Apraxia

The term apraxia refers to a wide variety of high-level motor disorders, characterised by an impairment of purposeful voluntary movement skill. Apraxia is only indicated if aberrant motor behaviour cannot be accounted for fully by pyramidal, extrapyramidal, cerebellar or peripheral motor deficits or sensory loss, but may be observed in association with a number of low level motor disorders (e.g. weakness, rigidity, tremor, dystonia). Equally, an apraxic deficit cannot be inferred without excluding associated cognitive deficits, for example of language or perception, as primary and sufficient explanations for the observed behaviour. The occurrence of apraxic errors is mediated greatly by the context in which the action is elicited (e.g. clinical setting or natural environment), the stimulus prompting the action (e.g. real object or verbal command), the nature of the action (e.g. meaningful or meaningless gesture), the hand with which the action is performed, and the difficulty of the action procedure (e.g. single gesture or as part of a simple or complex action sequence). Apraxic deficits may also be body-part specific; accordingly, a greater specification of upper limb, gait and trunk, and orofacial apraxias is provided below. Susequently, disorders which controversially carry the term 'apraxia' and the role of praxis in naturalistic action are considered.

Upper limb apraxia

The most commonly drawn distinction in upper limb apraxia is that between ideomotor apraxia and ideational apraxia. Individuals with ideomotor apraxia (IM) commonly show disruption in the spatial and temporal form of stored and novel gestures, which is associated with damage to the left inferior parietal operculum. Patients with ideational apraxia (IA) on the other hand tend to make well-formed movements but show a disruption of the conceptual content of action production, resulting in tool misuse, production of complete but inappropriate gestures and disorganisation of movements in an action sequence. IA typically results from left parieto-occipital lesions (just posterior to areas associated with IM), but the localising value of IA has been questioned because the condition is rarely seen in isolation. Indeed, the clinical usefulness of the distinction has been undermined by the frequent co-occurrence of IM and IA; in a study of apraxic left hemisphere brain damaged patients, 60% showed symptoms of both IM and IA.[1]

Contemporary models of upper limb praxis mirror models of language processing, with voluntary motor action involving a series of cognitive processing stages (e.g. input, output, transcoding and conceptual knowledge).[2] Such models support the notion that IM and IA actually comprise a constellation of dissociable deficits. A variety of techniques may be used to assess the integrity of differing components of the action system (for examples, see Table 1). Furthermore, given the number of terminological difficulties in this area, upper limb apraxia may be more accurately defined by the type and quality of action production errors (for a breakdown of error types, see Table 2). In evaluating the significance of praxic errors however, the specificity of gestural errors in a given context must be considered. For example, body-part-as-object errors (e.g. using the index finger to pantomime brushing teeth) have been shown to occur equally often in healthy controls as left and right hemisphere brain damaged subjects, and, in left hemisphere patients, not to be associated with severity of apraxia.[3] The modality of stimulus presentation (e.g. verbal, visual or both) for gesture production tasks must be carefully selected to maximise the likelihood that any action production errors reflect praxic dysfunction rather than concomitant cognitive deficits (e.g. misperceiving a complex, meaningless hand posture demonstrated by the clinician).

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Table 1. Techniques employed in the assessment of upper limb apraxia.

Praxic domain	Cognitive domain	Task type	Example
Reception	Praxis input	Gesture naming	Examiner performs gesture: "Tell me what I am doing"
		Gesture decision	Examiner performs real/unreal gesture: "Is this the correct way to turn a key?"
		Gesture recognition	Examiner performs a series of three gestures (one target, two foils): "Which one of these gestures is correct for using a trowel in the garden?"
Production	Praxis output	Gesture to verbal command	Examiner says: "Show me how you use a hammer to pound a nail into a wall in front of you."
		Gesture to visual tool	Examiner shows patient a tool: "Show me how you use this [hammer]."
		Gesture to tactile tool	With eyes closed/covered, patient is asked: "Show me how to use this tool [hammer] I am placing in your hand."
Imitation	Lexical/non-lexical imitation system	Gesture imitation	Examiner says: "I will produce a gesture and I want you to do it the same way I do it."
		Nonsense imitation	Examiner says: "I will produce a gesture and I want you to do it the same way I do it. It is not a real gesture like the other ones you have been doing"
Action semantics	Conceptual system	Tool selection	Patient views an object representing an incomplete action (e.g. half sawn piece of wood) and three tools (1 target e.g. saw; 2 foils): "Point to the tool which goes with the object."
		Alternative tool selection	Patient views an object representing an incomplete action (e.g. partially banged in nail) and three tools (none ideal but one with appropriate features for the task e.g. brick).
		Multiple step tasks	Examiner provides letter, envelope, stamp and pen: "Show me how to prepare a letter for posting."

Table 2. A classification of praxic error types.[4]

Error Class	Example subtypes and descriptions
Spatial	*Internal configuration* – incorrect spatial relationship between different body parts (e.g. fingers in incorrect arrangement)
	External configuration – incorrect spatial relationship between body part and imagined tool (e.g. brushing teeth with hand too far away from the face)
	Movement – e.g. twisting pretend screwdriver from the shoulder rather than elbow
	Body part as tool – e.g. when pretending to smoke cigarette, puffing end of finger
	Amplitude – increase, decrease or irregularity in typical amplitude of a movement
Temporal	*Sequencing* – adding, deleting or transposing a movement in a multi-stage sequence
	Timing – abnormally increased, decreased or irregular rate of action production
	Occurrence – repetitive production of characteristically single movements (e.g. turn key) or reduced production of typically repetitive movements (e.g. screwdriver)
Content	*Perseverative* – response includes all or part of a previously produced pantomime
	Related – e.g. pantomime playing a trombone for the target of a bugle
	Non-related – e.g. pantomime playing a trombone for the target of shaving
	Hand – performing the action without a real or imagined tool (e.g. ripping paper by hand when asked to demonstrate use of scissors)
Other	*Concretisation* – performing pantomimed act on an inappropriate real object (e.g. when asked to saw some wood, pantomiming sawing on their leg)
	No response
	Unrecognisable – not recognisable and with no spatial or temporal features of the target

Gait, leg and trunk apraxia

Gait apraxia refers to an impaired ability to execute the highly practised, co-ordinated movements of the lower legs required for walking, but remains rather poorly specified and probably includes a number of different complex gait syndromes.[5] Disturbances of voluntary, non-routine movements of the lower limbs (leg apraxia) have also been reported in patients with gait apraxia.[6] However, it remains unclear whether leg apraxia and gait apraxia should be considered manifestations of damage to a common lower limb praxic centre, or whether leg apraxia is more closely related to the ideomotor apraxia more typically described in the upper limbs. A clearer dissociation has been described between limb apraxias and axial or trunk apraxia, in which patients may have difficulty generating body postures (e.g. stand like a boxer), rising from a lying position, rolling over or adopting a sitting position.

Orofacial apraxia

Patients with orofacial (or buccofacial) apraxia exhibit difficulties with performing voluntary meaningful and meaningless movements with facial structures including the cheeks, lips, tongue and eyebrows. Attempting to perform a pantomime to verbal command may result either in no response or often a characteristic verbal repetition of the target action (e.g. "Could you show me how to cough?" "Cough"). For some patients, imitation of an examiner's pantomime may be achieved more accurately. Orofacial apraxia may occur independently of limb apraxia, and should also be distinguished from apraxia of speech which is a disorder of articulatory integration associated with non-fluent aphasia. Orofacial apraxia is commonly associated with damage in the left frontal operculum and insula, although the left hemisphere is particularly implicated in lower face movements whilst the right hemisphere may play a role in both upper and lower face actions.[7]

Controversial apraxias

In addition to the body part-specific apraxias described above, the term apraxia has also been applied more controversially to a range of other motor disorders. Limb-kinetic (or melokinetic) apraxia refers to an inability to make precise, smooth, fine and independent movement of the fingers. The observation that the disorder can affect all types of gesture in any context irrespective of hemispheric lateralisation of damage has led to suggestions that limb-kinetic apraxia is in fact primarily a deficit of the motor system.[8] Other specialists maintain limb-kinetic apraxia is truly apractic in nature, resulting from premotor cortex damage.[9,10] The appropriateness of terms such as constructional apraxia and dressing apraxia has also been questioned, where a combination of perceptual, spatial and motor deficits may explain at least some of the action disorder.[11]

Naturalistic action disorders

Naturalistic action refers to well-established sequences of movements aimed at achieving practical goals such as food consumption or grooming activities. Naturalistic action is organised by goal hierarchies which structure behaviour over long periods of time, and is critically dependent upon cognitive processes largely subserved by the frontal lobes (e.g. planning, attention, working memory.)[12] The term frontal apraxia describes a breakdown in this sequential organisation of behaviour, and is characterised by object substitutions and misuse (e.g. spooning butter into coffee, using the wrong implements to eat or stir).[9,13] Although evidence of limb apraxia is elicited typically in a clinical setting, studies of the real world behaviour of ideomotor apraxic patients reveal a reduced frequency of tool-related action production and an increased number of tool-action errors relative to other patient groups.[14]

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