Altered sense of humour is an early and characteristic symptom in frontotemporal dementia. However, humour deficits are difficult to assess and poorly understood. Here we investigated humour processing using a novel neuropsychological battery manipulating situational congruency and familiarity in non-verbal cartoon stimuli in cohorts of patients with behavioural variant frontotemporal dementia (bvFTD; n=xx) and semantic dementia (SD; n=xx) in relation to healthy older individuals (n=xx). Relative to healthy individuals, both the bvFTD and SD groups showed impaired humour recognition but when compared the syndromic groups had distinct profiles of deficits: the bvFTD group had particular difficulty recognising more complex, novel humorous scenarios (and tended to mis-label control stimuli as humorous) while the SD group had particular difficulty recognising slapstick scenarios. Voxel-based morphometry of brain MRI in the patient cohort revealed neuroanatomical associations of slapstick processing in temporal pole and superior temporal gyrus; and novel scenario processing and incongruency resolution in posterior temporoparietal cortex. Our findings suggest separable brain mechanisms for abstracting humour from novel scenarios and for accessing the ‘lexicon’ of culturally sanctioned humorous scenarios, and further suggest that these mechanisms may be differentially targeted by canonical syndromes of frontotemporal lobar degeneration. Humour is a candidate model system for probing incongruency and related social cognition processes in the frontotemporal lobar degenerations and impairments of humour processing may have diagnostic utility in these diseases.