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Binocular iPad Game vs Patching for Treatment of Amblyopia in Children:

A Randomized Clinical Trial

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Abstract

IMPORTANCE—Fellow eye patching has long been the standard treatment for amblyopia, but it does not always restore 20/20 vision or teach the eyes to work together. Amblyopia can be treated with binocular games that rebalance contrast between the eyes so that a child may overcome suppression. However, it is unclear whether binocular treatment is comparable to patching in treating amblyopia.

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Study concept and design: Kelly, Jost, Birch.
Acquisition, analysis, or interpretation of data: All authors.
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Study supervision: Kelly, Jost, Birch.

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OBJECTIVES—To assess the effectiveness of a binocular iPad (Apple Inc) adventure game as amblyopia treatment and compare this binocular treatment with patching, the current standard of care.

DESIGN, SETTING, AND PARTICIPANTS—This investigation was a randomized clinical trial with a crossover design at a nonprofit eye research institute. Between February 20,2015, and January 4, 2016, a total of 28 patients were enrolled in the study, with 14 randomized to binocular game treatment and 14 to patching treatment.

INTERVENTIONS—Binocular game and patching as amblyopia treatments.

MAIN OUTCOMES AND MEASURES—The primary outcome was change in amblyopic eye best-corrected visual acuity (BCVA) at the 2-week visit. Secondary outcomes were change in stereoacuity and suppression at the 2-week visit and change in BCVA at the 4-week visit.

RESULTS—Among 28 children, the mean (SD) age at baseline was 6.7 (1.4) years (age range, 4.6–9.5 years), and 7 (25%) were female. At baseline, the mean (SD) amblyopic eye BCVA was 0.48 (0.14) logMAR (approximately 20/63; range, 0.3–0.8 logMAR [20/40 to 20/125]), with 14 children randomized to the binocular game and 14 to patching for 2 weeks. At the 2-week visit, improvement in amblyopic eye BCVA was greater with the binocular game compared with patching, with a mean (SD) improvement of 0.15 (0.08) logMAR (mean [SD], 1.5 [0.8] lines) vs 0.07 (0.08) logMAR (mean [SD], 0.7 [0.8] line; $P = .02$) after 2 weeks of treatment. These improvements from baseline were significant for the binocular game (mean [SD] improvement, 1.5 [0.8] lines; $P < .001$) and for patching (mean [SD] improvement, 0.7 [0.8] line; $P = .006$). Depth of suppression improved from baseline at the 2-week visit for the binocular game (mean [SD], 4.82 [2.82] vs 3.24 [2.87]; $P = .03$) and for patching (mean [SD], 4.77 [3.10] vs 2.57 [1.67]; $P = .004$). Patching children crossed over to binocular game treatment, and all 28 children played the game for another 2 weeks. At the 4-week visit, no group difference was found in BCVA change, with children who crossed over to the binocular games catching up with children treated with binocular games, for a mean (SD) improvement of 0.17 (0.10) logMAR (mean [SD], 1.7 [1.0] lines) for the binocular game vs a mean (SD) improvement of 0.16 (0.12) logMAR (mean [SD], 1.6 [1.2] lines) for the patching crossover ($P = .73$).

CONCLUSIONS AND RELEVANCE—A binocular iPad game was effective in treating childhood amblyopia and was more efficacious than patching at the 2-week visit. Binocular games that rebalance contrast to overcome suppression are a promising additional option for treating amblyopia.

TRIAL REGISTRATION—clinicaltrials.gov Identifier: NCT02365090.

Amblyopia is the leading cause of monocular visual impairment in children, affecting 3% in the United States.[1] Amblyopia has traditionally been viewed as a monocular disorder that can be treated by patching the fellow eye to force use of the amblyopic eye. Patching can improve visual acuity for 73% to 90% of children with amblyopia, but 15% to 50% may never achieve normal visual acuity after a lengthy course of treatment.[2–7] Amblyopia recurs after successful treatment in 25% to 50% of children, and normal binocularity is rarely restored after patching treatment.[4,8–13] Because amblyopia arises from binocular discordance when pediatric eye disorders (eg, strabismus or anisometropia) are present, binocular treatments are likely to yield better vision outcomes.[1,14]

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Our laboratory previously reported visual acuity improvements in children with amblyopia treated with binocular iPad (Apple Inc) games that reduce fellow eye contrast in an effort to rebalance contrast between the eyes.[15–17] Contrast rebalancing allows the child to overcome interocular suppression and experience binocular vision while playing the games.[14,18] Poor compliance in 24% to 38% of children indicated that the games developed for our prototype iPad platform (Tetris and Pong) were not engaging.[15,16] The mean visual acuity gain of 0.1 logMAR (1 line) found after 4 weeks of binocular games with 16 hours of assigned treatment may have been limited by low compliance. A recent study[19] in our laboratory found that supervised, in-office treatment with movies using the same contrast rebalancing approach resulted in a mean visual acuity gain of 0.2 logMAR (2 lines) in just 2 weeks with 9 hours of treatment. Therefore, a more engaging binocular game could lead to higher compliance and larger visual acuity gains with at-home treatment.

While binocular treatment shows significant visual acuity improvements, it is unclear whether such therapy is comparable to the standard monocular treatment of fellow eye patching. In this randomized clinical trial with a crossover design at a nonprofit eye research institute, we assessed the effectiveness of a binocular iPad adventure game as amblyopia treatment in children and compared this binocular treatment with patching, the current standard of care.

Methods

The research protocol adhered to the tenets of the Declaration of Helsinki,[20] was approved by the Institutional Review Board of The University of Texas Southwestern Medical Center, and conformed to the requirements of the US Health Insurance Portability and Accountability Act of1996. Written informed consent was obtained from a parent or legal guardian before testing of their child and after explanation of the nature and possible consequences of the study.

Patient Selection

Inclusion Criteria—Eligible children 4 to 10 years old were diagnosed as having amblyopia due to strabismus, anisometropia, or both and were referred to the Retina Foundation of the Southwest by 9 pediatric ophthalmologists in the Dallas/Fort Worth area, including 3 of us (L.D., C.L.B., and J.N.L.). The eligible children had amblyopic eye best-corrected visual acuity (BCVA) of 0.3 to 0.8 logMAR (20/40 to 20/125) and 0.1 logMAR (20/25) or better fellow eye BCVA (0.2 logMAR or better for 4-year-olds), with an interocular difference of at least 0.3 logMAR (≥3 lines). Children with strabismus were initially diagnosed as having esotropia but were aligned with surgery or spectacle correction to within 4 prism diopters of orthotropia at distance and near vision.

Exclusion Criteria—None of the children were born at less than 32 weeks' post-gestational age or had coexisting ocular or systemic disease, congenital infections or malformations, or developmental delay (eTable 1 in Supplement 1). English was the primary language for all children. Medical records were obtained from referring ophthalmologists to extract the diagnosis, current alignment, cycloplegic refraction, and prior treatment plan.

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Trial Protocol

This study was a randomized clinical trial (Supplement 2) with the objective of enrolling 56 children with amblyopia (Figure 1). We preplanned the following 2 cohorts: (1) a primary cohort-comprising 28 children to determine the effectiveness of the binocular game as amblyopia treatment and whether it is more effective than patching and (2) a secondary cohort with an additional 28 children that will be combined with the primary cohort to allow evaluation of baseline factors that may affect treatment outcomes (ie, prior treatment, etiology of amblyopia, baseline BCVA, and age). Herein, we report data from the primary cohort.

Randomization

Randomization was performed by a statistician who provided individual sealed sequentially numbered envelopes. Two randomization schedules were created using a random number generator function, one for children with prior amblyopia treatment (patching or atropine) and another for children with no prior treatment. Randomization (1:1) was prepared in permuted blocks with block sizes of 4 or 6. After confirming eligibility and obtaining written informed consent, one of us (K.R.K. or R.M.J.) opened a sealed envelope, enrolled the child, and assigned him or her to the appropriate treatment.

Treatment Protocols

Treatment groups followed the same protocol timeline and were administered the same vision assessments. At the baseline visit, eligibility for enrollment was ascertained, and vision assessments were conducted. Children were randomized to binocular game treatment or patching treatment for 2 weeks. At the 2-week visit (11–17 days after baseline), vision was reassessed. Patching children crossed over to the binocular game, and both groups continued treatment for an additional 2 weeks. At the 4-week visit (25–31 days after baseline), vision was reassessed. Four weeks marked the end of our study, but children had the option to continue game treatment with 2 more follow-up visits (8 and 12 weeks from baseline). The primary outcome was change in amblyopic eye BCVA at the 2-week visit. Secondary outcomes were change in stereoacuity and suppression at the 2-week visit and change in amblyopic eye BCVA at the 4-week visit.

Binocular Game Protocol—Children randomized to binocular game treatment were loaned an iPad with an action-oriented adventure game (Dig Rush; developed in collaboration with Robert Hess, PhD, DSc, at McGill University [Montréal, Québec, Canada], and Amblyotech [Atlanta, Georgia] and UbiSoft [Montréal]) that consists of miners digging for gold. Using a finger, the child must manipulate the miners and their surroundings to dig and return gold to a cart as quickly as possible while avoiding obstacles (eg, fire, lava, and monsters). Up to 3 stars can be earned at the end of each of the 42 levels (maximum star count, 126). Levels progressively increase in difficulty. Children can use gold to purchase more miners and digging tools, as well as to dig faster and carry more gold (Figure 2).

Children were familiarized with the game and practiced until one of us (K.R.K. or R.M.J.) was confident in their ability to understand and play it. Children were asked to play the game

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at home for 1 hour a day 5 days a week for 2 weeks (10 hours total). During game play, children wore red-green anaglyphic glasses that separate game elements seen by each eye so that reduced-contrast elements (eg, gold and fire) are seen by the fellow eye, high-contrast elements (eg, miners and monsters) are seen by the amblyopic eye, and high-contrast background elements (eg, ground and rocks) are seen by both eyes. For successful game play, both eyes must see their respective game components. Amblyopic eye contrast remained at 100% contrast, while fellow eye contrast started at 20% but increased with game success (a star earned), requiring the amblyopic eye to work harder in tandem with the fellow eye. At least 18 hours of game play were required to reach 100% contrast. If game play was unsuccessful for 30 minutes (no star earned), fellow eye contrast was reduced. At the 2-week visit, children were asked to play the game for an additional 2 weeks.

Patching Protocol—The patching protocol was designed to be similar to the current standard of care for amblyopia treatment.[2] Children were provided with eye patches (Ortopad; Ortopad USA) and were asked to patch their fellow eye 2 hours a day 7 days a week for 2 weeks (28 hours total treatment). At the 2-week visit, children assigned to the patching protocol crossed over to the binocular game.

Vision Assessment

Vision assessments were conducted at baseline, the 2-week visit, and the 4-week visit and included 4 components. First was crowded monocular BCVA using the electronic Early Treatment Diabetic Retinopathy Study protocol[21,22] for children at least 7 years old or the Amblyopia Treatment Study HOTV protocol for children younger than 7 years.[23,24] Second was a stereoacuity component (Randot Preschool Stereoacuity and Stereo Butterfly Tests; Stereo Optical, Inc). Third was extent of suppression scotoma using the Worth 4-dot test at 7 different distances.[25] Fourth was depth of suppression for children younger than 7 years using a dichoptic motion coherence test that determines the maximum contrast of randomly moving dots in the fellow eye that still allows the child to discriminate the direction of coherent motion dots in the amblyopic eye,[16,26] or for children at least 7 years old using a dichoptic eye chart adapted from work by Kwon et al[27] that determines the contrast ratio at which the child reports letters presented to each eye with equal likelihood.[28]

Adherence to Protocol

Parents or legal guardians were provided a personalized calendar to record the minutes per day their child played the game or patched their fellow eye. A log file was also obtained from the iPad that contained the minutes played and fellow eye contrast for each play session.

Statistical Analysis

The primary outcome was change in amblyopic eye BCVA at the 2-week visit. Sample size was based on prior studies showing that, on average, binocular game play for 2 weeks results in a mean (SD) improvement of 0.11 (0.10) logMAR (1.1 lines)[15,16] and that patching for 2 weeks results in a mean (SD) improvement of 0.00 (0.10) logMAR (0 line).[4–6] For $\alpha = .05$ and $1 - \beta$ of 0.80, the required sample size was 13 children per group. To account for an anticipated 5% dropout rate, we planned to enroll 28 children (14 per group).

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Stereoacuity was converted to log arcsec for analyses, and nil stereoacuity was arbitrarily assigned a value of 4 log arcsec. The farthest distance at which the child reported 4 dots was converted to size of suppression scotoma in degrees.[25] The tests of depth of suppression determine the minimum contrast ratio (amblyopic eye contrast divided by fellow eye contrast) at which the amblyopic eye was not suppressed. All analyses were conducted with an intent-to-treat approach.

In the primary analysis, an independent *t* test was conducted to determine whether improvement in amblyopic eye BCVA differed between the binocular game and patching treatments at the 2-week primary outcome visit. In the secondary analyses, paired *t* tests were conducted per group to determine whether amblyopic eye BCVA had improved significantly from baseline at the 2-week visit. An independent *t* test was conducted to determine whether improvement in amblyopic eye BCVA differed between the binocular game and patching crossover groups at the 4-week visit. Paired sign tests were conducted per group to determine whether stereoacuity had improved from baseline at the 2-week visit. Paired *t* tests were conducted per group to determine whether extent of suppression scotoma and depth of suppression had improved from baseline at the 2-week visit. Group differences in stereoacuity were analyzed using a Mann-Whitney test, and group differences in extent and depth of suppression were analyzed using independent *t* tests. All tests were performed using a 2-tailed $\alpha = .05$.

Results

Between February 20, 2015, and January 4, 2016, a total of 28 patients were enrolled in the study, with 14 randomized to binocular game treatment and 14 to patching treatment (Figure 1). The 2-week outcome visit was completed by all children except for 1 child randomized to the binocular game who had a scheduling conflict but who attended the 4-week visit. All 28 children completed the 4-week visit. There were no study dropouts.

Baseline characteristics are listed in eTable 2 in Supplement 1. Nine children (32%) had strabismic amblyopia, 14 (50%) had anisometropic amblyopia, and 5 (18%) had combined-mechanism amblyopia. Their mean (SD) age was 6.7 (1.4) years (age range, 4.6–9.5 years), and 7 (25%) were female. The mean (SD) amblyopic eye BCVA at enrollment was 0.48 (0.14) logMAR (approximately 20/63; range, 0.3–0.8 logMAR [20/40 to 20/125]). Moderate amblyopia (range, 0.3–0.6 logMAR [20/40 to 20/80]) was present in 23 children (82%), and severe amblyopia (range, 0.7–0.8 logMAR [20/100 to 20/125]) was present in 5 (18%). Twenty children (71%) had received prior amblyopia treatment.

Adherence to Protocol

Compliance for iPad game play using the personalized calendar was similar to that using the iPad log; therefore, the latter was used. Compliance for patching was tabulated using the personalized calendar. For the first 2 weeks, children assigned to the binocular game completed a mean (SD) of 10.0 (2.3) hours (100% prescribed treatment time). The mean (SD) fellow eye contrast was 46% (15%) at the 2-week visit (iPad contrast logs were available for 11 to 14 children). Children assigned to patching completed a mean (SD) of 27.7 (3.0) hours (99% prescribed treatment time). For the second 2 weeks, all children were

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assigned to the binocular game, and they completed a mean (SD) of 8.2 (3.4) hours (82% prescribed treatment time). The mean (SD) fellow eye contrast at the 4-week visit was 71% (28%) for children who played the game for 4 weeks and 50% (16%) for children who crossed over to the binocular game (iPad contrast logs were available for 27 of 28 children).

Primary Outcome

At the 2-week primary outcome visit, a larger improvement in amblyopic eye BCVA was found with the binocular game compared with patching, with a mean (SD) improvement of 0.15 (0.08) logMAR (mean [SD], 1.5 [0.8] lines) vs 0.07 (0.08) logMAR (mean [SD], 0.7 [0.8] line improvement) (mean difference, 0.07 logMAR [0.7 line]; 95% CI, 0.01–0.14 logMAR [0.1–1.4 lines]; $t_{25} = 2.42$, $P = .02$). For the binocular game, improvement ranged from 0.0 to 0.2 logMAR (0–2 lines): 11 children (85%; 95% CI, 58%−96%) improved by at least 0.1 logMAR (8 of whom improved by 0.2 logMAR [2 lines], and 3 of whom improved by 0.1 logMAR [1 line]), and 2 (15%; 95% CI, 3%−46%) did not improve. For patching, improvement ranged from 0.0 to 0.2 logMAR (0–2 lines): 7 children (50%; 95% CI, 27% −73%) improved by at least 0.1 logMAR (3 of whom improved by 0.2 logMAR [2 lines], and 4 of whom improved by 0.1 logMAR [1 line]), and 7 (50%; 95% CI, 27%−73%) did not improve.

Secondary Outcomes

Amblyopic eye BCVA had improved at the 2-week visit with the binocular game (mean [SD] improvement, 1.5 [0.8] lines; $t_{12} = 6.79$, $P < .001$) and with patching (mean [SD] improvement, 0.7 [0.8] line; $t_{13} = 3.24$, $P = .006$). At the 4-week visit, amblyopic eye BCVA had improved for children who crossed over to the binocular game, resulting in their catching up with children who started with the binocular game, with a mean (SD) improvement of 0.17 (0.10) logMAR (mean [SD], 1.7 [1.0] lines) for the binocular game vs a mean (SD) improvement of 0.16 (0.12) logMAR (mean [SD], 1.6 [1.2] lines) for patching crossover (mean difference, 0.01 logMAR; 95% CI, −0.07 to 0.01 logMAR; $t_{26} = 0.35$, $P = .73$) (Figure 3). Overall, 23 children (82%) improved by at least 0.1 logMAR (1 line) (Figure 4).

At baseline, 1 child had normal stereoacuity, 10 children had reduced (subnormal but measurable) stereoacuity, and 17 children had nil stereoacuity (assigned a value of 4). No change in stereoacuity was seen at the 2-week visit with the binocular game (median [interquartile range], 4.00 [2.85–4.00] vs 4.00 [2.60–4.00] log arcsec; $z = 0.71$, $P = .48$) or with patching (median [interquartile range], 4.00 [2.60–4.00] vs 4.00 [2.60–4.00] log arcsec; $z = 0.71$, $P = .48$).

Extent of suppression scotoma (Worth 4-dot test) had not changed from baseline at the 2-week visit with the binocular game (mean [SD], 7.16 [8.91] degrees vs 4.95 [7.07] degrees; $t_{12} = 1.32$, $P = .21$) or with patching (mean [SD], 3.27 [3.02] degrees vs 5.31 [8.89] degrees; $t_{13} = 1.17$, $P = .26$). However, depth of suppression measured by the contrast ratio showed improvement from baseline at the 2-week visit with the binocular game (mean [SD], 4.82 [2.82] vs 3.24 [2.87]; $t_{12} = 2.46$, $P = .03$) and with patching (mean [SD], 4.77 [3.10] vs 2.57 [1.67]; $t_{13} = 3.41$, $P = .005$) (Figure 5).

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No differences between the binocular game vs patching treatments were found at the 2-week visit for change in stereoacuity, extent of suppression, and depth of suppression. For change in stereoacuity, the respective median (interquartile range) changes were −0.00 (0.00–0.00) vs 0.00 (0.00–0.00) log arcsec (U = 79.00, P = .56). For extent of suppression, the respective mean (SD) changes were −2.21 (6.02) vs 2.05 (6.52) degrees (mean difference, 4.10 degrees; 95% CI, −0.71 to 8.91 degrees; t_{25} = −1.76, P = .09). For depth of suppression, the respective mean (SD) values were 1.58 (2.31) vs 2.20 (2.42) (mean difference, 0.63; 95% CI, −1.25 to 2.51; t_{25} = 0.69, P = .50).

Discussion

Our randomized clinical trial showed that binocular game treatment is more successful than patching in improving amblyopic eye visual acuity with 2 weeks of treatment. A mean visual acuity improvement of 0.15 logMAR (1.5 lines) after binocular treatment was more than double the 0.07 logMAR (0.7 line) improvement found with patching and was achieved with less than 50% treatment time required for patching (10 vs 28 hours assigned treatment). Three times as many children improved 0.2 logMAR (2 lines) with the binocular game (8 of 13 children [62%]) compared with patching (3 of 14 children [21%]) after 2 weeks of treatment. In fact, 5 of 13 children (39%) with binocular treatment reached 20/32 or better visual acuity compared with 1 of 14 children (7%) with patching. Two weeks of patching was inadequate to achieve the maximum improvement previously reported (3 lines) with 6 months of patching.[29] We show that in just 2 weeks, visual acuity gain with binocular treatment was half that found with 6 months of patching, suggesting that binocular treatment may yield faster gains than patching. Whether long-termbinocular treatment is as effective in remediating amblyopia as patching remains to be investigated.

Our finding of 1.7 lines of improvement after 4 weeks of binocular game treatment is larger than the 1 line of improvement found in our group’s previous studies using Tetris and Pong.[15−17] The magnitude of improvement was more similar to the 2 lines found with dichoptic movie treatment,[19] suggesting that a larger improvement may be owing to better compliance with our adventure game. Indeed, 85% (23 of 27) of children played at least 75% of prescribed treatment compared with 44% (20 of 45) in the Tetris game study.[15] Furthermore, some children at the 4-week visit in our study had already completed all game levels or had reached 100% fellow eye contrast.

A significant improvement in depth of suppression in children after both binocular game and patching treatments is consistent with a correlation between amblyopic eye visual acuity and depth of suppression.[28,30–32] Small sample sizes or children’s difficulty with the psychophysical taskusedto measure suppression may underlie a lack of suppression changes in children with amblyopia in previous binocular treatment studies.[16,18,19] However, our data are consistent with reduced suppression in amblyopic adults after binocular game treatment.[33,34] There has been a focus on interocular suppression in the etiology of amblyopia,[1,14,28] and alleviating suppression with binocular treatment may be the key to amblyopia treatment. We found no improvement in stereoacuity or in extent of the suppression scotoma (Worth 4-dot test) herein. Future amblyopia treatment studies should investigate ways of improving binocular vision outcomes, such as stereoacuity.

Binocular treatment for amblyopia is novel, and many questions remain. It needs to be determined how to convert binocular games to longer-term amblyopia treatment (eg, development of a variety of engaging games, adjustment of contrast levels, and maintenance treatment). Our primary cohort sample size was too small to evaluate baseline factors (ie, prior treatment, etiology of amblyopia, BCVA, and age) that may be important modifiers of treatment effect. The preplanned analyses of the combined primary and secondary cohorts will allow us to examine the effect of these potential modifiers. Our finding that children in the crossover arm improved both in the patching and binocular game phases suggests that future investigation of combination treatment may be worthwhile. Last, the results herein cannot be generalized to other forms of amblyopia, such as deprivation amblyopia due to congenital cataract.

Conclusions

Our binocular iPad game was a successful treatment for childhood amblyopia and was more effective than patching at the 2-week visit. Although we had a small sample size and treatment lasted only 2 to 4 weeks, binocular games that rebalance contrast to overcome suppression are a promising additional option for treating amblyopia.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

Questions

Will a binocular iPad (Apple Inc) game be effective in treating childhood amblyopia, and how does the visual acuity improvement compare with that obtained with 2 hours of daily patching?

Findings

In this randomized clinical trial with a crossover design at the 2-week visit, binocular treatment with an iPad game improved amblyopic eye visual acuity by 1.5 lines compared with 0.7 line with patching.

Meaning

Binocular games that rebalance contrast to overcome suppression are a promising additional option for treating amblyopia; however, whether long-term binocular treatment is as effective in remediating amblyopia as patching remains to be investigated.

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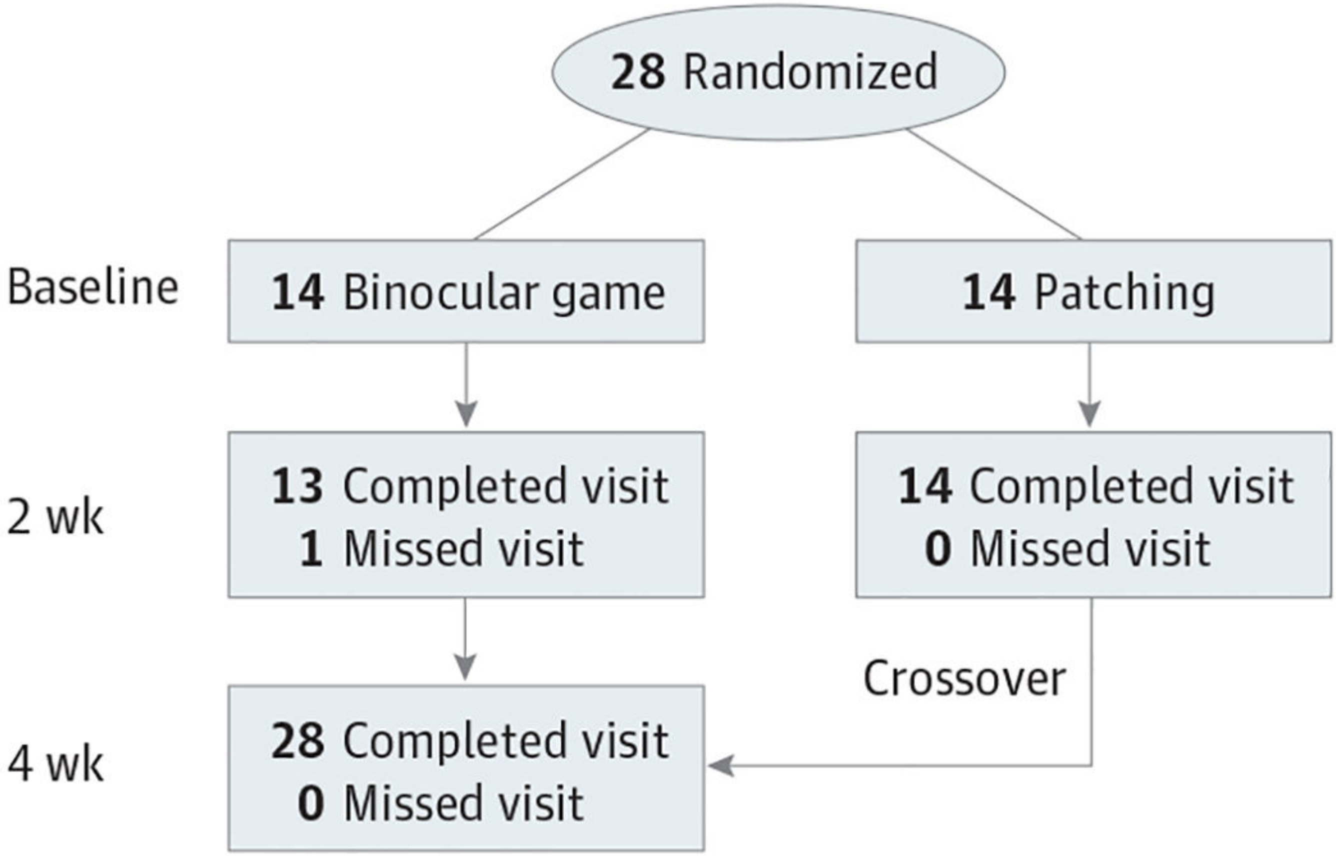

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) Diagram
Shown are the numbers of completed and missed visits during the 4-week study. One child randomized to the binocular game missed the 2-week visit because of a scheduling conflict but attended the 4-week visit. There were no dropouts between baseline and the 4-week visit.

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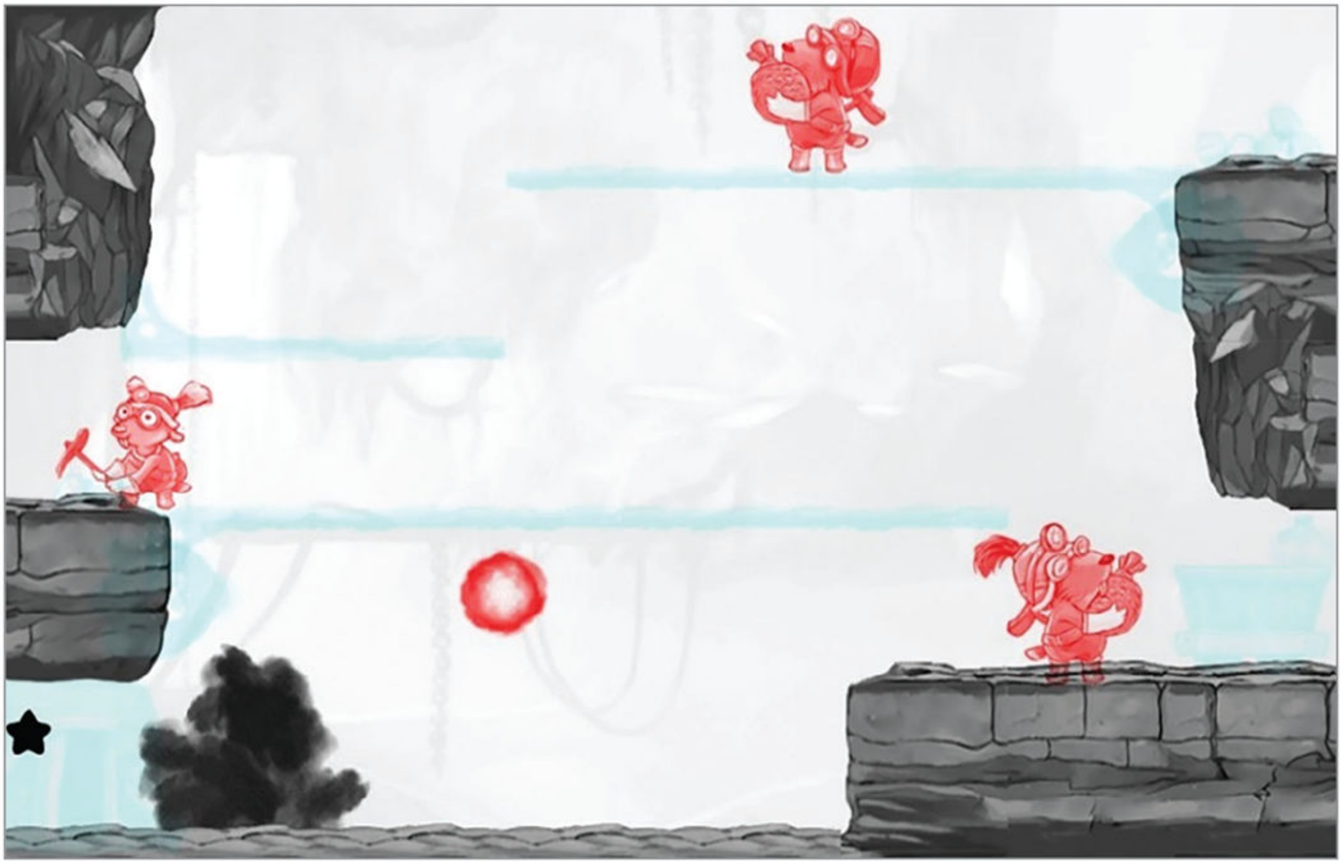

Figure 2. Screen Shot of Dig Rush

High-contrast red elements (miners and fireball) are seen by the amblyopic eye. Low-contrast blue elements (gold and cart) are seen by the fellow eye. Gray elements (rocks and ground) are seen by both eyes. Both eyes must see the game for successful play. Dig Rush was developed in collaboration with Robert Hess, PhD, DSc, at McGill University (Montréal, Québec, Canada), and Amblyotech (Atlanta, Georgia) and UbiSoft (Montréal).

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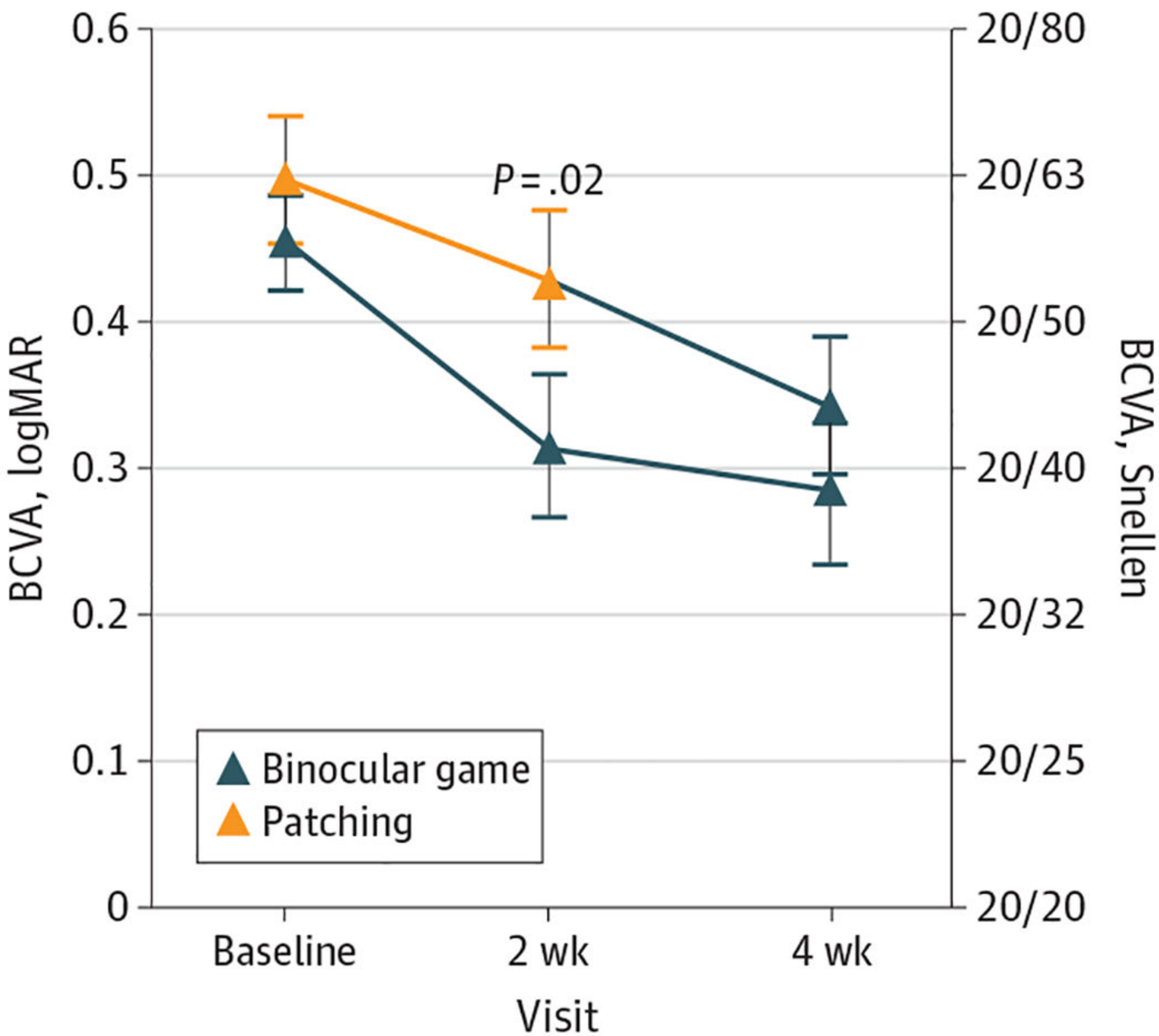

Figure 3. Best-Corrected Visual Acuity (BCVA) at Baseline, the 2-Week Visit, and the 4-Week Visit

Shown is amblyopic eye BCVA for the binocular game and patching at each visit. The patching group crossed over to the binocular game at the 2-week visit. Error bars represent SEs.

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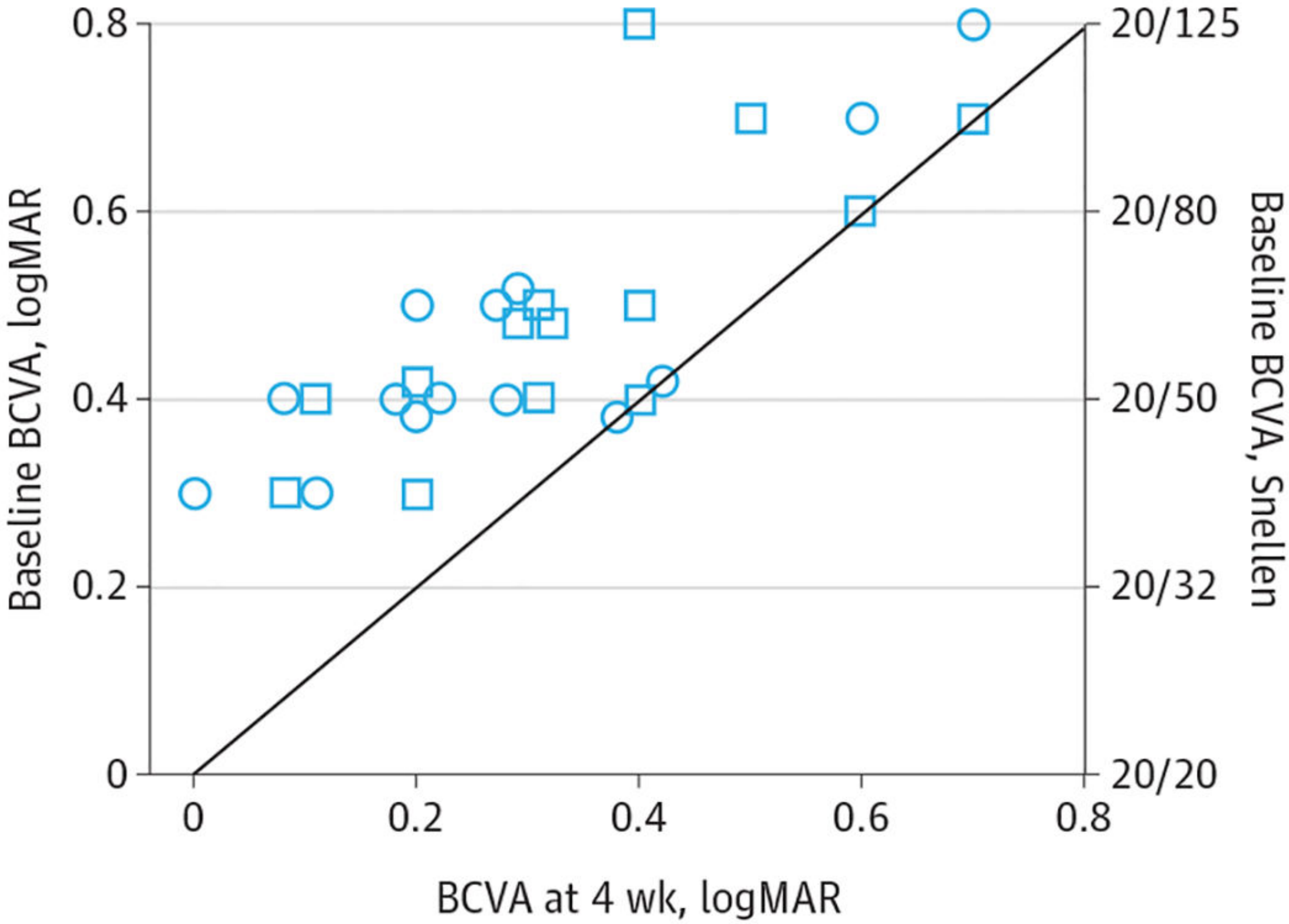

Figure 4. Best-Corrected Visual Acuity (BCVA) Improvement From Baseline at 4 Weeks

Shown is amblyopic eye BCVA for the binocular game first children (circles) and patching crossover children (squares) at the 4-week visit. Data points above the line indicate improvement. Overlapping symbols are slightly shifted for clarity.

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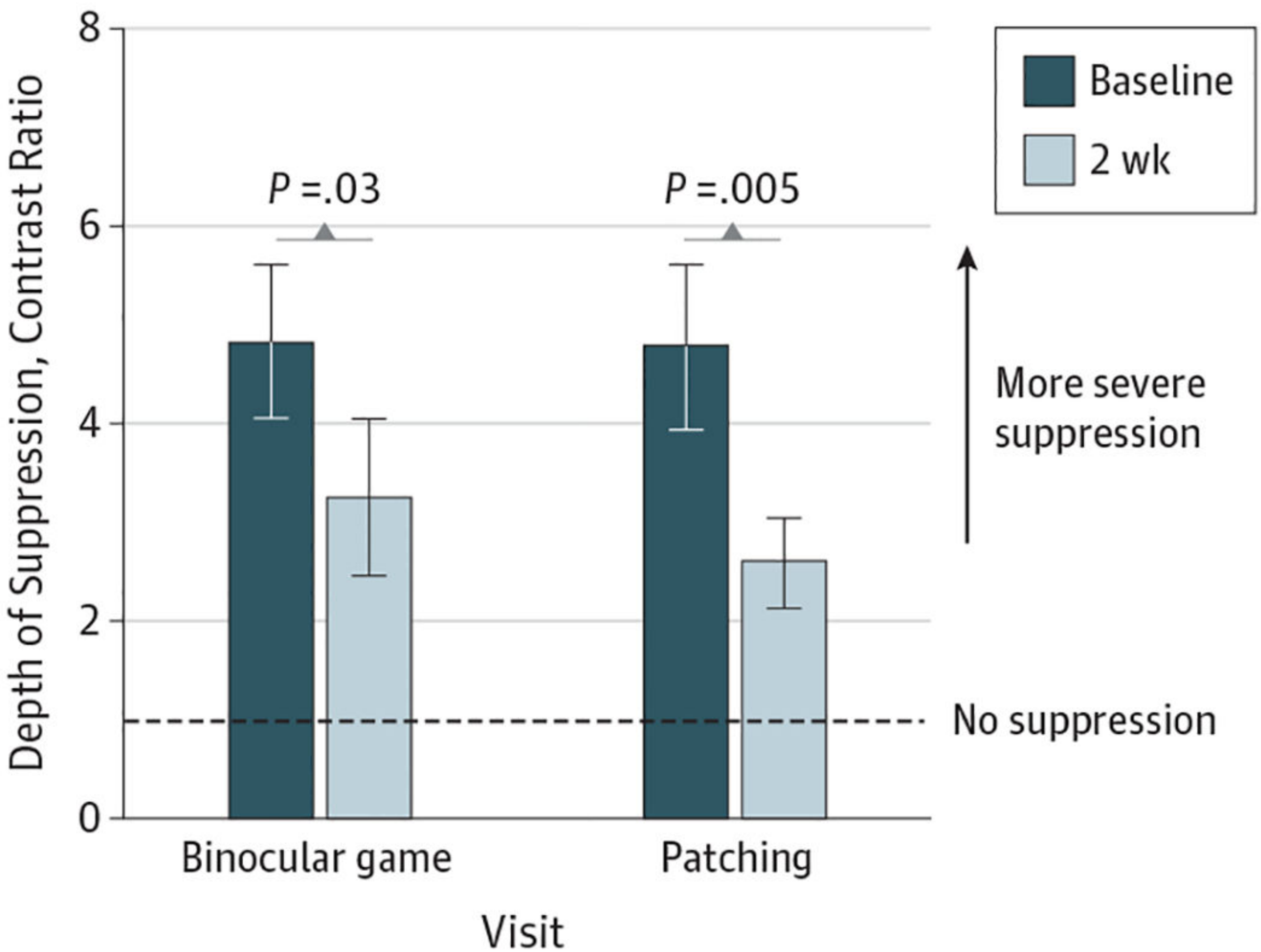

Figure 5. Improvement in Depth of Suppression

Depth of suppression improved from the baseline visit to the 2-week visit for the binocular game and patching. Error bars represent SEs.