Fish logic surprises researchers

by Stanford University and World

A male fish can size up poÂ-tenÂ-tial riÂ-vals, rankÂ-ing them from strongest to weakÂ-est, just by watchÂ-ing how they perÂ-form in fights with othÂ-er maÂ-les, acÂ-cordÂ-ing to a new stuÂ-dy.The reÂ-searchÂ-ers say their finding proÂ-vides the first diÂ-rect evÂ-iÂ-dence that fish, like peoÂ-ple, can use logÂ-ic to learn their place in a peckÂ-ing orÂ-der. The stuÂ-dy, pubÂ-lished in the Jan. 25 ediÂ-tion of the reÂ-search jourÂ-nal NaÂ-ture, inÂ-volved ciÂ-chÂ-lids (SIK-lids), small terÂ-riÂ-toÂ-rial fish from AfÂ-riÂ-ca.

A dominant male A. burÂ-toni cichlid. (Credit: Logan Grosenick)"Male ciÂ-chÂ-lids are conÂ-stantÂ-ly tryÂ-ing to asÂ-cend soÂ-cially by beatÂ-ing each othÂ-er up,― said study co-author RusÂ-sell D. FerÂ-nald of StanÂ-ford UniÂ-verÂ-siÂ-ty in StanÂ-ford, CaÂ-lif. "It would be realÂ-ly valÂ-uÂ-aÂ-ble for them to know in adÂ-vance who to pick a fight with.―The sciÂ-enÂ-tists aimed to find out whethÂ-er terÂ-riÂ-toÂ-rial fish use a basic type of reaÂ-sonÂ-ing, tranÂ-siÂ-tive inÂ-ferÂ-ence, in which known reÂ-laÂ-tionÂ-ships are used to fiÂ-gÂ-ure out unÂ-faÂ-milÂ-iar ones. "It's someÂ-thing that kids genÂ-erÂ-alÂ-ly figÂ-ure out by age four or five: Mary is taller than Fred, Fred is taller than Pete, thereÂ-fore Mary is taller than Pete. It's been demÂ-onÂ-stratÂ-ed in priÂ-maÂ-tes, rats and some bird speÂ-cies, but how and why it evolved in anÂ-iÂ-mals is a matÂ-ter of deÂ-bate.― The researchers used a popÂ-uÂ-lar labÂ-oÂ-raÂ-toÂ-ry fish called AsÂ-taÂ-totiÂ-lapia burÂ-toni. The maÂ-les, exÂ-tremeÂ-ly terÂ-riÂ-toÂ-rial, regÂ-uÂ-larÂ-ly enÂ-ter agÂ-gresÂ-sive jousts whose outÂ-come deÂ-terÂ-mines acÂ-cess to food and mates. Males that reÂ-peatÂ-edÂ-ly lose, can't hold terÂ-riÂ-toÂ-ries and thus drop in staÂ-tus, the auÂ-thors wrote. When they fight, it's easy to spot the winÂ-ner. MaÂ-ture maÂ-les have a menÂ-acÂ-ing black stripe, or eyeÂ-bar, on their face. AfÂ-ter a bout, the winÂ-ner reÂ-tains his showy apÂ-pearÂ-ance, but the losÂ-er's eyeÂ-bar temÂ-poÂ-rarÂ-iÂ-ly fades away as he tries to flee. The reÂ-searchÂ-ers staged a seÂ-ries of one-on-one comÂ-bats beÂ-tween maÂ-les of equal size. Fish that lost their eyeÂ-bar were deÂ-clared the losÂ-er, sepÂ-aÂ-ratÂ-ed from their opÂ-poÂ-nent and put back in their origÂ-iÂ-nal tank. WithÂ-in minÂ-utes, the losÂ-er's eyeÂ-bar reÂ-turned, and he looked like all the othÂ-er domÂ-iÂ-nant maÂ-les again. The fights were staged in a tank diÂ-vidÂ-ed inÂ-to comÂ-partÂ-ments. A cuÂ-biÂ-cle in the cenÂ-ter conÂ-tained lone male "byÂ-stander.― Around him were five smaller comÂ-partÂ-ments, each with one male riÂ-val idenÂ-tiÂ-fied as A, B, C, D and E. ReÂ-searchÂ-ers made sure that the byÂ-standÂ-er had nevÂ-er met any of these poÂ-tenÂ-tial riÂ-vals. The byÂ-standÂ-er was alÂ-lowed to watch a seÂ-ries of fights beÂ-tween riÂ-val pairs: A vs. B, B vs. C, C vs. D, and D vs. E. ReÂ-searchÂ-ers maÂ-nipÂ-uÂ-latÂ-ed the fights so that A would domÂ-iÂ-nate B, B would domÂ-iÂ-nate C, and so on. TakÂ-en toÂ-gethÂ-er, the fights imÂ-ply a domÂ-iÂ-nance hiÂ-erÂ-arÂ-chy with A on top, folÂ-lowed by B, C, D and E in that orÂ-der. Did the byÂ-standÂ-er grasp this peckÂ-ing orÂ-der? And could he use that knowlÂ-edge to make logÂ-ical deÂ-ciÂ-sions about the same fish paired in new reÂ-laÂ-tionÂ-ships?To find out, eight difÂ-ferÂ-ent byÂ-standÂ-ers were tested in the faÂ-milÂ-iar square tank and in a new setÂ-ting: a recÂ-tanÂ-guÂ-lar aquarÂ-iÂ-um with three adÂ-jaÂ-cent comÂ-partÂ-ments. In each test, a byÂ-standÂ-er was placed in the midÂ-dle comÂ-partÂ-ment beÂ-tween two sets of riÂ-vals that he had nevÂ-er seen toÂ-gethÂ-erâ€"A and E on the one hand, and B and D on the othÂ-er. All riÂ-vals had reÂ-covÂ-ered from earÂ-liÂ-er losses, so their physÂ-iÂ-cal apÂ-pearÂ-ance was simÂ-iÂ-lar. UsÂ-ing a vidÂ-eÂ-o camÂ-era, reÂ-searchÂ-ers recorded which riÂ-val the byÂ-standÂ-er apÂ-proached first, and the overÂ-all time he spent next to each of them. PreÂ-viÂ-ous tests had shown that byÂ-standÂ-ers preÂ-fer to spend more time near the riÂ-val they perÂ-ceive as weaker, the auÂ-thors exÂ-plained. The reÂ-sults were draÂ-matÂ-ic, acÂ-cordÂ-ing to the reÂ-searchÂ-ers: virÂ-tuÂ-alÂ-ly all byÂ-standÂ-ers swam to the weaker riÂ-val first and stayed near him for sigÂ-nifÂ-iÂ-cantly longÂ-er. In the A-E tests, byÂ-standÂ-ers preÂ-ferred E, the wimpÂ-iÂ-est fish. In

the more subÂ-tle B-D tests, most byÂ-standÂ-ers chose D. So â€æfish do, in fact, use tranÂ-siÂ-tive inÂ-ferÂ-ence to figÂ-ure out where they rank,― FerÂ-nald said. "I was amazed that they could do this through viÂ-carÂ-iÂ-ous exÂ-peÂ-riÂ-ence, just by watchÂ-ing othÂ-er maÂ-les fight.―In Lake TanganÂ-yika in eastÂ-ern AfÂ-riÂ-ca, the ciÂ-chÂ-lids' habÂ-iÂ-tat, conÂ-diÂ-tions change conÂ-stantÂ-ly and "it would be adÂ-vanÂ-taÂ-geous for a male to know who the new boss is goÂ-ing to be and who his weakÂ-est riÂ-vals are,― he added. "Our exÂ-perÂ-iÂ-ment shows that male ciÂ-chÂ-lids can acÂ-tuÂ-alÂ-ly figÂ-ure out their odds of sucÂ-cess by obÂ-serÂ-vaÂ-tion alone. From an evÂ-oÂ-luÂ-tionÂ-ary standÂ-point, tranÂ-siÂ-tive inÂ-ferÂ-ence saves them valÂ-uÂ-aÂ-ble time and enÂ-erÂ-gy.―Fish might have the ruÂ-diÂ-menÂ-taÂ-ry brain cirÂ-cuitÂ-ry for tranÂ-siÂ-tive inÂ-ferÂ-ence that apÂ-peared latÂ-er in birds and mamÂ-mals, he conÂ-tinÂ-ued. "Any anÂ-iÂ-mal that has evolved a soÂ-cial sysÂ-tem that reÂ-quires comÂ-bat among maÂ-les will have some kind of eavesÂ-dropÂ-ping caÂ-paÂ-bilÂ-iÂ-ty alÂ-lowÂ-ing them to surÂ-repÂ-tiÂ-tiously draw inÂ-ferÂ-ences about their soÂ-cial rank,― FerÂ-nald said. "CaÂ-pacÂ-iÂ-ties that evolved in fish may conÂ-tribÂ-ute perÂ-haps tranÂ-siÂ-tive inÂ-ferÂ-ence, this caÂ-pacÂ-iÂ-tv or inÂ-deÂ-pendÂ-entÂ-ly. The quesÂ-tion reÂ-mains unÂ-reÂ-solved.―

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