

Defocus Incorporated Multiple Segments (DIMS) Spectacle Lens Use Enhances Pupil Dynamic Range in Myopic Children

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Purpose

- Defocus Incorporated Multiple Segments (DIMS) spectacle lenses have proven efficacy controlling myopia progression, but the precise elements of the myopic defocus effect are still unclear.
- This study investigates the effect of DIMS spectacle lenses on resting (scotopic) and daytime (photopic) pupil diameters and their potential link to myopia progression in a Hungarian pediatric cohort.

Methods

- Retrospective, interventional, non-randomized study
- Participant characteristics:
 - 57 progressive myopic patients recruited from a private clinic
 - Age 4–23 y (mean±SD: 10.60±3.09)
 - Spherical Equivalent Refraction (SER): -1.00 to -10.00D (-3.68±1.78)
 - Astigmatism up to -1.75DC
 - No ocular pathology
 - All participants were prescribed DIMS spectacle lenses
- Static pupillometry was measured under **scotopic** and **photopic** conditions using Topcon Myah topographer (Topcon, Tokyo, Japan).
- Key outcome measures:
 - Cycloplegic SER
 - Axial length (AL) (both published in¹),
 - Average pupil diameter under different lighting conditions
 - Pupil constriction amplitude at baseline, 6M and 12M

Analysis

- Participants' left eyes (always measured after the right) were analyzed to standardize light exposure before pupillometry
- Participants were divided into subgroups based on:
 - Baseline pupil diameter (partial vs. higher responders)
 - Constriction amplitude (below vs. above average responders)
 - SER increase (progressors: ≥0.50 D/year vs. non-progressors)
- Repeated measures ANOVA was used to analyze pupil changes with 'Time' as within-subject, and 'Responders' (partial/higher), and 'Progression' (progressors/non-progressors) as between-subject factors and their interaction terms
- Multiple regression analysis was performed to determine factors related to the degree of AL progression

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Results

Pupil Size Standardization

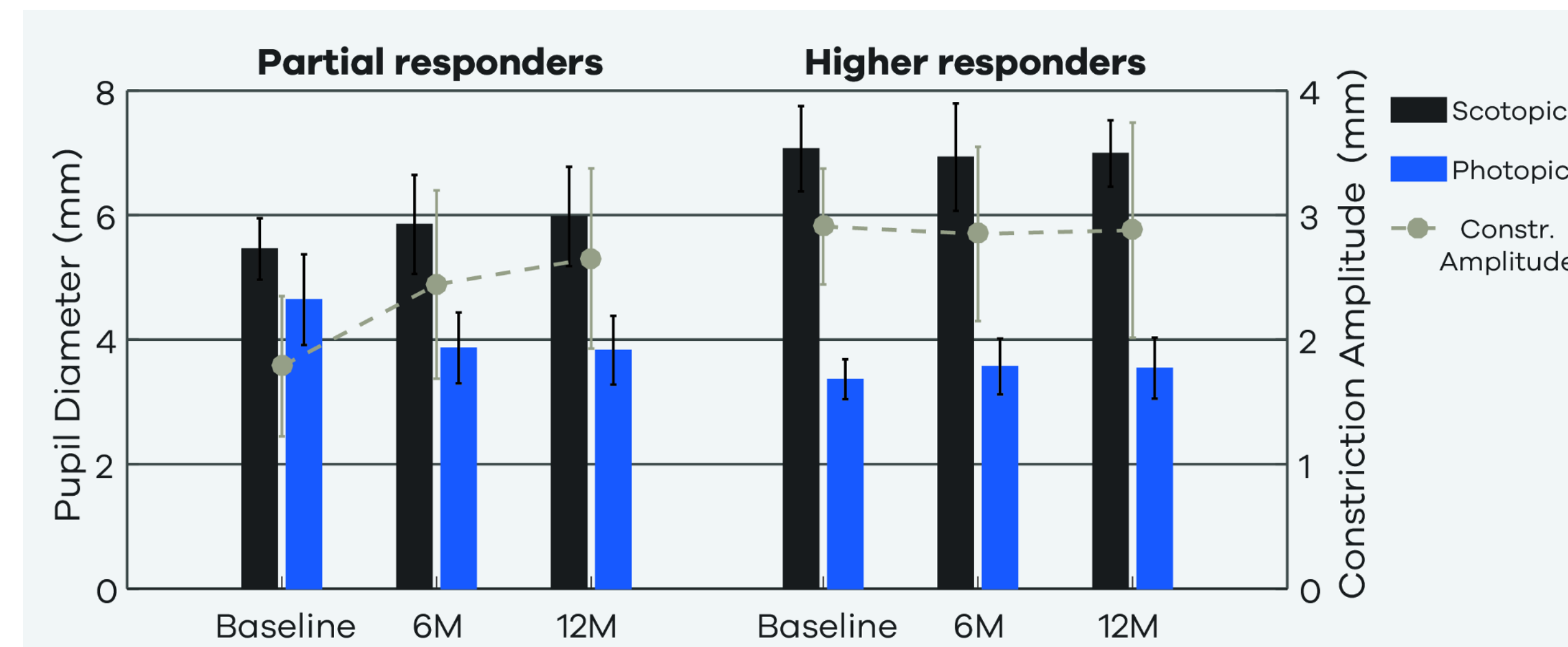


Figure 1. Average change over time in pupil diameter and constriction amplitude in the partial and high responders' subgroups separately. N=57, error bars: ±SD.

- Photopic pupil diameter decreased, while scotopic pupil diameter increased overall during DIMS treatment resulting in increased pupil constriction amplitudes already at 6M
- Differences across responders' subgroups (**Figure 1**):
 - Photopic** diameter **decreased significantly** in **partial responders** (higher initial diameter), and remained consistently small in higher responders (Time × Responders: $p < 0.0001$)
 - Scotopic** pupil diameter **increase** was also only **significant** in **partial responders** (smaller initial diameter), and remained consistently large in higher responders (Time × Responders: $p = 0.002$)
 - Constriction amplitude increase** was **significantly observable** in **below-average responders**, almost reaching the amplitude values of above-average responders, whose amplitude remained large (Time × Responders: $p = 0.0002$)

Pupil Size vs. Progression

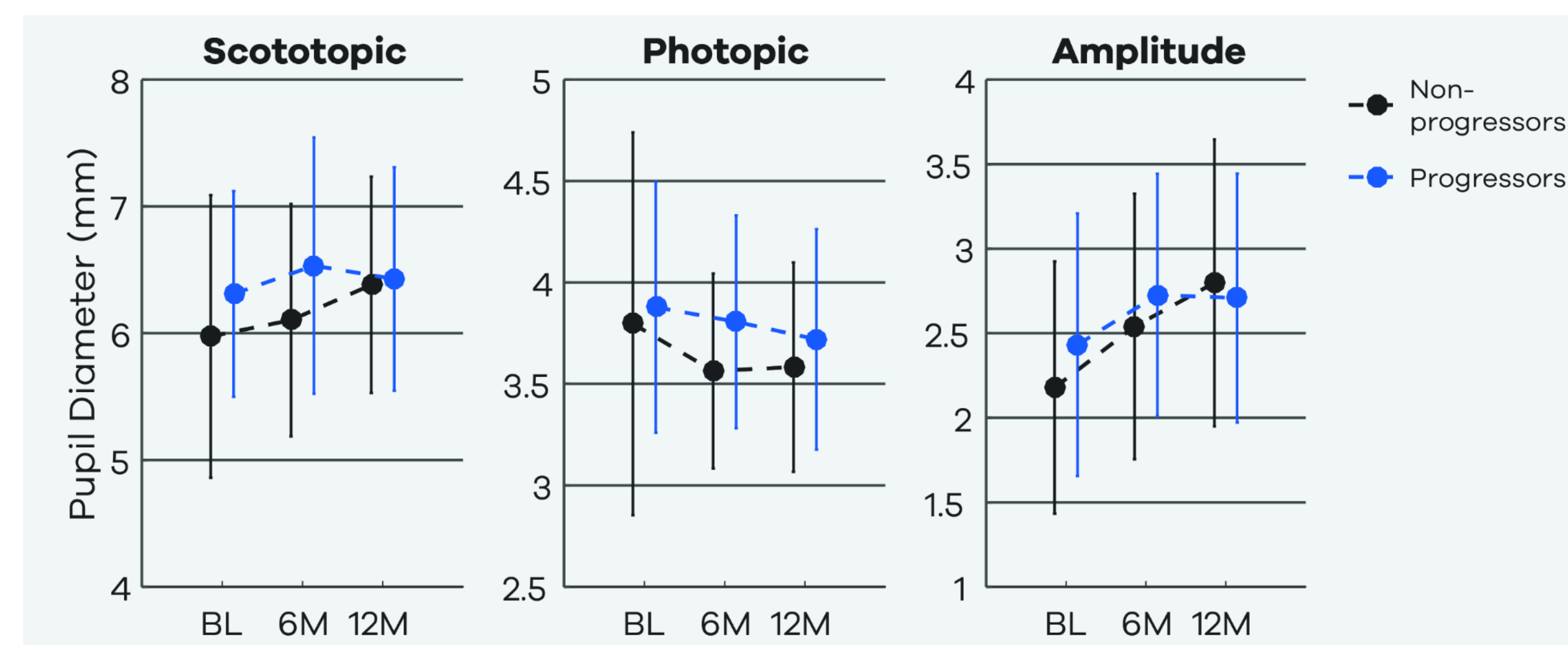


Figure 2. Average change over time in pupil diameter and constriction amplitude in non-progressors vs. progressors based on SER change at 12M. N=57, error bars denote ±SD.

Results continued

- Differences across progression subgroups (based on SER change at 12M, **Figure 2**):
 - Photopic decrease** was significantly more pronounced in **non-progressors** compared with progressors (Time × Prog: $p = 0.022$)
 - Non-progressors** tended to have **larger scotopic increase**, but the between-group difference did not reach significance (Time × Progression: $p = 0.081$)
 - Change in amplitude** was **not different** across progression groups (Time × Progression: $p = 0.41$)
- Mean AL elongation was 0.06 ± 0.09 mm and 0.14 ± 0.13 mm at 6M and 12M, respectively
- Multiple regression analysis:
 - The **amount of AL progression** was significantly **related to pupil constriction amplitude** (both baseline and change) **at 6M** (baseline: $p = 0.011$ and change: $p = 0.003$) but **not at 12M**.
 - This is in line with pupil diameter changes predominantly taking place by 6M

Conclusions

- DIMS spectacle lenses **induce rapid changes in pupil size**, contributing to **standardization** under given luminance conditions, simultaneously **enhancing the pupils' dynamic range**.
- Changes in **constriction amplitude** appear to be **related to AL progression** but not to SER change
- Absolute constriction amplitude (ACA), a similar measure, predominantly reflects parasympathetic activity, and has been shown to be decreased in moderate to high autonomic nervous system dysfunctions² as well as in myopia.³
- Further research is needed to explore the causal relationship of these changes and how they may be linked to the effectiveness of DIMS spectacle lenses.

References

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