under the child’s control. These findings were consistent with others in the study. Kekelis and Andersen found that sighted children consistently received rich labeling of objects in the form of attributes (e.g., “That is a cat. A cat makes a meowing sound, is soft, and has four legs.”) while young children with visual impairments tended to receive only the label itself (e.g., “Yes, that is a cat.”). As was the case with imperative sentences, the authors consider this finding to be counterintuitive, as one might assume that rich attributes would be of greater benefit to a young child with a visual impairment versus a young sighted child, because the latter has greater visual access to the proximal environment.

The results of subsequent research are consistent with those of Kekelis and Andersen (1984). Moore and McConachie (1994) analyzed the videotaped home interactions of 16 mother–child dyads. Children were approximately 18 months of age at the time of recording. These researchers noted that mothers’ utterances were composed of a high percentage of imperative sentences. Furthermore, mothers’ descriptions of objects in the environment were limited, often only providing a label for the object in question. Thus, when parent–child interactions are analyzed, it appears that the transaction between the child and his or her parent(s) might not, by default, optimally support the child’s continued language development.

The research outlined previously has examined parent–child interactions in general contexts. Rogers
and Puchalski (1984) specifically examined the play behavior of parent–child dyads and arrived at similar conclusions. These researchers analyzed the videotaped interactions of 21 parent–child dyads (ages 4–25 months) and 16 sighted, age-matched control dyads. The group of children with visual impairments had no additional disabilities. Mothers of children with visual impairments tended to produce fewer positive vocalizations and spend less time looking at the child's face—potentially missing important cues, a finding consistent with earlier research by Fraiberg (1979). Also, the young children with visual impairments tended to be less responsive to their mothers' input than were sighted infants. Therefore, mothers of children with visual impairments may be at risk for ineffectively interpreting their child's communicative cues and consequently providing input that is less than optimal (Rowland, 1984).

More recent research has been unable to replicate the findings of Kekelis and Andersen (1984) and Moore and McConachie (1994). See Table 1 for a summary of earlier and more recent research. Kekelis and Prinz (1996) found that young children with visual impairments did not tend to receive any more directives than did sighted children. These researchers observed four parent–child dyads. Two of the dyads had a child with a visual impairment, while the other dyads contained age-matched sighted children. The nature and frequency of child-directed requests (imperatives) were determined by coding videotaped play interactions between parent and child. Results indicate that, although both children with visual impairments responded to significantly fewer of their parent's directive utterances, there was no significant difference between the number of directives uttered by parents of the children with visual impairments versus those of sighted children. These researchers observed four parent–child dyads. Two of the dyads had a child with a visual impairment, while the other dyads contained age-matched sighted children. The nature and frequency of child-directed requests (imperatives) were determined by coding videotaped play interactions between parent and child. Results indicate that, although both children with visual impairments responded to significantly fewer of their parent's directive utterances, there was no significant difference between the number of directives uttered by parents of the children with visual impairments versus those of sighted children. The researchers conclude by noting that further research is needed to reconcile the discrepancy between their findings and those of previous studies. A more recent study by Campbell (2003) confirms these findings. Campbell videorecorded the play sessions of eight mother–child dyads: four where the child had a visual impairment with no additional disabilities and four with age-matched sighted children. Mothers' child-directed imperative utterances were classified under one of five categories of directive utterances (e.g., utterances to elicit either attention or action, or those meant as requests, prompts, or deterrents). With the exception of the use of “visual directives” (e.g., “Look at this”) and the deterrence of self-harm (e.g., “Do not poke your eye”), Campbell was unable to detect statistically significant differences in the frequency of child-directed imperative utterances of mothers of young children with visual impairments and those of sighted children.

**Accounting for These Differences: A Role for Early Intervention?**

Several accounts of these discrepant findings have been posited. Conti-Ramsden and Perez-Pereira (1999) attribute these discrepancies to differences in how researchers interpret data related to parental “directiveness.” In their study of parent–child communication of three dyads (one with a child who is blind, one with low vision, and one sighted control), these researchers note that, although the child who is blind did receive a greater frequency of directive utterances, these utterances were significantly more likely to contain descriptive information. Thus, research that dichotomizes imperative and descriptive utterances may overlook the potentially adaptive nuances of imperative language.

Campbell (2003) also suggests that the finding that parents direct a greater frequency of imperative statements toward young children with visual impairments versus their sighted peers is perhaps the result of a narrow conceptualization of “directiveness.” By examining five discrete categories of mothers’ directive intention, Campbell was unable to detect any significant differences between the utterances of parents of sighted children and those of children with visual impairments. Thus, methodological or conceptual issues may contribute to the variability in the extant literature described in previous sections.

An alternative account of these differences may relate to the provision of early intervention services to families of young children with visual impairments. Since 1986, family-centered early intervention services for children at developmental risk in the United States have been mandated by the Individuals with Disabilities Education Act (Katsiyannis, Yell, & Bradley, 2001). Children with visual impairments and their families qualify for early intervention services under these statutes (Chen, 1999). Although programming will vary between agencies and organizations,
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<td>With limited exceptions, there were no significant differences between the frequency of directive utterances received by children with VI and sighted children.</td>
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*VI = visual impairment.*
supporting parent–child communication appears to be a common competency among professionals working with young children with visual impairments and their families. Dote-Kwan, Chen, and Hughes (2001) surveyed 121 of these professionals and found 96.67% agreement in the belief that competent professionals working with this population must possess knowledge of how visual impairment may impact the infant–care provider relationship and early development. Furthermore, 87.16% of professionals agreed that supporting communication skills was a primary professional responsibility. According to these data, supporting early communication between parents and young children with visual impairments figures prominently in early intervention services across the United States.

Previously described research by Dote-Kwan (1995) underscores the importance of parent–child communication to early development. In her observational study of 18 mother–child dyads, Dote-Kwan found that the frequency of mothers’ responsive behaviors (e.g., repeating or rephrasing the child’s utterance) were positively associated with the child’s scores on one or both of the developmental measures used in the study (i.e., Reynell-Zinkin, Maxfield-Bucholz). Essentially, parents who show a greater understanding of their child’s communicative needs tend to have children with more positive developmental outcomes. Thus, early interventionists should seek to inform parents about their young child’s restricted access to the visual world and how parent language can compensate for this restriction. Specifically, it may be suggested that parents attempt to use more declarative sentences as well as fewer imperative sentences. In addition, they should extend descriptive language beyond the provision of labels to provide young children with richer descriptions using attributes. In doing so, parents will be better able to positively shape their child’s interactions with the surrounding environment.

**Limitations of the Extant Research Literature**

There are a number of key limitations of the extant research literature surrounding the early language development of young children with visual impairments. Owing to the low incidence of visual impairment in the population of young children, research tends to feature case studies of individuals (Dote-Kwan, 1995). As with all case study research, these data may not necessarily be validly generalized to the entire population of young children with visual impairments (Warren, 1994). In a similar vein, issues of validity also arise when comparing samples of children with visual impairments to sighted samples. Perez-Pereira and Conti-Ramsden (1999) note that some researchers assume that a particular behavior serves the same function for both children with visual impairments and sighted children. Beginning with early research by Burlingham (1964), authors have noted that assumptions about the functional equivalence of a given behavior between these two groups may not be valid. Finally, the conclusions are often based on the researcher’s interpretation of observational data (Perez-Pereira & Conti-Ramsden, 2001). Thus, it is not easy to compare and integrate these findings. Although the extant research has contributed a great deal to our understanding of the early language development of children with visual impairments, increased methodological rigor will work toward ensuring that valid conclusions can be drawn from the data.

**Conclusion**

Language has a special importance for young children with visual impairments, providing the child with important information about his or her environment. However, early research into the interaction between a sighted caregiver and a young child with a visual impairment has revealed that caregivers may be at risk of misinterpreting the young child’s communicative cues. Furthermore, caregivers may not be aware of what tends to constitute optimal language input for young children with visual impairments. More recent research has failed to detect any significant inconsistency between parents’ child-directed utterances and the child’s unique communicative needs. Accounts of this discrepancy in the extant research literature have been posited. These accounts have focused on methodological and conceptual differences between earlier research and more recent work. These wholly plausible accounts emphasize factors that are inherent to the research to account for the phenomenon in question. Given the importance of facilitating early communication in the constellation of services offered through early intervention, it may also be the case that more recent research is noting the effects of more comprehensive family-centered early
intervention services. Thus, this discrepancy may be due, in part, to changes in the quality of input that children with visual impairments receive from caregivers in the proximal environment. Although this hypothesis has yet to be subjected to empirical scrutiny, it remains an interesting alternative account.

References


**Going Blind**: A Film Review

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Going Blind (Lovett, 2009) is a documentary film about what it is like to lose one’s sight, as told from the “inside out.” Film director Joe Lovett has glaucoma. Glaucoma is an eye condition in which increased pressure within the eye leads to damage to the optic nerve. Lovett takes us along on his journey, sharing with us his thoughts and feelings as he adjusts to his deteriorating vision. On this journey, he also introduces us to others he has met in order to try to better understand the state of going blind. He talks about his fears, the fact that he knows very little about blindness, and the realization that he has never known a person who is blind.

Lovett created Going Blind with the intent of increasing awareness of vision loss and improving communication between health professionals. Lovett (2010) asks, “Why are the sighted so uninformed about how blind people live?” and “Is fear of blindness so great that we fear blind people themselves?” Currently, there are many barriers to efficient pathways of communication between medical vision specialists and rehabilitation workers. With the medical model’s focus on “cure,” there is a devaluing of rehabilitation services. As a result, referrals for vision rehabilitation services are typically made late or not at all, thus undermining the potential of rehabilitation for improving the quality of life of people who have lost sight.

In the film, Lovett takes us to appointments with his ophthalmologist, and we are able to witness invasive medical procedures that are only sometimes effective, and medical professionals with little apparent empathy or awareness of the experience of going blind. This puts him in a perpetual cycle of hope and despair. Lovett also shows us other challenges stemming from loss of vision that may be less intuitive. For example, one might expect that missing areas of the visual field would show up as dark or opaque blobs, therefore making it clear where one is missing visual information. However, instead, the brain fills in these areas with a best guess as to what is missing based on surrounding context and prior experience. This guess is not always correct, however, and Lovett describes how objects sometimes would appear unexpectedly out of nowhere and how he finds himself running into many of them.

Despite his many challenges, Lovett derives hope and inspiration through the stories of others he encounters who are blind or partially sighted, and who have managed to adapt to their loss of sight. One of these people is Jessica Jones, a young woman who has gone blind as result of diabetic retinopathy but who has the courage and determination to live independently. Jessica has found new

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meaning in her life through a position teaching art at a school for children with multiple impairments. Peter D’Elia, an 85-year-old architect, also shares with us his story. Peter continues to follow his passion and to draw despite his loss of vision. He has been fortunate enough to regain some of the vision he lost to AMD through new breakthroughs in medicine. Finally, Emmett, a young boy with low vision due to albinism takes it in his own hands to deal with the challenge of sticking out among his peers. He gains the respect and admiration of others by entertaining them through comedy and by demonstrating self-acceptance, approaches that are particularly admirable given his young age.

Lovett hopes that through dialogue, ignorance about vision loss and barriers to vision rehabilitation services can be reduced or eliminated. In order to facilitate this dialogue, the film’s Web site (www.goingblindmovie.com) includes a toolkit with strategies on how to best use the film. The film is available at an educational price directly from its website and the toolkit is downloadable for free.

All in all, the film represents a valiant effort to address general ignorance about blindness and partial sight among both the general public and professionals, a lack of awareness that has persisted for decades. This film alone cannot be expected to accomplish this task but it definitely makes a contribution to public awareness and public education campaigns. While some of the content is specific to the U.S. context (e.g., visits to Lighthouse International), the message is one that is relevant globally. I encourage others to view the film and to engage in the dialogue.

References


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