Supplemental materials for: High-order cognition is supported by information-rich but compressible brain activity patterns

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Topic label	Cognitive label	Term 1	Term 2	Term 3	Term 4	Term 5	Term 6	Term 7	Term 8	Term 9	Term 10
Cognitive control and task performance	Cognitive control	tasks	control	network	conditions	comparison	performed	common	correlates	experiment	pre
Developmental aging and maturation	-	age	adults	children	development	adolescents	aging	developmental	adolescence	childhood	adult
Eye movements and visual attention	Attention	eye	gaze	eyes	visual	saccades	movements	saccade	direction	gait	target
Facial and voice recognition	Sensory perception	recognition	familiar	identity	unfamiliar	voice	familiarity	route	voices	fg	facial
Social interaction and contextual behavior	Social cognition	context	game	human	interaction	ppi	contextual	contexts	agency	interactions	partner
Language processing and semantic knowledge	Language processing	semantic	words	word	lexical	verbal	language	tasks	naming	fluency	phonological
Experimental design and behavioral performance	-	trials	stimulus	responses	trial	reaction	time	event	target	events	times
Genetic polymorphisms and risk factors	-	carriers	allele	gene	genotype	met	genetic	polymorphism	val	comt	rs
Sensorimotor integration and movement control	Motor control	motor	movement	movements	sensorimotor	primary	finger	control	imagery	sensory	execution
Drug addiction and substance abuse	-	cocaine	users	drug	bpd	controls	cannabis	addiction	craving	dependent	heroin
Music perception and auditory processing	Sensory perception	music	musical	pitch	auditory	musicians	sequences	rhythm	listening	beat	singing
Menstrual cycle and hormonal regulation	-	phase	women	cycle	phases	menstrual	hf	expression	sex	luteal	follicular
Cognitive functions and role playing	Cognitive control	role	play	human	plays	cognitive	evidence	critical	distinct	key	subregions
Inhibition and gender differences	-	inhibition	women	inhibitory	sex	females	gender	males	stop	male	female
Somatosensory stimulation and motor control	Motor control	stimulation	somatosensory	tms	tactile	primary	touch	motor	rtms	transcranial	sensory
Multisensory integration and perception	Sensory perception	auditory	visual	sensory	modality	sounds	integration	sound	stimulus	primary	modalities
Social perception and empathy	Social cognition	social	empathy	experience	people	person	responses	perspective	individuals	attachment	empathic
Gesture recognition and visual attention	Attention	target	gestures	targets	orientation	visual	distractors	gesture	grasp	distractor	location
Experimental design	-	design	block	blocks	event	mixed	condition	ca	writing	blocked	runs
Alcohol cue reactivity	Reward	cues	cue	alcohol	anticipation	cued	preparation	anticipatory	exposure	expectancy	preparatory
Neuroimaging and metabolism	-	pet	tomography	emission	positron	flow	glucose	binding	metabolism	metabolic	receptor
Abnormalities in schizophrenia	-	schizophrenia	controls	reduced	abnormalities	symptoms	deficits	matched	control	abnormal	schizophrenic
Eating and body weight	-	food	taste	body	weight	eating	women	obese	reward	foods	caloric
Sleep and olfactory processing	Sensory perception	sleep	olfactory	odor	sd	deprivation	odors	rem	wakefulness	night	wake
Alzheimer's disease and mild cognitive impairment	-	ad	disease	mci	alzheimer	cognitive	impairment	mild	amci	controls	atrophy
Working memory and executive function	Memory	memory	load	tasks	verbal	maintenance	performance	term	difficulty	dual	cognitive
Moral decision making and phobias	-	moral	phobia	phobic	ec	guilt	spider	decision	art	phobics	intentional
Language laterality	Language processing	language	asymmetry	organization	human	dominance	asymmetries	lateralized	handed	located	representation
Attention	Attention	attention	attentional	visual	spatial	top	selective	stimulus	control	orienting	target
Resting-state brain activity in smokers	Resting state	reho	smokers	resting	smoking	nicotine	homogeneity	sci	controls	rs	spontaneous
Social cognition/judgment	Social cognition	social	judgments	mind	mental	theory	mentalizing	cognition	judgment	person	people
Reward and decision making	Reward	reward	decision	choice	outcomes	rewards	monetary	decisions	anticipation	responses	outcome
ADHD and attention deficits	Attention	adhd	disorder	attention	deficit	children	hyperactivity	deficits	control	controls	reduced
Neurobiological variability and individual diff...	-	individual	relationship	local	dependent	change	global	responses	neuronal	magnitude	lower
Spatial cognition	Spatial cognition	spatial	space	location	locations	navigation	virtual	visual	visuospatial	visuo	position
Therapeutic interventions and training	-	training	acupuncture	therapy	cr	control	trained	improvement	mindfulness	stimulation	induced
Color perception and deception	Sensory perception	color	search	feature	deception	features	responses	colour	dimension	lying	conjunction
Neurodegenerative diseases and disorders	-	disease	pd	controls	atrophy	clinical	motor	dementia	sd	multiple	sclerosis
Cognitive control and interference	Cognitive control	conflict	control	interference	stroop	incongruent	selection	congruent	trials	cognitive	monitoring
Structural MRI and brain volume analysis	-	volume	gray	voxel	gm	morphometry	grey	volumes	vbm	density	age
Fear conditioning and extinction	Emotion	fear	switching	conditioning	responses	stimulus	extinction	cs	switch	threat	conditioned
Skill learning and expertise	Memory	learning	practice	learned	sequence	performance	training	sequences	skill	implicit	motor
PTSD and trauma	Emotion	ptsd	trauma	stress	disorder	traumatic	posttraumatic	childhood	survivors	exposure	controls
Neural oscillations and electrophysiology	-	frequency	source	alpha	amplitude	beta	gamma	recorded	frequencies	potential	simultaneous
Temporal dynamics of stimulus processing	Sensory perception	time	sustained	duration	onset	period	stage	timing	delay	transient	event
Tinnitus and hearing loss	Sensory perception	tinnitus	loss	hearing	status	driving	subjective	objective	unfair	offers	rejection
Abstract categories and representations	Language processing	category	adaptation	representations	categorization	categories	abstract	stimulus	representation	features	knowledge
Pain perception and sensory stimulation	Sensory perception	pain	painful	stimulation	somatosensory	intensity	noxious	heat	chronic	sensory	nociceptive
Body and primates	-	body	human	humans	monkeys	itch	primates	species	monkey	bodies	macaque
Phonological processing in reading	Language processing	reading	chinese	phonological	visual	language	readers	dyslexia	characters	children	word
Rule-based performance and complexity	Cognitive control	rule	complexity	size	force	rules	effect	grip	amount	distance	artificial
Autism Spectrum Disorder (ASD) and social impai...	Social cognition	asd	autism	social	spectrum	individuals	controls	disorders	children	td	reduced
Major depression disorder and emotions	Emotion	depression	mdd	depressed	depressive	major	mood	disorder	sad	controls	control
Blindness and vision	Sensory perception	blind	visual	sighted	individuals	humor	laughter	congenitally	blindness	plasticity	braille
Deafness and sign language	Language processing	condition	conditions	deaf	hearing	sign	signs	referential	signers	ci	nss
Genetic risk and familial factors in psychosis	-	risk	genetic	sz	siblings	relatives	individuals	unaffected	factors	family	psychosis

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Action observation and imitation	Motor control	action	actions	observation	motor	mirror	goal	imitation	execution	directed	movements
Cognitive performance and control	Cognitive control	performance	cognitive	control	memory	executive	test	tasks	individuals	behavioral	deficits
Mental disorders and controls	-	disorder	ocd	bipolar	hc	bd	controls	ts	control	abnormalities	compulsive
Pharmacological effects of placebo and drug adm...	-	placebo	dopamine	effect	drug	ht	administration	blind	dopaminergic	double	mg
Personality and anxiety	Social cognition	anxiety	personality	trait	individuals	scores	traits	threat	disorders	social	avoidance
Mental imagery and math abilities	Cognitive control	mental	imagery	numerical	arithmetic	rotation	calculation	magnitude	digit	tasks	mathematical
Priming and repetition effect	Memory	priming	repetition	suppression	repeated	effect	implicit	literal	target	prime	metaphors
Working memory and error monitoring	Memory	wm	error	errors	prediction	performance	correct	monitoring	ltm	feedback	predicted
Sentence comprehension and syntax	Language processing	sentences	language	sentence	comprehension	syntactic	semantic	verbs	verb	word	meaning
Resting state networks	Resting state	network	resting	default	mode	rest	intrinsic	cognitive	correlations	seed	spontaneous
Episodic memory encoding and retrieval	Memory	memory	encoding	retrieval	recognition	episodic	items	successful	subsequent	recollection	recall
Visual object recognition	Sensory perception	object	visual	objects	shape	images	scenes	scene	selective	recognition	stream
Effective causal modeling of neural networks	-	effective	causal	modeling	dynamic	network	top	influence	modulation	interactions	causality
Relational reasoning and fluid intelligence	-	reasoning	FALSE	TRUE	intelligence	relational	belief	relations	nonverbal	fluid	analogical
Lesion and stroke rehabilitation	-	lesions	lesion	stroke	damage	injury	controls	recovery	patient	tracts	integrity
Affective valence and feedback processing	-	negative	positive	feedback	valence	arousal	bias	positively	negatively	evaluation	swallowing
Autobiographical memory in epilepsy	Memory	autobiographical	events	future	epilepsy	episodic	memory	memories	past	mtle	personal
Evidence and effect in behavioral studies	-	evidence	provide	effect	behavioral	underlying	demonstrated	understanding	potential	responses	support
Stress and physiological responses	-	stress	tdcs	cortisol	autonomic	heart	responses	rate	regulation	physiological	induced
Speech and language processing	Language processing	speech	language	auditory	production	perception	comprehension	listening	acoustic	linguistic	prosody
Network interactions and evidence in human systems	-	network	evidence	human	systems	support	process	distinct	integration	provide	engaged
Neuroimaging techniques	-	standard	images	individual	time	image	voxel	spatial	test	clinical	mapping
Visual perception of motion and form	Sensory perception	motion	visual	perception	perceptual	biological	dynamic	moving	human	static	illusion
Emotional processing and regulation	Emotion	emotional	emotion	neutral	facial	expressions	affective	responses	negative	regulation	emotions

Table S1: **Neurosynth-derived topics.** We report the top-weighted terms for each of 80 topics identified using Latent Dirichlet Allocation (**?**) applied to 9,204 functional neuroimaging articles in the Neurosynth database (**?**). The topics, as well as associated brain maps identified using Neurosynth, were identified and reported in several prior studies (**???**). The topic labels for each topic were generated automatically with the following ChatGPT (chat.openai.com) prompt: "Please help me come up with intuitive labels for topic topics I found by fitting a topic model to thousands of neuroscience and psychology articles. I'll paste in the top 10 highest-weighted words for each topic, and I'd like you to respond with a suggested label. For each topic, please respond with just the topic label and no other formatting or text. Here are the next topic's top words:" followed by a comma-separated list of the given topic's top-weighted words reflected in the table. For some topics, ChatGPT responded with a longer-form response rather than a concise topic label. In these instances, on a case-by-case basis, we used a second follow-up prompt to achieve the given topic's label: "could you please come up with a more concise label for that topic?". We then manually identified a set of 11 cognitive labels that were intended to encapsulate a representative range of widely studied low-level and high-level cognitive functions. In choosing the set of cognitive labels, we jointly considered each topic's ChatGPT-derived topic label, along with the top-weighted words for the topic. We attempted to generate a concise set of labels that still spanned the full set of cognitive functions reflected across the 80 topics. Topics that appeared unrelated to specific cognitive functions (e.g., topics related to specific methods or clinical themes) are designated with dashes.

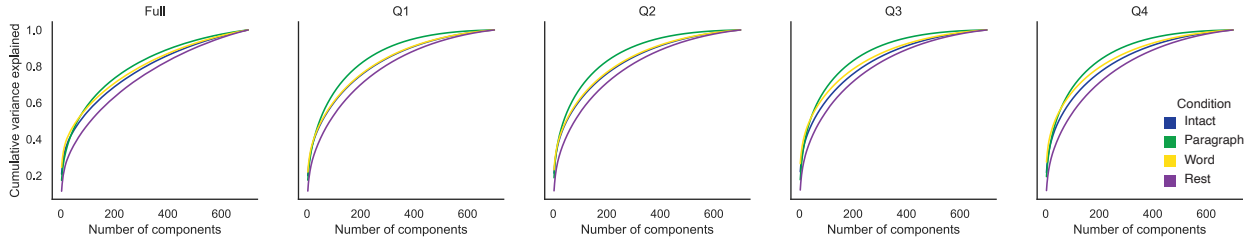

Figure S1: **Cumulative variance explained by component, condition, and part.** Each panel displays the cumulative variance explained in the neuroimaging data as a function of the number of principal components. Colors denote experimental conditions. The left panel displays results for all data, and the right panels display results separated by story segment (Q1: first quarter; Q2: second quarter; Q3: third quarter; Q4: fourth quarter).

Figure S2: **Top terms associated with the highest-weighted components by condition, broken down by story segment.** Each group of five rows corresponds to an experimental condition (denoted by color, as indicated in the legend in the lower right), and the columns and shading correspond to the component number (ranked by proportion of variance explained). The colored squares in front of many of the topics denote manually identified cognitive labels (Tab. S1).

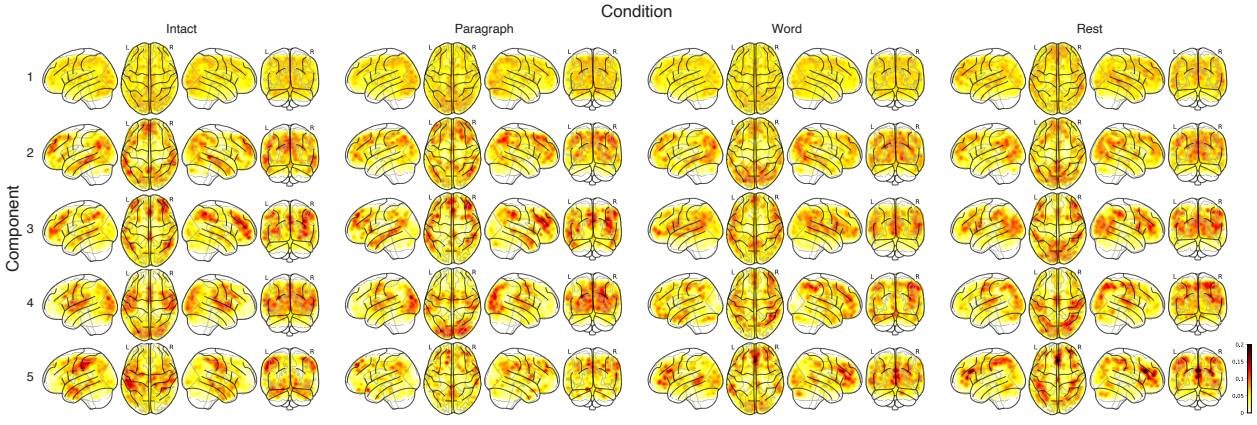

Figure S3: **Brain maps by component and condition.** For the top five highest-weighted principal components (rows), from each experimental condition (columns), the components' brain maps are projected onto four views: left sagittal, axial, right sagittal, and coronal. The color scale is the same for all panels and matches the coloring in Fig. 5C.

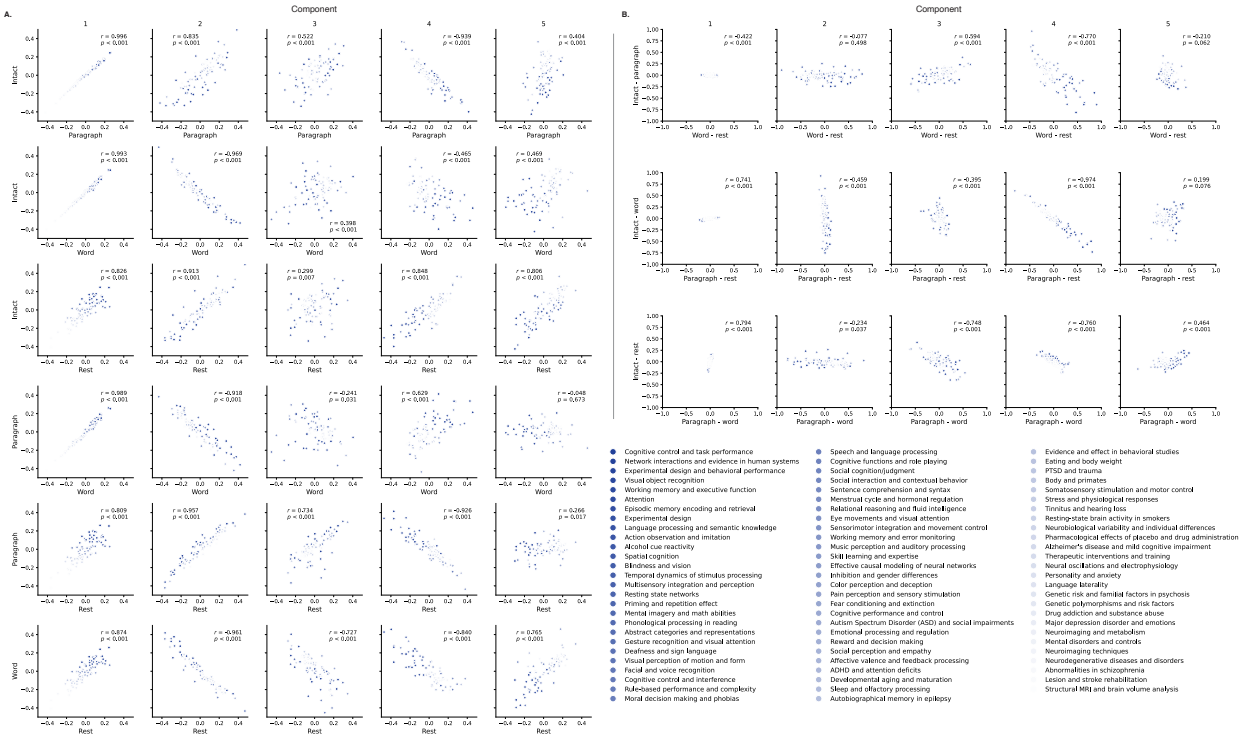

Figure S4: **Comparisons between per-component topic correlations across conditions.** Each sub-panel displays a scatterplot comparing the per-topic correlations for two or more experimental conditions. Each dot donotes the correlations for a single topic (indicated by the legend on the right). The topics are colored according to the ranked order of the correlations between the topic's brain maps and the brain map for the first principal component in the intact condition. **A. Comparisons between correlations for each pair of experimental conditions.** The conditions being compared are marked on the x and y axes. Each sub-panel (column) reflects the correlations for one principal component. **B. Comparisons between *differences* in correlations for pairs of experimental conditions.** In these sub-panels, the x and y coordinates reflect differences in correlations for the indicated experimental conditions, for the given component (column). All panels: the across-topic correlations reported in each panel are between each topic's x and y coordinates.

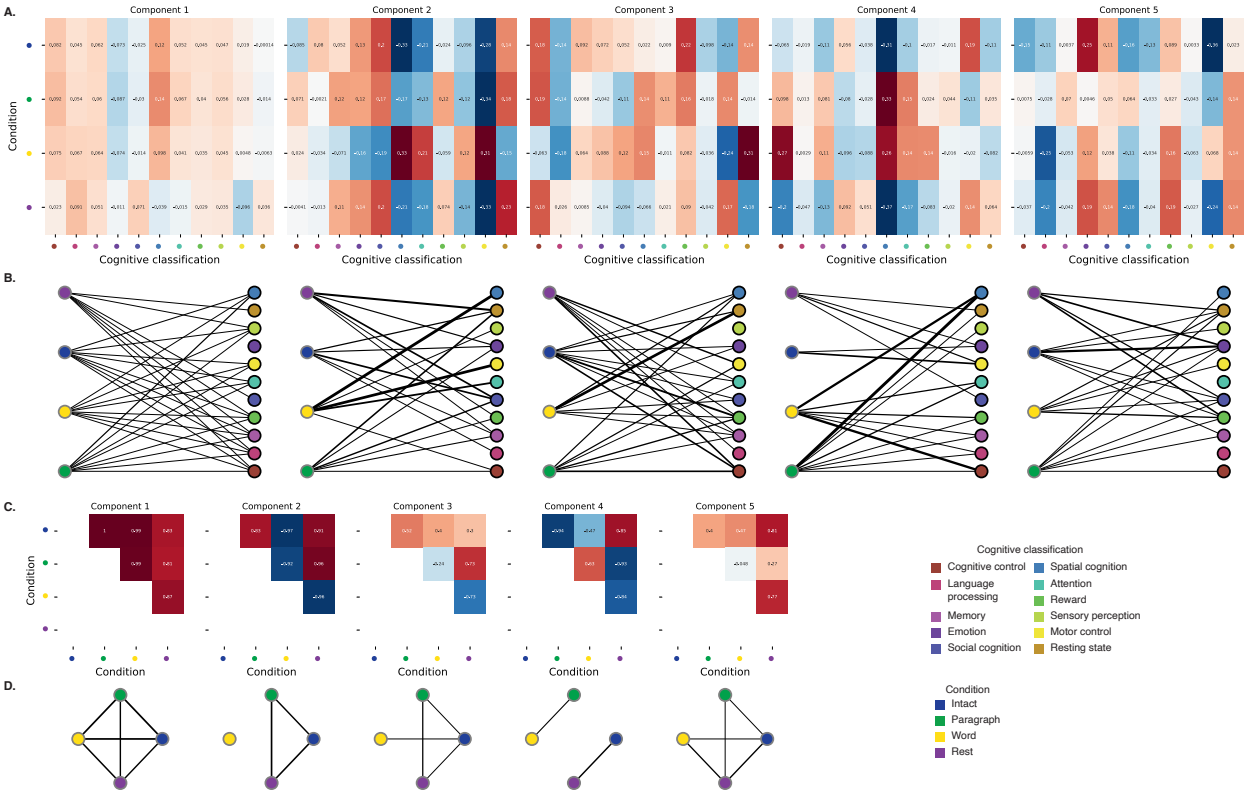

Figure S5: **Functions associated with top-weighted components by condition. A. Top-weighted topics by condition.** Here we display per-condition (rows, indicated by colored dots) topic correlations, averaged across topics that pertain to each of several broad cognitive functions (columns within each sub-panel, indicated by colored dots). Each sub-panel reflects correlations for the components indicated in the panel titles. A legend for the condition and cognitive function classifications is displayed in the lower right of the figure. Table S1 provides a list of each topic's top-weighted terms, along with each topic's manually labeled cognitive classification. A full list of the topics most highly associated with each component may be found in Figure **??**. **B. Associations between per-condition components and cognitive functions.** The network plots denote positive average correlations between the component images for each condition (gray-outlined dots on the left sides of each network; colors denote conditions) and topic-specific brain maps associated with each indicated cognitive function (black-outlined dots on the right sides of each network; colors denote cognitive functions). The line thicknesses are proportional to the correlation values (correlation coefficients are noted in the heatmaps in Panel A). **C. Correlations between each principal component, by condition.** The heatmaps display the correlations between the brain maps (Fig.) for each principal component (sub-panel), across each pair of conditions (rows and columns of each sub-panel's matrix, indicated by colored dots). **D. Associations between per-condition topic weights, by component.** Each sub-panels network plot summarizes the pattern of correlations between the topic correlations from each of the n^{th} top-weighted principal components (sub-panel), for each experimental condition (gray-outlined dots). The line thicknesses are proportional to the correlation values (correlation coefficients are noted in the heatmaps in Panel C).