Evidence for a global oculomotor program in reading

Supplementary Materials

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**Multiple regressions on saccade amplitudes in non-equal length
Sentences (S1), Shuffled (S2), and Z-string (S3)**

Table S1: Fixed effects of the multiple regression model fitted to incoming saccade amplitudes in non-equal length sentences (N = 2460, 184 items, 38 participants). The SD of the residual is 0.730, the SD of random intercepts for item and participant is 0.244 and 0.296, and the SD for the by-participant random slope of word position is 0.355. The correlation between the latter two is -0.26. "Rcs" stands for restricted cubic splines, fitted with 3 knots.

	Estimate	Std. Error	Df	t-value	p-value
Intercept	1.500	0.156	214.220	9.953	<0.001
Word Length	0.0323	0.022	170. 910	1.465	0.145
Word position, rcs term 1	2.171	0.271	275.630	8.009	<0.001
Word position, rcs term 2	-2.073	0.384	258.180	-5.397	<0.001

Table S2: Fixed effects of the multiple regression model fitted to incoming saccade amplitudes in non-equal shuffled sentences (N = 1547, 179 items, 38 participants). The SD of the residual is 0.912, the SD of random intercepts for item and participant is 0.273 and 0.352, and the SD for the by-participant random slope of word position is 0.882. The correlation between the latter two is -0.23. "Rcs" stands for restricted cubic splines, fitted with 3 knots.

	Estimate	Std. Error	df	t-value	p-value
Intercept	1.179	0.203	160.200	5.796	<0.001
Word Length	0.080	0.029	141.600	2.739	0.007
Word position, rcs term 1	3.375	0.419	224.180	8.049	<0.001
Word position, rcs term 2	-4.369	0.709	236.220	-6.159	0.011

Table S3: Fixed effects of the multiple regression model fitted to incoming saccade amplitudes in non-equal Z strings (N = 2435, 185 items, 38 participants). The SD of the residual is 0.691, the SD of random intercepts for item and participant is 0.268 and 0.253, and the SD for the by-participant random slope of word position is 0.370. The correlation between the latter two is -0.45. "Rcs" stands for restricted cubic splines, fitted with 3 knots.

	Estimate	Std. Error	df	t-value	p-value
Intercept	1.561	0.157	218.990	9.917	<0.001
Word Length	0.065	0.023	176.520	2.836	0.005
Word position, rcs term 1	0.966	0.273	304.850	3.536	<0.001
Word position, rcs term 2	-1.217	0.407	274.620	-2.993	0.003

**Segmented regression on saccade amplitudes in equal length
Shuffled and Z-string (S4)**

Table S4: Best-fitting segmented and linear regression models for shuffled sentences and z-strings in the equal condition, with saccade amplitude as a function of word position.

	Word Length	Predictor	Estimate	Std. Error	t value	Pr(>/t/)
Shuffled	4	Intercept	2.143	0.199	10.746	<0.001
		WordPos	0.628	0.346	1.814	0.071
	5	Intercept	2.043	0.176	11.611	<0.001
		WordPos	0.987	0.306	3.222	0.001
	6	Intercept	2.479	0.171	14.508	<0.001
		WordPos	0.550	0.304	1.811	0.071
	7	Intercept	2.746	0.199	13.776	<0.001
		WordPos	0.766	0.349	2.197	0.029
Z-strings	4	Intercept	1.863	0.045	40.988	<0.001
		WordPos	0.042	0.077	0.553	0.581
	5	Intercept	2.141	0.046	46.719	<0.001
		WordPos	0.038	0.077	0.500	0.617
	6	Intercept	2.230	0.061	35.516	<0.001
		WordPos	0.268	0.103	2.605	0.009
	7	Intercept	2.594	0.066	39.289	<0.001
		WordPos.Segment1	0.260	0.114	2.280	0.023
		WordPos.Segment2	-36.046	26.766	-1.347	

Multiple regressions on single fixation durations in non-equal length
Sentences (S5), Shuffled (S6), and Z-string (S7)

Table S5: Fixed effects of the multiple regression model fitted to single fixation durations in non-equal length sentences (N = 2460, 122 items, 38 participants). The SD of the residual is 84.49, the SD of random intercepts for item and participant is 10.53 and 37.36 and the SD for the by-participant random slope of word position is 50.77. The correlation between the latter two is -0.70.

	Estimate	Std. Error	Df	t-value	p-value
Intercept	194.219	12.452	143.200	15.597	<0.001
Word Length	4.112	1.675	381.400	2.455	0.015
Word position	28.534	12.264	38.700	2.327	0.025

Table S6: Fixed effects of the multiple regression model fitted to single fixation durations in non-equal shuffled sentences (N = 2435, 122 items, 38 participants). The SD of the residual is 121.49, the SD of random intercepts for item and participant is 13.41 and 27.38, and the SD for the by-participant random slope of word position is 25.49. The correlation between the latter two is 0.07.

	Estimate	Std. Error	Df	t-value	p-value
Intercept	242.414	15.793	154.000	15.349	<0.001
Word Length	5.820	2.397	482.300	2.428	0.016
Word position	16.441	13.250	30.800	1.241	0.224

Table S7: Fixed effects of the multiple regression model fitted to single fixation durations in non-equal Z strings (N = 1547, 123 items, 38 participants). The SD of the residual is 126.11, the SD of random intercepts for item and participant is 0.00 and 66.54, and the SD for the by-participant random slope of word position is 90.97. The correlation between the latter two is -0.49.

	Estimate	Std. Error	Df	t-value	p-value
Intercept	264.038	20.685	239.400	12.765	<0.001
Word Length	-0.325	2.890	1499.700	-0.113	0.910
Word position	2.406	20.562	39.400	0.117	0.907

**Multiple regressions on single fixation durations in equal length
Sentences (S8), Shuffled (S9), and Z-string (S10)**

Table S8: Fixed effects of the multiple regression model fitted to single fixation durations in equal length sentences (N = 3732, 112 items, 38 participants). The SD of the residual is 92.17, the SD of random intercepts for item and participant is 12.71 and 27.24 and the SD for the by-participant random slope of word position is 21.63. The correlation between the latter two is 0.24.

	Estimate	Std. Error	Df	t-value	p-value
Intercept	159. 340	10.510	183.700	15.161	<0.001
Word Length	11.690	1.470	445.400	7.956	<0.001
Word position	45.820	10.830	40.700	4.232	<0.001

Table S9: Fixed effects of the multiple regression model fitted to single fixation durations in equal shuffled sentences (N = 3563, 109 items, 38 participants). The SD of the residual is 113.050, the SD of random intercepts for item and participant is 23.600 and 45.560, and the SD for the by-participant random slope of word position is 67.05. The correlation between the latter two is -0.47.

	Estimate	Std. Error	Df	t-value	p-value
Intercept	230.652	15.038	171.300	15.338	<0.001
Word Length	7.642	2.006	495.000	3.809	<0.001
Word position	47.183	18.558	71.400	2.543	0.013

Table S10: Fixed effects of the multiple regression model fitted to single fixation durations in equal Z strings (N =874, 71 items, 38 participants). The SD of the residual is 124.754, the SD of random intercepts for item and participant is 9.463 and 86.944, and the SD for the by-participant random slope of word position is 37.684. The correlation between the latter two is -1.00.

	Estimate	Std. Error	df	t-value	p-value
Intercept	232.957	29.156	95.650	7.990	<0.001
Word Length	4.579	4.066	77.060	1.126	0.264
Word position	1.005	21.620	11.340	0.046	0.964

Non-equal length stimuli

1. a. His boss is thirty years old and has never thrown a party.(Sentence)
   b. Try bids at muffin banks tea tin fun apply blinks a clock. (Shuffled)

2. a. The ducks swim in the pond near the bridge. (Sentence)
   b. Bay chase trim to fly turn belt ear chills. (Shuffled)

3. a. The lock on the door to the shed is rusty. (Sentence)
   b. Tin leak to ate four by too eyes crisp. (Shuffled)

4. a. Dao is a talented artist but lacks initiative. (Sentence)
   b. Tin by a trailing student ten badge maximizing. (Shuffled)

5. a. The rancher hunts on his own property. (Sentence)
   b. Bus captain goals by air boy awakened. (Shuffled)

6. a. The hunters on the expedition are all women. (Sentence)
   b. Lit camping an dig embezzling how kid chair. (Shuffled)

7. a. The boys cashed the three checks yesterday. (Sentence)
   b. Dot four origin try dirty ageless cheekiest. (Shuffled)

8. a. The trust fund spells out the terms of agreement. (Sentence)
   b. Bye truck fish boots jog jam agree an squeezing. (Shuffled)

9. a. The fresh flowers filled the room with a nice smell. (Sentence)
   b. Dry burns abiders drive may dove pans a zaps thief. (Shuffled)

10. a. They rushed the crash victims to the hospital.(Sentence)
    b. Harp boasts see glows ceasing an tip breaking. (Shuffled)

11. a. The famous singer disappointed his fans multiple times. (Sentence)
    b. Ten causes dainty jackhammered ban team bolsters rocks. (Shuffled)

12. a. A sudden thunderstorm created havoc on the freeways. (Sentence)
    b. A career maximization culprit fancy to spa chickens. (Shuffled)

13. a. A simple marital contract is common in this situation. (Sentence)
    b. A noises quizzes frosting if degree on save downsized. (Shuffled)

14. a. His tight clothing restricts his movement on the dance floor. (Sentence)
    b. Toy elite fruitful expectant cub framings to fee earns kings. (Shuffled)

15. a. They disinfect all the equipment at the end of each day. (Sentence)
    b. Snow extensive bag bum histamine to tie not if flow yes. (Shuffled)

16. a. The problem of the test sounds was too complicated for the technician. (Sentence)
    b. Pet assault as bed gulp basket dot tub abbreviated rum ate accountant. (Shuffled)

17. a. The woman sampled his famous sandwich and cheesecake. (Sentence)
    b. Shy bonds firstly top esteem finalize spy adductions. (Shuffled)

18. a. His tactless comments insult many people. (Sentence)
    b. Zit quizzes dialysis annoys bear engulf. (Shuffled)

19. a. The building inspector detected a faint smell of gas. (Sentence)
    b. Toe despised academics elevator a gowns lends to wag. (Shuffled)

20. a. The professor was annoyed by the list of addresses. (Sentence)
    b. Rig announces tan focuses so men ants an explains. (Shuffled)

21. a. Jake decided to go through the tunnel on the way to work. (Sentence)
    b. Born fixates by of account lap engulf to all bit an bunt. (Shuffled)

22. a. The book read in the class was about a man in the work force. (Sentence)
    b. Tie horn tips to fit grand old mayor a pal to sir brew paths. (Shuffled)

23. a. The paper on the bottom of the pile was presented to the committee for review. (Sentence)
    b. For merge or jug equals an fin burn zoo astounded by gum factoring tea puzzle. (Shuffled)

24. a. The beautiful roses in the vase near the window are from her mom. (Sentence)
    b. Off collecting picks to vow cold exit cuff jumped rye hair sly out. (Shuffled)

25. a. The ball rolled down the stairs and stopped on the landing. (Sentence)
    b. Man fall window flow cat fridge bat picture to fat dialing. (Shuffled)

26. a. The hunters had walked through the thick bush to track the bears to the river. (Sentence)
    b. Pea charged boo bounce damages lay earth moth by quest tea pears my win candy. (Shuffled)

27. a. The trash in the garbage pail started to rot from the heat of the sun. (Sentence)
    b. Car hello on lap fighter deer nothing in top free bit leaf to far lever. (Shuffled)

28. a. The sailors were told to scrub the decks with a strong disinfectant.(Sentence)
    b. Fry lighter flee pine it clock fit rails mean a bring taxidermists. (Shuffled)

29. a. The money between the pages belongs to the previous owner of this book. (Sentence)
    b. Lip seven glasses new night merging in bee hydrants power by seen dime. (Shuffled)

30. a. The talk show host was stunned by the accusation of the audience member. (Sentence)
    b. Dip dumb tree blob fur kingdom on pea television if try chickens cancer. (Shuffled)

31. a. The transaction at the bank for a home equity loan will be finalized without any problems. (Sentence)
    b. Tar development by bar mice lie a wind willow fine den me mannerism cuback sit cemetery. (Shuffled)

32. a. We were looking for the perfect house to buy for our retirement. (Sentence)
    b. Me hide follows buy per zoomed moose in fly now depression. (Shuffled)

33. a. The swimmer had been seeing a special trainer for strength exercises. (Sentence)
    b. Pop cutback eye ruin mellow I bowling jingle why laughing triggered. (Shuffled)

34. a. The workers can wax the car with this soft cloth.(Sentence)
    b. Pip bruises rye pit one see fly dish chew right moth. (Shuffled)

35. a. The parents could hum a tune to the baby in the crib. (Sentence)
    b. Try catered night hit a seed by cry lean to lit form. (Shuffled)

36. a. The theme for the party was childhood story book characters. (Sentence)
    b. Too dinner tie bin devil dye hindering inner chick grapefruit. (Shuffled)

37. a. The graceful dancer and her partner glided across the stage. (Sentence)
    b. Zit steering dingle sip hip crunches tinkle slicer you strip. (Shuffled)

38. a. The boy was biting his nails and wringing his hands. (Sentence)
    b. Odd low pan falcon met patio may hopeless oat fuzzy. (Shuffled)

39. a. The final draft of the term paper must be delivered by noon. (Sentence)
    b. Net rally scold to sew sold foamy torn to assertive if germ. (Shuffled)

40. a. Her progressive ideas will win valuable votes during the next election. (Sentence)
    b. Six juxtaposing taxes hat hip idealize tango forced flu fine humbling. (Shuffled)

41. a. The black ashes from the volcano filled the air and covered the green hills. (Sentence)
    b. Tip swear today each red lowered allow mug old out markers yam super deals. (Shuffled)

42. a. This special protein drink should make athletes feel powerful and energetic. (Sentence)
    b. Turn alcohol yawning hints brings zoom adhesion wild blankets sun clippings. (Shuffled)

43. a. The man wanted a brief interview with the chief negotiator. (Sentence)
    b. Fan fit bushes a known departure head net learn abacterial. (Shuffled)

44. a. The baby is tiny and has green eyes and brown hair. (Sentence)
    b. Lot subs so kite won ego blogs mark call pager spay. (Shuffled)

45. a. They bought new shelf paper to put in the kitchen cupboards. (Sentence)
    b. From arrest fin wiped world by all to try abdomen cancelled. (Shuffled)

46. a. The judge was lenient and patient with the young offender. (Sentence)
    b. Jot corny sap browsed tea clamped meal van boots ancestry. (Shuffled)

47. a. The conscientious objectors marched and protested in front of the building. (Sentence)
    b. Sit abnormalities clearance parking mom dandelion it banjo to ill archive. (Shuffled)

48. a. The principle accepted credit for the morale of her teachers and students. (Sentence)
    b. One immigrant computer napkin ego yes orange by rip backflip icy employed. (Shuffled)

49. a. The government provides taxpayers with the directions for filing tax forms. (Sentence)
    b. Say acquainted epidural activated food all addictions try placid bet never. (Shuffled)

50. a. Every dog owner thinks his or her animal is the best in the world. (Sentence)
    b. Arrow fan apply bailed log by low beaten to pop door is rat below. (Shuffled)

Equal length stimuli

1. a. Tina knew when Matt came back home. (Sentence)
   b. Stem sons rims noun keep hero gift. (Shuffled)

2. a. Lara says that they went home then. (Sentence)
   b. Stem sons rims noun keep hero gift. (Shuffled)

3. a. Sarah feels angry while Julia feels happy.(Sentence)
   b. Cleft entry inner minor money niece plant. (Shuffled)

4. a. David shows pride while Molly feels glory.(Sentence)
   b. Prove dwell begin creed niche bliss smoke . (Shuffled)

5. a. Common people should attend church weekly. (Sentence)
   b. Abuses accost doable flayed froths jumble. (Shuffled)

6. a. Carrie worked around social people during school. (Sentence)
   b. Belief bloody earing easily father ground groove. (Shuffled)

7. a. Elected congress present serious future changes. (Sentence)
   b. Fuzzier euphoric perplex zoology quench buckled. (Shuffled)

8. a. Mathew decided against picking certain services outside America. (Sentence)
   b. Expand privacy sandbox unclamp playful sneezed plumper quarrel. (Shuffled)

9. a. Business research students question American economic security.
   b. Boondock category extremes finalist fibrosis grilling foremost.

10. a. Mean Pete took rice with beef away from Kate. (Sentence)
    b. Arms aunt trial tray fame away flow torn back. (Shuffled)

11. a. Most tiny dogs want love more than free food. (Sentence)
    b. Frog fuzz goal hole jaws kiwi nuts plug fake. (Shuffled)

12. a. Baked sweet bread often makes hungry mouths water. (Sentence)
    b. Quail trail quick radio sacks scalps shells tasty. (Shuffled)

13. a. Young bison wander lands where aging moose never visit.(Sentence)
    b. Abort draws pints flows devil funds flaps icons mopes. (Shuffled)

14. a. Pretty ladies prance around glassy lakes waving dainty pansies. (Sentence)
    b. Shorty sinner simile recoils punchy froze dazzle corner cookies. (Shuffled)

15. a. Frantic crowds walked across Market Street toward Palace Square. (Sentence)
    b. Aroused puzzle cashed adults allied bleach bumper blurts dumping. (Shuffled)

16. a. Michael enjoyed playing Frisbee outside despite extreme weather.(Sentence)
    b. Fancied soulful nursery artwork unhired bailout gazette lobster.   (Shuffled)

17. a. Roaming rangers measure several melting glacier icecaps across Alberta.(Sentence)
    b. Awesome darling reverse ordinal secrets shammed relaxes penalty premium. (Shuffled)

18. a. Edmonton academic websites reported expected elephant skeleton arrivals. (Sentence)
    b. Organism playlist speeches talented trainers untwists acrylics birdfeed. (Shuffled)

19. a. Jennifer excelled at painting majestic tornados whenever assigned. (Shuffled)
    b. Airbrush clumpier it conceals ethnical festival glossary hologram. (Assigned)

20. a. Many guys have been over this past year. (Sentence)
    b. Evil face down cows busy cake bibs acid. (Shuffled)

21. a. This idea came from that damn hard time. (Sentence)
    b. Pigs poem shoe rugs seep zinc week wind. (Shuffled)

22. a. Girls write about their mental health and bodily fluids. (Sentence)
    b. Wheat treat freak warms valves mucous lug lotion fangs. (Shuffled)

23. a. These drugs could cause those young women to dance. (Sentence)
    b. Wives wreck youth watts zeros tired think be wagon. (Shuffled)

24. a. The birds built their nests under those bushy trees. (Sentence)
    b. Try unzip fries trick flake sunny lower fiery wiper. (Shuffled)

25. a. Things seemed pretty normal until people changed their speech. (Sentence)
    b. Cavity bridal bowler flower apple aboard trooper fifty arrive. (Shuffled)

26. a. Babies become strong enough after eating peanut butter. (Sentence)
    b. Lotion planet joyful keypad stunt lumber nachos middle. (Shuffled)

27. a. Sexual chimps showed little talent inside the United States. (Sentence)
    b. Famous preach weapon shower tackle poison car wafted pastas. (Shuffled)

28. a. Pythons usually swallow victims without showing tension. (Sentence)
    b. Seaweed yearned sandbox trucker snapper poppers soldier. (Shuffled)

29. a. Several private medical schools equally provide radical results. (Sentence)
    b. Sunrise snipers smaller seafood trimmer topsoil valence vectors. (Shuffled)

30. a. Another popular college student stopped sitting outside.(Sentence)
    b. Liquids marched poultry rambled rockets stories adverse.(Shuffled)

31. a. Business research programs probably maintain adequate progress. (Sentence)
    b. Homeward hospital illusion leopards monogram official overlaps. (Shuffled)

32. a. Language analysis research includes powerful computer software features.(Sentence)
    b. Annotate upgraded vocalism whitened stinking stroller surround outfield. (Shuffled)

33. a. American military soldiers received specific physical messages. (Sentence)
    b. Outdoors password passions question reissued relapsed biologic. (Shuffled)

34. a. That evil king puts down baby cats into tiny beds. (Sentence)
    b. Bull size ahoy wise only visa egos boat morn deal. (Shuffled)

35. a. John will chow down that cake with your dull fork.(Sentence)
    b. Tank toe road hair hook ears toad kite swan damp. (Shuffled)

36. a. They took five beer jugs from your room. (Sentence)
    b. Bass cave bump take find tags bell fell. (Shuffled)

37. a. Their truly crazy moose stole these lucky shoes.(Sentence)
    b. Warts yolks steep spray spoke folks sucks sword. (Shuffled)

38. a. Uncle Peter often drank those cheap shots after lunch. (Sentence)
    b. Above blobs water trays slope whale metal blear prior. (Shuffled)

39. a. Hired staff built their light green house above those hills. (Sentence)
    b. Tribe velar whirl yolks waste reply ranks proxy prude blend. (Shuffled)

40. a. Famous people always crouch behind chairs. (Sentence)
    b. Remold facial market invent rebind polity. (Shuffled)

41. a. Clumsy camels always waddle around during desert storms. (Sentence)
    b. Sailor vacuum washer zoomed temper wrists trolls suited. (Shuffled)

42. a. Arthur copied ninety haikus poorly within eleven months. (Sentence)
    b. Lively locked frothy killed longer master pencil goblin. (Shuffled)

43. a. Ghastly witches holding chained hostages crazily display the demonic cabinet. (Sentence)
    b. Sliding retiles pothole granule grandest gallery hamster try insight buzzing. (Shuffled)

44. a. Seventy skilled Spanish fishers capture aquatic animals bravely.
    b. Wetland weather zoology valleys unifies tropical voyages.

45. a. Untitled document recently revealed powerful lymphoid sampling medicine. (Sentence)
    b. Parsnips romantic silkiest tallying vigilant warnings whispers afforded. (Shuffled)

46. a. Ravenous primeval children frighten hysteric chipmunk hungrily together. (Sentence)
    b. Activist emissive equality hesitant ligament keyboard misquote sortable. (Shuffled)

47. a. Servers smashed spiders crawling towards various windows. (Sentence)
    b. Pirates snoozed armpits snowman station chewing cliental. (Shuffled)

48. a. Many boys have cats that like blue toys. (Sentence)
    b. Stew main rank sure oval gave bang wind. (Shuffled)

49. a. Furious workers trashed country markets. (Sentence)
    b. Kickbox dazzled quicker subject pickoff. (Shuffled)

50. a. Orange trucks zoomed around freely.(Sentence)
    b. Rarest erases estate street tattoo. (Shuffled)