

Linguistic Features Identify MS-related Early Cognitive Impairment in Narrative Speech

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INTRODUCTION AND PURPOSE

More than half of people with Multiple Sclerosis (pwMS) are cognitively impaired, and many more experience significant cognitive decline that impacts real life functioning (Sumowski et al., 2018). To characterize and measure the individual decline that impacts the life of pwMS, low-burden monitoring tools for cognition are required. Digital speech-based biomarkers can validly assess cognition (Robin et al., 2020) and can be administered remotely, and so may be useful for the detection and monitoring of cognitive impairment in MS. The aim of the present work is to investigate the potential of speech-based, remote and objective biomarkers for the assessment of cognition.

METHODS

Administration of the Cookie Theft Picture Description task was recorded in a sample of $n = 169$ German speaking participants (76 pwMS, 93 healthy controls (HC)). $N = 48$ pwMS had low levels of disability (Expanded Disability Status Scale (EDSS) score 1-3). The picture contains 25 concepts including actions, actors, objects and places. Linguistic features assessing the content of speech, word properties, timing and sentence structure were extracted and compared in HC and pwMS, and to pwMS with low levels of disability.

RESULTS

The number of correctly named concepts that are depicted in the scene significantly differed between HCs and pwMS ($p < .001$; Table 1). The effect remains significant even when only pwMS with low disability were considered in the analysis (Table 2). The number of words and the length of utterances did not differ between groups. Further linguistic features, such as the number of verb clauses significantly differed between HCs and pwMS.

Table 1
Group comparison of lexical features between HCs and pwMS

Feature	p-value	Adjusted p-value	Effect size	HC vs. pwMS
Number of correct concepts	<.001	.036	0.53	>
Proportion of verb phrases	<.001	.001	0.74	>
Number of subordinate clauses	.008	<i>n.s.</i>	0.39	>
Total phonation time	.042	<i>n.s.</i>	0.28	>
Word count	.043	<i>n.s.</i>	0.28	>
Variability of pause length	<i>n.s.</i>	<i>n.s.</i>	-	-
Mean pause duration	<i>n.s.</i>	<i>n.s.</i>	-	-

Note. Group comparisons were performed using Kruskal-Wallis test.

CONCLUSION

Linguistic features derived from a picture description task significantly differed between HCs and pwMS. PwMS showed a reduction in the number of correctly named items. Since pwMS did not produce less speech, the lower number of informational units is consistent with the conclusion that cognitive impairment is the source of the difference seen. However, the effect sizes are low. Speech-based biomarkers show great promise for low-burden detection and monitoring of cognitive impairment in MS, even at an early impairment stage.

Figure 1

The Cookie Theft Picture (Goodglas & Kaplan, 1983). Items highlighted according to Croisile et al.'s (1996) breakdown



Actors: boy, girl, mother **Places:** kitchen, exterior **Objects:** faucet, water, sink, floor, dishes on the counter, counter, cookies, jar, cabinet, stool, window, curtain.
Actions: boy taking the cookie, boy/stool falling, mother washing the dishes, girl asking for a cookie, mother unconcerned by overflowing, mother not noticing the children

Table 2
Group comparison of lexical features between HCs and pwMS with EDSS 1-3

Feature	p-value	Adjusted p-value	Effect size	HC vs. pwMS
Number of correct concepts	.004	<i>n.s.</i>	0.63	>
Proportion of verb phrases	<.001	.011	0.22	>
Number of subordinate clauses	.022	<i>n.s.</i>	0.36	>
Total phonation time	<i>n.s.</i>	<i>n.s.</i>	-	-
Word count	<i>n.s.</i>	<i>n.s.</i>	-	-
Variability of pause length	.020	<i>n.s.</i>	0.37	-
Mean pause duration	<i>n.s.</i>	<i>n.s.</i>	-	-

Note. Group comparisons were performed using Kruskal-Wallis test.

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DISCLOSURES

Susett Garthof and Julia Elmers have nothing to disclose. Anja Dillenseger received personal compensation and travel grants from Biogen, Celgene/Bristol-Myers Squibb, Roche, Janssen-Cilag and Sanofi for speaker activity. Tjalf Ziemssen reports personal fees for lecturing and consulting from Biogen, BMS, F. Hoffmann-La Roche Ltd, Merck, Novartis, Sanofi, Teva and Almirall; and grants or research support from Biogen, F. Hoffmann-La Roche Ltd, Teva, Sanofi and Novartis. Simona Schäfer, Nicklas Linz, Johannes Tröger are employees of ki:elements GmbH. Nicklas Linz and Johannes Tröger are shareholders of ki:elements. Björn Tackenberg, Tina Boggiano, Jan Wesiack and James Overell are employees of F.Hoffmann-LaRoche AG, Switzerland.