as well as hypertrophy. Because Burmese pythons naturally undergo a 40%, fully reversible increase in ventricular mass in the two days after a meal, they could provide an attractive model for investigating the fundamental mechanisms that lead to cardiac remodelling and ventricular growth[9]. The physiological stimuli underlying this hypertrophy are still unknown, but are likely to include neural and humoral factors.

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Synaesthesia

When coloured sounds taste sweet

Synaesthesia is the involuntary physical experience of a cross-modal linkage — for example, hearing a tone (the inducing stimulus) evokes an additional sensation of seeing a colour (concurrent perception). Of the different types of synaesthesia, most have colour as the concurrent perception[1], with concurrent perceptions of smell or taste being rare[2,3]. Here we describe the case of a musician who experiences different tastes in response to hearing different musical tone intervals, and who makes use of her synaesthetic sensations in the complex task of tone-interval identification. To our knowledge, this combination of inducing stimulus and concurrent perception has not been described before.

E.S. is a 27-year-old professional musician who is female, right-handed and of average intelligence[4] (IQ, 115). Whenever she hears a specific musical interval, she automatically experiences a taste on her tongue that is consistently linked to that particular interval (Table 1). Besides this exceptional interval-to-taste synaesthesia, she also reports the more common tone-to-colour synaesthesia, in which each particular tone is linked to a specific colour (for example, C and red; F sharp and violet).

Both synaesthetic perceptions have always been consistently reproducible. We repeatedly tested E.S. for over a year and have confirmed that her interval-to-taste synaesthesia is unidirectional: she does not hear tone intervals when exposed to taste. In addition, E.S. applies this synaesthesia in identifying tone intervals (which is evidence of a synaesthesia–cognition cascade).

To assess the influence of E.S.'s synaesthetic gustatory perception on her ability to identify tone intervals, we adapted the Stroop task[5] (for methods, see supplementary information). Four selected tone intervals (seconds and thirds) were presented while applying four differently tasting solutions (sour, bitter, salty and sweet) to E.S.'s tongue. Her task was to identify the tone intervals by pressing a particular button for each interval on a computer keyboard. Reaction times and errors were measured for trials in which the applied taste was either congruent or incongruent with the tone interval; tone intervals were also presented without taste stimulation.

We found that E.S.'s tone-interval identification was perfect and was significantly faster during the congruent condition compared with all the other conditions (Fig. 1). Five non-synaesthetic musicians were tested as controls using the same procedure: no significant between-condition differences were found. The reaction times of the controls were comparable to those of E.S. in the no-taste condition (Fig. 1).

To exclude conceptual priming effects as an explanation for these results (for example, the subject might imagine sourness when presented with 'sour' as either a taste or word), we also tested E.S. by showing her the word(s) describing each taste. We found no between-condition difference in this conceptual task (Fig. 1).

Together, these results indicate that E.S.'s performance in the gustatory Stroop task is most likely to be due to her extraordinary type of synaesthesia, in which a complex inducing stimulus leads to a systematic, concurrent gustatory sensation. This case differs from another gustatory synaesthete, S., who reported blended gustatory sensations (such as specific meals) in response to simple auditory stimuli (tones and sounds)[2]. E.S.'s application of her synaesthetic sensations in identifying tone intervals — a complex task that requires formal musical training — demonstrates that synaesthesias may be used to solve cognitive problems.

Table 1 **Tastes triggered by tone intervals**

Tone interval	*Taste experienced*
Minor second	Sour
Major second	Bitter
Minor third	Salty
Major third	Sweet
Fourth	(Mown grass)
Tritone	(Disgust)
Fifth	Pure water
Minor sixth	Cream
Major sixth	Low-fat cream
Minor seventh	Bitter
Major seventh	Sour
Octave	No taste

Tastes experienced by synaesthete E.S. in response to different musical tone intervals are shown; in the case of the fourth and tritone intervals, however, complex visual and emotional perceptions, respectively, are induced. Note that dissonant tone intervals induce unpleasant tastes and consonant ones induce pleasant ones (for example, the minor second intervals induce sour tastes, and the major thirds induce sweet ones). There is also an apparent symmetry in some of the responses: the minor second and major seventh, which are mirror-image intervals in terms of octave equivalence, are both rated as sour, and the major second and minor seventh are both rated as bitter.

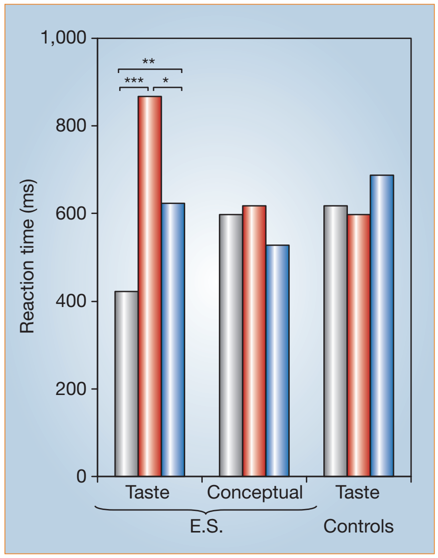

Figure 1 Mean reaction times in a gustatory Stroop task linking perception of tone intervals with different tastes for congruent-taste (grey), incongruent-taste (red) and no-taste (blue) conditions for synaesthete E.S. and for five non-synaesthetic musicians (controls). In the 'Taste' condition, musical intervals were presented while solutions of different taste (citric acid, 20 g litre^{-1}; quinine, 60 mg litre^{-1}; salt, 10 g litre^{-1}; sucrose, 120 g litre^{-1}) were delivered to the subject's tongue. The 'Conceptual' condition followed the same procedure, except that words describing the tastes, instead of the tastes themselves, were visually presented 2 s before the tone interval. Non-parametric randomization tests were used for statistical comparison. For E.S., all statistical comparisons in the taste condition were associated with P values of less than 0.01 (*$P<0.05$, **$P<0.01$, ***$P<0.001$). For control subjects and for the conceptual condition, none of the comparisons revealed significant differences. The reaction time of E.S. in the no-taste condition is similar to those of the controls, but is faster in the congruent condition and slower in the incongruent condition.

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