Screening for Visual Difficulties in Early childhood – A Rationale for Using Large Scale Monitoring Data to Optimize the Identification of Children at Risk (Integral version)

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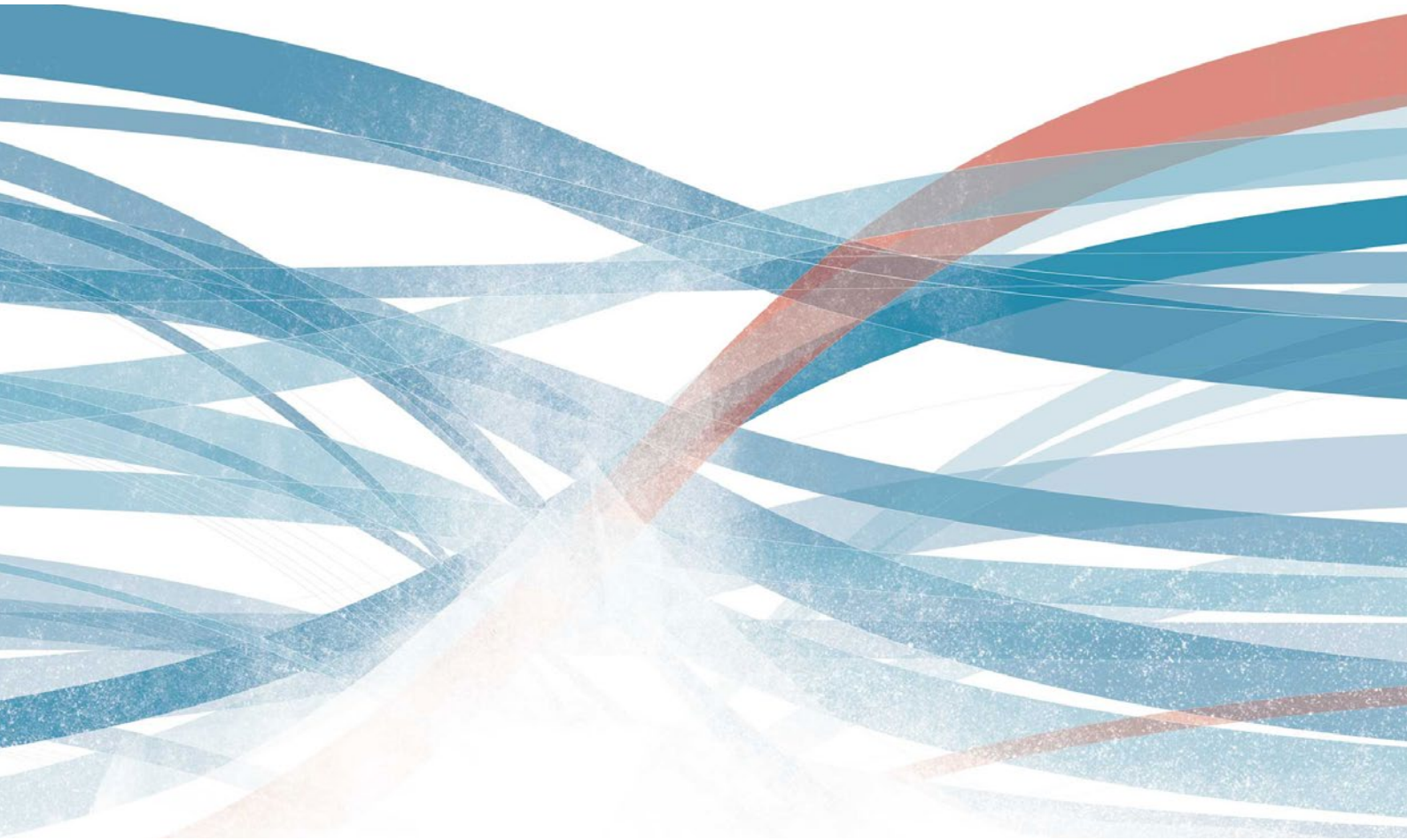

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Screening for Visual Difficulties in Early childhood – A Rationale for Using Large Scale Monitoring Data to Optimize the Identification of Children at Risk (Integral version)

Vision is crucial for day-to-day life. Human beings use their vision to navigate the world, to categorize and mentally organize their surroundings, to plan their actions and gestures, to socialize, to interact and to learn (Chokron & Dutton, 2022). Difficulties in the processing and interpretation of visual information can, therefore, be quite debilitating. In this paper, the term Visual Difficulties (VD) was employed to designate children who present difficulties in either lower- or higher-level visual processing. Higher level visual processing difficulties can empirically express in many ways, depending on the cerebral structures underlying the processing deficit (Philip & Dutton, 2014). With this, VD becomes an axis of inequality being situated among other (dis)ability-related factors.

Considering the importance of vision in everyday life, its impairment entails consequences in terms of learning that link directly to school performance (Chokron et al., 2010). Early screening and identification of children at risk is, therefore, extremely important, not only to prevent longitudinal learning costs that come with undiagnosed VD, but also to ensure that adequate aids are set in place (Boonstra et al., 2022). Areas such as reading (Chokron et al., 2021), writing (Dutton, 2003), mathematics (Barclay, 2015), conceptualization (Dutton, 2003), motion (Chokron & Dutton, 2016) and interactions with the environment (Chokron et al., 2021) are particularly vulnerable.

To minimize the extent to which VD are left undiagnosed and, therefore, interfere long-term with scholastic achievements, the Luxembourg Centre for Educational Testing (LUCET) of the University of Luxembourg and the *Centre pour le Développement des compétences relatives à la Vue* (CDV) of the Ministry of Education, Children and Youth (MENJE), joint forces. The LUCET is responsible for the national school monitoring programme, called *Épreuves Standardisées* (ÉpStan), a standardized nationwide large-scale assessment tool to evaluate whether key school competences, as defined by the national school curriculum, are achieved. The CDV, as part of its institutional mission, is responsible for the individual screening of grade 1 children's neurovisual and visual functions' competences. This screening is done on a one-to-one basis at school and takes around 20 minutes. It consists of measures targeting lower-level visual processing (e.g. visual acuity, color perception, contrast sensitivity) that are evaluated by an optometrist or an orthoptist and of measures targeting higher level visual processing (e.g., visual memory, selective visual attention, visual recognition) that are evaluated by a trained psychologist. The goal of the partnership between LUCET and CDV is to develop a set of visual tasks composing a pre-screener, i.e., a brief large-scale assessment aiming to flag students potentially struggling with VD, as early as the beginning of fundamental schooling, to be able to set up support strategies and prevent lowered academic performance resulting from VD (Schmidgall et al., 2017). By integrating the pre-screener into the national school monitoring, the access to the individual screening of higher and lower-level visual capacities can be rolled out to a nation-wide level, as children who might be at risk of VD would first be selected by the pre-screener and then pass the individual assessment to

test the hypothesis. The visual tasks developed for the pre-screener underwent procedures of quality control before being integrated in the school monitoring programme. They were first included in a sample of ÉpStan's pretest booklets (N = 1129) in the school year of 2021-2022. The same children who participated in the visual tasks of the ÉpStan pretest also participated in the CDV's individual screening.

To investigate the effect of VDs on school performance, the performance of children identified as being at risk of VD was compared to typically developing (TD) children, in the domains of early literacy, mathematics and listening comprehension at the beginning of grade 1. VD children showed ophthalmological (n = 189), visuo-attentional (VA) (n = 38), or both ophthalmological and visuo-attentional difficulties (n = 12). This chapter focuses solely on the children with ophthalmological difficulties who struggled with the visual measures administered by optometrists and orthoptists thus suggesting vulnerabilities with lower-level visual processing (e.g., monocular visual acuity, color discrimination, binocular visual acuity under optimal conditions as well as under reduced contrast conditions). Children who did not display any difficulties on lower and/or higher-level visual measures were classified as TD (n = 890). The descriptives of children's background characteristics per group can be found in Table 1.

Table 1: **Distribution of children's background characteristics across screening outcomes**

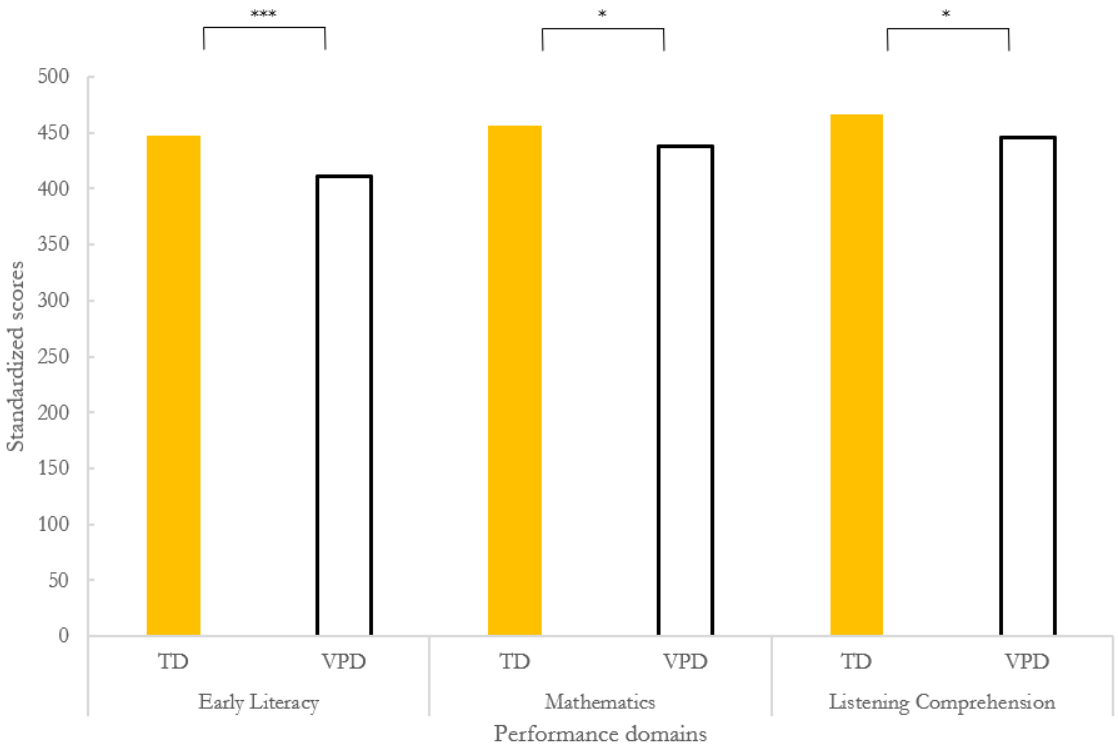
		VD Subgroups			
Screening outcome		**TD**	**Ophthalmological**	**VA**	**VA & Ophthalmological**
Gender (N)	Female	445	63	18	6
	Male	430	124	20	6
Home language (N)	Lux/Ger	379	80	14	5
	Other	511	109	24	7
Migration profile (N)	Native	380	73	18	2
	Non-native	380	87	13	7
Educational level (N)	Low	265	57	10	4
	High	485	97	17	5

Note: (VD = Visual Difficulties, TD= Typically developing performance above the defined cut-offs for visuo-attentional and ophthalmological measures, VA= Visuo-attentional: performance below the defined cut-offs for visuo-attentional measure; VA & Ophthalmological= Visuo-attentional & Ophthalmological: performance below the defined cut-offs for both visuo-attentional measure and visual measures applied by optometrists and orthoptists).

To investigate the potential impact of VD (exclusively at lower level of visual processing) on academic performance in grade 1 competence tests, a forward stepwise linear regression was used to model the relationship between being flagged (with ophthalmological difficulties) as predictor variable and the performance scores in the domains of early literacy, mathematics and listening comprehension as outcome variables, whilst controlling for background variables known to influence school performance

(Hornung et al., 2021) such as the Socio-Economic Status (SES) derived from the highest International Socio-Economic Index of Occupational Status in the household (Ganzeboom et al., 1992), gender, language spoken at home, level of parental education and migration status.

Figure 1: **Impact of ophthalmological diagnosis on performance whilst controlling for background variables (SES, gender, language spoken at home, level of parental education and migration status)**



Note: *p < .05; *** p < .001

TD = Typically Developing; VD = Visual Difficulties (including solely ophthalmological subgroups)

Figure 1 shows the impact of ophthalmological difficulties on children's performance in the three competence domains assessed. TD children significantly outperformed peers with ophthalmological difficulties in all three competency domains, even after controlling for background variables that are already known to influence performance[1]. Thus, the performance differences show regardless of the visual content that needed to be processed within the ÉpStan's competence tests, which was less visually

[1] We focused solely on the subsample of ophthalmological children due to space restraints, however the results of the VA group go in a similar direction to the ones of the ophthalmological sample for mathematics and early literacy, but not for listening comprehension where VA and TD children perform at the same level (cf. Monteiro et al., 2023).

demanding for the competence of listening comprehension when compared to mathematics or early literacy.

To check for performance differences depending on the VD profile, the ophthalmological group was further divided into 4 subgroups:

1. Children who underperformed in the binocular visual acuity for near vision and in the low contrast sensitivity in near vision (10 % plate) LEA symbols optotypes were considered as the binocular visual acuity disorder (VAD) subgroup.
2. Children who struggled to perform in the monocular LEA symbols optotypes were classed as the monocular visual acuity disorder (VAD) subgroup.
3. Children who had difficulties in color discrimination in the Ishihara plates were assigned to the color vision disorder group.
4. Children whose profile was a combination of monocular visual acuity disorder (VAD) for far and binocular VAD for near vision were classed together.

Analyses of variance (ANOVA) on performance scores between ophthalmological subgroups and TD children were conducted. For all competences tested, the scores yielded significant variation among subgroups[2]. The multiple comparisons of ophthalmological sub-groups' performances in the three competency domains can be found on Table 2. For all three competency domains the subgroup of children with visual acuity disorder performed significantly below TD peers. In the competency of listening comprehension children with color vision difficulties performed above children whose visual acuity was affected (but still below TD children).

[2] $F_{(4, 1042)} = 4.44$, $p = .001$, $\eta^2 = .017$. For early literacy the performance scores equally held significant variation among subgroups $F_{(4, 979)} = 8.35$, $p < .0001$, $\eta^2 = .033$ as they did for listening comprehension $F_{(4, 992)} = 6.76$, $p < .0001$, $\eta^2 = .027$.

Table 1: **Multiple group comparisons between the 4 subgroups using post hoc Tukey HSD tests per competency domain**

Competency	Subgroup (I)	Subgroup (J)	Mean difference (I-J)	Sig.
Mathematics	Typically Developing	Binocular VAD	16.75	.620
		Color VD	-5.20	.998
		Monocular VAD	**42.57**	**.001**
		Monocular & Binocular VAD	16.24	.906
	Binocular VAD	Color VD	-21.94	.799
		Monocular VAD	25.82	.454
		Monocular & Binocular VAD	-.50	1.00
	Color VD	Monocular VAD	47.78	.090
		Monocular & Binocular VAD	21.44	.904
Early Literacy	Typically Developing	Binocular VAD	28.65	.338
		Color VD	12.68	.978
		Monocular VAD	**77.10**	**.000**
		Monocular & Binocular VAD	47.73	.321
	Binocular VAD	Color VD	-16.00	.973
		Monocular VAD	48.45	.122
		Monocular & Binocular VAD	19.08	.965
	Color VD	Monocular VAD	64.42	.087
		Monocular & Binocular VAD	35.05	.823
Listening Comprehension	Typically Developing	Binocular VAD	19.39	.670
		Color VD	-18.22	.888
		Monocular VAD	**65.69**	**.000**
		Monocular & Binocular VAD	8.70	.996
	Binocular VAD	Color VD	-37.61	.517
		Monocular VAD	46.30	.106
		Monocular & Binocular VAD	-10.69	.995
	Color VD	**Monocular VAD**	**83.91**	**.003**
		Monocular & Binocular VAD	26.92	.897

Note: VAD= Visual Acuity Disorder; VD= Vision Disorder

The negative impact of lower-level VDs on scholastic performances, jointly with the nation-wide range of the pre-screener that allows to reduce resource allocation, helping to implement CDV's mission of individualized screening at a national scope and maximize VDs detection strategy, provide a rationale for the development and integration of visual screening tools targeting larger samples. These would aid the early identification of children at risk and subsequent interventions to adapt to these children's

needs, formerly identified in research (Barclay, 2015) and now firstly identified in the Luxembourgish context.

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