The Role of Subphonemic Units in Sub lexical Speech Errors: Insights from Resource Models of Working Memory

Jenah Black*and Nazbanou Nozari
Department of Physiology, Carnegie Mellon University, Pittsburgh, PA, USA
***Corresponding author: Jenah Black,** Department of Physiology, Carnegie Mellon University, Pittsburgh, PA, USA; E-mail: jenahb@andrew.cmu.edu

Supplementary data

Appendix 1: Full set of 444 words used in the picture naming task.

Hand	Brush	Stem	Helicopter	Donkey	Bongos	Garage
Cat	Candy	Bathtub	Steak	Sled	Pan	Remote
Tree	Microphone	Bull	Nose	Radio	Jellyfish	Can opener
Door	Mussel	Waffle	Blowfish	Avocado	Meatloaf	Tongue
Wrench	Broom	T-shirt	Shirt	Urinal	Blimp	Wasp
Grapes	Cauliflower	Flask	Razor	Lion	Pliers	Train
Fly	Finger	Otter	Funnel	Bagpipe	Lobster	Cherries
Pen	Spatula	Mop	Fork	Strawberry	Pinky	Glue
Cellphone	Hyena	Drum	Chalk	Nightstand	Monitor	Artichoke
Sundae	Spoon	Blueberries	Fireplace	Frog	Bed	Grasshopper
Tie	Mailbox	Lamp	Hamburger	Fern	Rhino	Bottle
Goat	Keyboard	Goose	Cactus	Eraser	Lime	Robe
Croissant	Glove	Record	Raccoon	Boot	Hairdryer	Organ
Curtains	Binder	Sock	Raft	Shark	Omelette	Tiger
Violin	Dolphin	Tomato	Accordion	Foot	Snake	Bedroom
Plum	Plunger	Stork	Shorts	Skateboard	Slipper	Bagel
Bear	Measuring cup	Truck	Refrigerator	Bacon	Xylophone	Colander
Thermos	Donut	Cheek	Kangaroo	Grapefruit	Stove	Octopus
Ear	Sheep	Chocolate	Ceiling	Toucan	Chopsticks	Shoulder
Brownie	Axe	Worm	Sandpaper	Ipad	Moth	Apple

					Measuring	
Duck	Bush	Stool	Faucet	Oreo	tape	Tape
Perfume	Blackberry	Grass	Dog	Highlighter	Paper	Banjo
Protractor	Sweater	Grater	Cookie	Saw	Recliner	Whale
Gate	Owl	Pancake	Cantaloupe	Slug	Seahorse	Olive
Harmonica	Radish	Scorpion	Boat	Hat	Thumb	Jeans
Airplane	Window	Date	Bee	Shelf	Eggplant	Burrito
Scale	Knife	Napkin	Ankle	Raisins	Skis	Tongs
Plate	Chameleon	Screw	Record player	Turtle	Butterfly	Cockroach
Ipod	Wagon	Calendar	Microwave	Cup	Trumpet	Canoe
Spider	Flashlight	Fox	Harp	Pizza	Orange	Highchair
Peeler	Pretzel	Elbow	Jacket	Tweezers	Sushi	Deodorant
Fig	Bra	Suit	Fish	Chicken	Desk	Bat
Stairs	Ant	Asparagus	Poptart	Laptop	Lizard	Bamboo
Bib	Router	Cardinal	Motorcycle	Knee	Nailclipper	Trombone
Toilet paper	Peach	Roof	Nail	Thumbtack	Paperclip	Cupcake
Rooster	Grill	Banana	Kitchen	Monkey	Toes	Flamingo
Clarinet	Ostrich	Unicycle	Taco	Garlic	Wolf	Scarf
Screwdriver	Cucumber	Popcorn	Eel	Rolling pin	Potato	Broccoli
Heel	Qtip	Marshmallow	Ginger	Straw	Apricot	Crib
Crackers	Bathroom	Neck	Tambourine	Caterpillar	Gong	Blender
Branch	Camel	Toothbrush	Watermelon	Underwear	Porcupine	Chest
Ottoman	Hoe	Seal	Dove	Rake	Dustpan	Centipede
Nutcracker	Charger	Cd	Ladle	Fence	Bowl	Pear
Van	Wrist	Thermometer	Belt	Toothpaste	Pencil	Jar
Raincoat	Mouse	Guitar	Popsicle	Swan	Spaghetti	Jukebox
Walrus	Clipboard	Rabbit	Calf	Notebook	Deer	Alligator
Smore	Pants	Jet	Shin	Toaster	Cake	Kayak
Car	Pig	Controller	Shovel	Crowbar	Pelican	Vest
Stingray	Submarine	Stapler	Pantry	Ladybug	Oven	
Camera	Comb	Gorilla	Bus	Bread	Couch	
Flute	Egg	Chair	Hippo	Raspberry	Roots	
Teapot	Panda	Sleeve	Lasagna	Crayon	Pigeon	
Rice	Dresser	Mushroom	Corn	Mattress	Toilet	
Flower	Pitchfork	Salad	Scissors	Penguin	Pot	
Apron	Soup	Snail	Zebra	Towel	Hotdog	
Hammer	Skunk	Saxophone	Dress	Suspenders	Turkey	

Starfish	Mango	Floss	Shampoo	Onion	Acorn	
Table	Arm	Envelope	Closet	Mosquito	Drawer	
Marker	Eagle	Squirrel	Cow	Tv	Lips	
Lemon	Hashbrowns	Coconut	Speaker	Jeep	Dragonfly	
Cotton candy	Level	Tick	Whisk	Moose	Parrot	
Chimney	Hummingbird	Deck	Shoe	Celery	Shoelace	
Sandal	Sandwich	Soap	Giraffe	Ladder	Compass	
Peacock	Ruler	Jack	Pineapple	Leaf	Cabinets	
Back	Bicycle	Elephant	Crab	Corkscrew	Piano	
Dishwasher	Pie	Muffin	Carrot	Attic	Shower	

Appendix 2: Constant values for ALINE distance calculations. Binary values (0,1) are assigned for nasal, retroflex, syllabic, long, lateral, aspirated, round, and voice features. Operations costs are applied during the alignment processed and are not incorporated into the distances.

Place		Manner		Height		Back	
Bilabial	1	Stop	1	High	1	Front	1
Labiodental	0.95	Affricate	0.9	Near high	0.83	Near front	0.75
Dental	0.9	Fricative	0.8	High mid	0.67	Central	0.5
Alveolar	0.85	Approximant	0.6	Mid	0.5	Near back	0.25
Retroflex	0.8			Low mid	0.33	Back	0
Palato-alveolar	0.75			Near low	0.17		
Palatal	0.7			Low	0		
Velar	0.6						
Uvular	0.5						
Pharyngeal	0.3						
Glottal	0.1						

Salience				Alignment costs	
Syllabic	5	High	5	Cost skip	5
Place	40	Back	5	Cost substitution	45
Voice	10	Manner	50	Cost expansion	45
Nasal	10	Retroflex	10	Cost vowel	5
Lateral	10	Long	1		
Aspirated	5	Round	5		

Appendix 3: Full results from second-pass analyses examining the effect of length on ALINE distance. Position and the interaction between position and length were included as a control variable.

	Factor	Coefficient	SE	t	p value
Aggregate	Intercept	2.81E-02	1.35E-01	0.208	0.84836

	Length	1.75E-01	1.18E-02	14.799	<2.00E-16
	Position	-2.29E-02	7.20E-03	-3.187	1.44E-03
	Length x position	2.83E-02	7.00E-03	4.046	5.23E-05
DH	Intercept	2.39E-02	2.13E-02	1.126	0.26093
	Length	1.99E-01	2.15E-02	9.265	<2.00E-16
	Position	-3.67E-02	1.31E-02	-2.799	0.00515
	Length x position	7.05E-03	1.27E-02	0.554	0.57958
EB	Intercept	3.63E-02	2.67E-02	1.362	0.1739
	Length	5.13E-02	2.69E-02	1.91	0.0569
	Position	6.99E-03	1.48E-02	0.473	0.6361
	Length x position	1.11E-02	1.44E-02	0.769	0.442
FM	Intercept	5.44E-02	2.42E-02	2.25	0.025
	Length	1.64E-01	2.44E-02	6.726	5.39E-11
	Position	-9.25E-03	1.46E-02	-0.635	0.526
	Length x position	-9.82E-03	1.42E-02	-0.693	0.488
KM	Intercept	-0.01075	0.01958	-0.549	0.5833
	Length	0.22072	0.01947	11.338	<2.00E-16
	Position	-0.03425	0.01592	-2.151	0.0316
	Length x position	0.08964	0.01549	5.787	7.85E-09

Appendix 4: Full results from t-tests examining the direction of articulation errors in individual patients.

	Participant	Estimate	t	Degrees of freedom	p value
Place	P1	0.137224	4.129947	633	<0.001
	P2	0.270655	6.081965	350	<0.001
	P3	-0.02273	-0.19033	43	0.849946
	P4	0.048485	0.79122	164	0.429958
Manner	P1	0.009464	0.358322	633	0.720222
	P2	0.008547	0.298123	350	0.765786
	P3	0.068182	0.902628	43	0.371752
	P4	-0.09091	-2.04193	164	0.04276

Appendix 5: Full results from second pass analyses examining the effect of length on simplification errors on the aggregate data. Position and the interaction between position and length were included as a control variable.

	Factor	Coefficient	SE	t	p value
Manner	Length	-0.0716	0.078104	-0.917	0.35927
	Position	-0.21074	0.070058	-3.008	0.00263
	Length x position	0.004221	0.075686	0.056	0.95552
Place	Length	0.15039	0.07398	2.033	0.0421
	Position	-0.01381	0.0658	-0.21	0.8337
	Length x position	-0.03796	0.07128	-0.533	0.5944