Supplementary material for:

Comparing biotic drivers of litter breakdown across streams compartments

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Table S1. Physicochemical characteristics of the 30 studied rivers: pH, temperature (Temp, °C), altitude (alt, m), latitude (Lat, degree), longitude (Long, degree), channel width (Width, m), water depth (cm), days of exposure (days), nitrate (N, mg/L), orthophosphate (P, mg/L), dissolved organic carbon (DOC, mg/L), canopy cover (Canopy), quantity of cobbles, quantity of gravel, amount of sand, quantity of silt, quantity of leaf litter in the open channel, quantity of submerged plants, quantity of submerged wood. Canopy cover, sediment morphology (cobbles, gravel, sand and silt) and the quantity of leaf litter, submerged plants (Sub plant) and submerged wood (Sub wood) were characterized semi–quantitatively in situ at each site (giving values ranging from 0 when no presence to a maximum of 3). Physicochemical measurements of pH, altitude, latitude, longitude, dissolved organic carbon, dissolved inorganic nitrogen, ammonium, nitrate and phosphate were obtained from the UK Environment Agency as annual averages when available.

| River   | pH | Temp | Alt | Lat | Long | Width | Water depth | Days of exposure | N   | P   | DO  | Amo | DIN | Canopy | Cobbles | Gravel | Sand | Silt | Leaf litter | Sub plant | Sub wood |
|---------|----|------|-----|-----|------|-------|-------------|-----------------|-----|-----|-----|-----|-----|--------|---------|--------|------|-----|----------|-----------|----------|
| Anton   | 8.81| 7.75 | 44.00 | 51.15 | 1.46 | 15.00 | 44.33 | 45.00 | 8.11 | 0.03 | 11.43 | 0.03 | 8.14 | 0.00 | 0.00 | 2.67 | 2.00 | 0.00 | 0.00 | 0.67 | 0.33 |
| B.brooks | 7.65 | 11.97 | 11.00 | 51.44 | 0.25 | 5.50 | 16.00 | 30.00 | 18.60 | 0.34 | 7.32 | 0.19 | 18.79 | 0.00 | 0.33 | 2.33 | 1.67 | 0.67 | 1.67 | 0.00 | 1.33 |
| Broadstone | 5.50 | 7.13 | 71.00 | 51.09 | 0.06 | 1.50 | 9.67 | 29.00 | 3.33 | 0.31 | 9.61 | 0.04 | 3.37 | 3.00 | 1.33 | 2.67 | 0.00 | 0.00 | 1.67 | 0.00 | 1.00 |
| Bure    | 8.12 | 8.67 | 20.00 | 52.82 | 1.20 | 8.50 | 47.33 | 31.00 | 6.23 | 0.06 | 10.32 | 0.04 | 6.27 | 1.00 | 0.00 | 2.00 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Crowdude | 7.98 | 6.76 | 103.00 | 54.65 | -2.60 | 12.00 | 18.00 | 45.00 | 0.89 | 0.01 | 11.43 | 0.01 | 0.90 | 3.00 | 1.67 | 2.00 | 1.33 | 0.00 | 1.33 | 0.00 | 0.33 |
| Deathwater | 7.68 | 6.96 | 76.00 | 51.11 | 0.85 | 3.00 | 45.00 | 29.00 | 0.88 | 0.03 | 9.08 | 0.03 | 0.91 | 3.00 | 0.00 | 0.33 | 3.00 | 0.67 | 2.00 | 0.00 | 0.67 |
| GI1     | 5.90 | 7.09 | 190.99 | 52.10 | -3.84 | 5.50 | 16.33 | 43.00 | 0.23 | 0.01 | 9.00 | 0.03 | 0.26 | 3.00 | 2.33 | 1.67 | 0.00 | 0.00 | 0.67 | 0.00 | 1.00 |
| Glaven  | 8.11 | 8.04 | 14.00 | 52.90 | 1.06 | 4.50 | 51.33 | 31.00 | 6.75 | 0.29 | 10.61 | 0.06 | 6.81 | 3.00 | 0.00 | 0.00 | 2.67 | 1.00 | 1.00 | 0.00 | 0.33 |
| Howe.beck | 8.00 | 7.41 | 168.99 | 54.61 | -2.59 | 5.00 | 25.00 | 49.00 | 0.67 | 0.01 | 13.35 | 0.01 | 0.68 | 0.00 | 3.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Kennet  | 7.72 | 8.21 | 124.99 | 51.42 | 1.72 | 12.00 | 19.67 | 45.00 | 7.51 | 0.03 | 10.05 | 0.03 | 7.54 | 1.00 | 0.00 | 3.00 | 1.00 | 0.00 | 0.33 | 0.00 | 0.00 |
| Lamports | 7.31 | 9.53 | 99.99 | 51.15 | 1.72 | 3.00 | 6.83 | 29.00 | 4.58 | 0.05 | 9.71 | 0.04 | 4.62 | 2.00 | 1.00 | 3.00 | 0.33 | 0.00 | 0.00 | 0.33 | 0.00 |
| Leith   | 8.33 | 6.67 | 108.99 | 54.61 | -2.62 | 6.50 | 26.00 | 49.00 | 2.21 | 0.05 | 9.00 | 0.13 | 2.34 | 0.00 | 2.33 | 1.67 | 0.00 | 0.00 | 1.00 | 0.67 | 0.00 |
| LI3     | 6.12 | 6.80 | 354.98 | 52.14 | -3.73 | 1.50 | 13.67 | 43.00 | 0.48 | 0.00 | 9.00 | 0.13 | 0.61 | 0.00 | 3.00 | 1.00 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 |
| LI6     | 6.67 | 7.29 | 294.99 | 52.13 | -3.72 | 1.50 | 18.33 | 43.00 | 0.04 | 0.00 | 9.00 | 0.13 | 0.17 | 1.00 | 2.67 | 1.33 | 0.00 | 0.00 | 0.67 | 0.00 | 0.00 |
| LI7     | 6.89 | 7.09 | 340.98 | 52.13 | -3.75 | 1.50 | 14.33 | 43.00 | 0.03 | 0.01 | 9.00 | 0.13 | 0.16 | 1.00 | 2.33 | 1.67 | 0.00 | 0.00 | 0.33 | 0.67 | 0.33 |
| LI8     | 5.23 | 7.56 | 316.99 | 52.16 | -3.75 | 1.50 | 19.67 | 43.00 | 0.30 | 0.01 | 9.00 | 0.13 | 0.43 | 0.00 | 2.33 | 1.67 | 0.00 | 0.00 | 0.33 | 0.00 | 0.00 |
| Loan.Oak | 6.40 | 6.92 | 118.99 | 51.08 | 0.10 | 2.00 | 8.33 | 29.00 | 0.55 | 0.03 | 9.77 | 0.03 | 0.58 | 3.00 | 3.00 | 1.00 | 0.00 | 0.00 | 1.67 | 0.00 | 0.33 |
| Loddon  | 7.61 | 9.55 | 60.00 | 51.42 | 1.72 | 5.00 | 54.67 | 45.00 | 12.04 | 0.17 | 8.51 | 0.03 | 12.07 | 0.00 | 0.00 | 3.00 | 0.67 | 0.00 | 1.00 | 0.67 | 0.33 |
### Continue Table S1

| River  | pH  | Temp | DO  | DIN  | N    | P    |
|--------|-----|------|-----|------|------|------|
| Lyde   | 8.19| 9.55 | 60.00| 51.29| 1.72 | 4.00 |
| Lyvennet| 8.57 | 6.76 | 109.99| 54.61| -2.62| 8.00 |
| Morland.beck | 8.40 | 6.71 | 115.00| 54.61| -2.61| 4.50 |
| Nadder | 7.76 | 8.62 | 111.99| 51.23| 1.72 | 0.80 |
| Oak.hanger | 7.58 | 9.29 | 79.00| 51.12| 0.90 | 2.00 |
| Old.lodge | 6.60 | 6.76 | 109.66| 51.05| 0.08 | 1.50 |
| Stiffkey | 7.80 | 8.05 | 10.00| 52.92| 0.89 | 4.50 |
| Tatt   | 7.42 | 7.27 | 47.00| 52.82| 0.75 | 3.00 |
| Test   | 8.08 | 8.04 | 43.00| 51.14| 1.47 | 15.00|
| Waveney | 7.54 | 6.90 | 10.00| 52.42| 1.36 | 9.00 |
| Wennsum| 7.24 | 7.27 | 10.00| 52.78| 0.95 | 5.00 |
| Wey    | 7.77 | 7.61 | 44.00| 51.19| 0.68 | 21.00|

### Additional Information
- **pH**: Measured pH values for each river sample.
- **Temp**: Temperature values for each river sample.
- **DO**: Dissolved Oxygen concentration values for each river sample.
- **DIN**: Dissolved Inorganic Nitrogen concentration values for each river sample.
- **N**: Nitrogen concentration values for each river sample.
- **P**: Phosphorus concentration values for each river sample.
Table S2. Identified Taxa list in the benthic (B) and hyporheic (H) zones for the 30 studied streams during the study period from October 2016 to December 2016: Anton (Ant), Beverly Brook (B.br), Broadstone (Bro), Crownddle (Cro), Deathwater (Dea), Glaven (Gla), Howe Beck (How), Kennet (Ken), Lamports (Lam), Leith (Lei), L13, L16, L17, L18, Lone oak (Loa), Lodden (Lod), Lyde (Lyd), Lyvennet (Lyv), Morland Beck (Mor), Nadder (Nad), Oak.hanger (Oak), Old lodge (Old), Stiffkey (Sti), Tatt (Tat), Test (Tes), Waveney (Wav), Wennsum (Wen), Wey. Taxonomic resolution = species (.sp), tribu (Tr.), sub-family (Sf.), family (F.), order (O.), sub-class (Sc.). Abbreviations for taxa names used in Fig. S5 are given in brackets.

| Taxa                             | Zone | Stream |
|----------------------------------|------|--------|
| **EUMETAZOA INVERTEBRATES**      |      |        |
| Non-insect                       |      |        |
| Nematoda (Nema)                  | B/H  | Ant, B.br, Boa, Cro, Dea, G11, Gla, How, Ken, Lam, Lei, L13, L16, L17, Lod, Lyd, Lyv, Mor, Nad, Oak, Sti, Tat, Tes, Wav, Wen, Wey |
| Acari (Aca)                      | B    | Ant, Det, Lam, Lyv, Wen |
| *Asellus* sp. (Ase)              | B    | B.br, Dea, Gla, Lam, Lei, Tes, Wav |
| *Gammarus* sp. (Gamma)           | B/H  | Ant, B.br, Bur, Cro, Dea, Gla, How, Ken, Lam, Lei, L17, Lod, Lyd, Lyv, Mor, Nad, Sti, Tat, Tes, Wav, Wen, Wey |
| Gastotricha (Gastro)             | B    | B.br |
| Sc. Oligochaeta (Oli)            | B/H  | Ant, B.br, Bro, Bur, Crow, Dea, G11, Gla, How, Ken, Lam, Lei, L13, L16, L17, L18, Loa, Lod, Lyd, Lyv, Mor, Nad, Oak, Old, Sti, Tat, Tes, Wav, Wen, Wey |
| Cl. Ostracoda (Ostra)            | B/H  | Ant, Bro, Lam, L18, Lod, Lyd, Old, Tat, Tes, Wen |
| *Sphaerium* sp (Sphae)           | B    | Lod |
| *Corophium* sp. (Coro)           | B    | Lei, Wey |
| Sc. Hirudinea (Hiru)             | B/H  | Ant, B.br, Cro, Gla, How, Ken, Lei, Lod, Mor, Sti, Tes |
| O. Harpacticoida (Harpa)          | B/H  | Ant, B.br, Gla, Ken, Lam, Lei, Loa, Lyd, Lyv, Mor |
| **Insects (O. Odonata)**         |      |        |
| *Calopterix* sp. (Calo)          | B    | B.br |
| **Insects (O. Plecoptera)**      |      |        |
| *Amphinemura* sp. (Amphi)        | B    | Cro, L17 |
| *Isoperla* sp. (Iso)              | B/H  | Ant, Cro, Dea, G11, How, Ken, L17, L16, L17, L18, Loa, Lyv, Mor, Old, Sti |
| *Leuctra* sp. (Leu)               | B    | Cro, G11, L13, L17, L18, Loa, Lyv |
| **Insects (O. Ephemeroptera)**   |      |        |
| *Baetis* sp. (Bae)                | B    | Ant, Bur, How, Ken, Lei, Lyd |
| *Caenis* sp. (Cae)                | B    | Gla, Kenn, Lyv, Wav, Wen |
| *Ephemereella* sp. (Ephe)         | B    | Ken, Lam |
| *Paraleptophlebia* sp. (Para)     | B    | How, Mor |
| **Insects (O. Trichoptera)**     |      |        |
| F. Leptoceridae (Lepto)           | B    | Ant |
### Continue Table S2

| Taxonomy | Common Name | B/L/H | Collectors |
|----------|-------------|-------|-------------|
| *Hydropsyche* sp. (Hydro) | | | Ant, GI1, Lud, Lyv, Mor, Wav, Wen, Wey |
| *Hydropsychella* sp. (Hypo) | | | Lam |
| *Ithytrichia* sp. (Ithy) | | | Ant, Bur, Lyd, Lyv, Sti, Tes, Wen |
| *Lepidostoma* sp. (Lept) | | | Gla, Sti, Wen |
| F. *Leptoceridae* (Lepto) | | | Lam |
| *Plectrocnemia* sp. (Plectro) | | | LI3 |
| *Polycentropus* sp. (Poly) | | | Sti |
| *Prosorhyacophila* sp. (Prosos) | | | Lyd |
| *Rhya* sp. (Rhyo) | | | GI1, How, Ken, Mor |
| *Nemotaulius* sp. (Nemo) | | | Tes |
| *Sericostoma* sp. (Seri) | | | Ant, GI1, How, Lyv, Tes, Wav, Wen |
| Sf. *Agapetae* (Aga) | | | Lyd |
| Sf. *Pseudoneuroclipsis* (Pseu) | | | Lyd |
| *Wormaldia* sp. (Worma) | | | Ken |
| *Silo* sp. (Silo) | | | Ant |
| *Oecetis* sp. (Oe) | | | Tes |

**Insects (O. Diptera)**

| Taxonomy | Common Name | B/L/H | Collectors |
|----------|-------------|-------|-------------|
| Chironomidae pupae (NA) | | | Dea, Ken, Nad, Wav, Wen |
| Sf. Ceratopogoninae (Cer) | | | Ant, Bro, Gla, How, Lam, Lei, LI3, LI8, Lyv, Stif, Tat, Tes, Wey |
| Sf. Clinocerinae (Cino) | | | Ant, GI1, Lei, Lyv |
| Sf. Hemerodromiinae (Heme) | | | Bur, GI1, Lam, Lyd |
| Sf. Orthocladiinae (Ortho) | | | Ant, B.br, Bro, Bur, Cro, Dea, GI1, Gla, How, Ken, Lam, Lei, LI1, LI6, LI7, LI8, Loa, Lod, Lyd, Lyv, Mor, Nad, Old, Sti, Tat, Tes, Wav, Wen, Wey |
| Sf. Tanypodinae (Tany) | | | Ant, B.br, Bro, Cro, Dea, GI1, Gla, How, Ken, Lam, Lei, LI3, Loa, Lod, Lyd, Lyv, Mor, Oak, Old, Sti, Tes, Wav, Wen |
| F. Stratyomiidae (Straty) | | | Cro, Lyv |
| Tr. Chironomini (Chiro) | | | Ant, B.br, Bor, Bur, Cro, Dea, GI1, Gla, How, Ken, Lei, LI3, LI6, Loa, Lod, Lyd, Lyv, Mor, Nad, Oak, Sti, Tat, Nad, Wav, Wey |
| Tr. Limoniini (Limo) | | | Cro, LI6, Mor, Tat, Tes, Wav |
| Tr. Pediciini (Pedi) | | | Gla, LI7, Lyd, Wey |
| Tr. Simuliini (Simu) | | | GI1, Gla, How, Lei, Old, Wav, Wen |
| Tr. Tanytarsini (Tany) | | | Ant, B.br, Bro, Bur, Cro, GI1, How, Ken, Lam, Lei, Lod, Lyd, Lyv, Mor, Nad, Old, Tat, Tes, Wav, Wen, Wey |
| F. Anthomyiidae (Antho) | | | Lam |
| Tr. Hexatomini (Hexa) | | | LI7 |

**Insects (O. Coleoptera)**

| Taxonomy | Common Name | B/L/H | Collectors |
|----------|-------------|-------|-------------|
| *Elmis* sp. Adult (Elmis (A)) | | | Ant, Gla, Lyd |
| *Elmis* sp. Larv (Elmis (L)) | | | Ant, Gla, Ken, Lam, Lei, Lod, Mor, Sti, Tes, Wen |
| *Halipus* sp. (Hali) | | | How, Ken, Lei, Lyv, Mor, Wav, Wey |
| *Limnias* sp. Adult (Limni (A)) | | | How, Sti |
| *Limnias* sp. Larv (Limni (L)) | | | Ant, Cro, GI1, Gla, Lei, Sti, Tes, Wav, Wen |
| *Orectochilus* sp. Larv (Ore (L)) | | | Lyv |
| *Riolus* sp larva (Rio (L)) | | | Lyv |
### Ciliates

| Group                  | Subgroup | B/H | Ant | B.br | Bro | Bur | Cro | Dea | How | Ken | Lam | Li6 | Li8 | Loa | Lod | Lyd | Lyv | Mor | Nad | Oak | Old | Sti | Tat | Tes | Wav | Wen | Wey |
|------------------------|----------|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Sc. Cyrtophorida (Cyrto) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Gymnostomatida (Gymno) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Heterotrichia (Hete) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Hymenostomata (Hyme) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Hypotrichia (Hypo)  |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Odontostomatida (Odo) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Oligotrichia (Oli)  |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Peritrichia (Peri)  |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Pleurostomatida (Pleuro) |    | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Prostomatida (Prosto) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Sc. Suctoria (Sucto)    |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Cyst (Cyst)             |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

### Flagelates

| Group | Subgroup | B/H | Ant | B.br | Bro | Bur | Cro | Dea | G11 | Gla | How | Ken | Lam | Lei | Li6 | Li7 | Li8 | Loa | Lod | Lyd | Lyv | Mor | Nad | Oak | Old |
|-------|----------|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Flagelates (Fla) |          | B/H |     |      |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

Continue Table S2
Table S3. Fitting coefficients of streambed compartment, decay rates, biological vectors and environmental vectors against the NDMS ordination model. Note that only significant values are reported. NO$_3$ = nitrate; DIN = dissolved inorganic nitrogen; Inv. biomass = invertebrate biomass; Prot. biomass = protozoa biomass; Inv. diversity = Eumetazoa invertebrate diversity; Prot. diversity = Protozoa diversity; Prok. met. rich = Prokaryota metabolic richness; Prok. met. div. = Prokaryota metabolic diversity; $k_{\text{cotton}}$ = decay coefficient cotton strips; $k_{\text{green}}$ = decay coefficient green–tea; S = long–term carbon stabilization factor

| Fitted variables          | NMDS1 | NMDS2 | R$^2$ | P   | sig |
|--------------------------|-------|-------|-------|-----|-----|
| Factor (Zone)            |       |       |       |     |     |
| BZ                       | -0.474| -0.034| 0.553 | 0.001| *** |
| HZ                       | 0.474 | 0.034 |       |     |     |
| Vectors                  |       |       |       |     |     |
| Inv. diversity           | -0.945| 0.328 | 0.773 | 0.001| *** |
| $k_{\text{cotton}}$      | -0.888| 0.459 | 0.651 | 0.001| *** |
| $k_{\text{green}}$       | -0.875| -0.484| 0.282 | 0.001| *** |
| Prot. diversity          | -0.935| -0.354| 0.388 | 0.001| *** |
| S                        | 0.999 | 0.045 | 0.485 | 0.001| *** |
| Body size                | -0.889| 0.459 | 0.169 | 0.003| **  |
| Prok. met. rich           | -0.684| -0.730| 0.175 | 0.003| **  |
| Inv. biomass             | -0.884| 0.467 | 0.175 | 0.004| **  |
| pH                       | -0.445| 0.896 | 0.169 | 0.004| **  |
| DIN                      | -0.158| 0.987 | 0.152 | 0.009| **  |
| NO$_3$                   | -0.164| 0.987 | 0.154 | 0.009| **  |
| Prok. met. div.          | -0.484| -0.875| 0.129 | 0.016| *   |
| Altitude                 | 0.146 | -0.989| 0.118 | 0.038| *   |
Table S4. ANOVA tables for the comparison of ecological variables (taxonomic group biomass, taxonomic α-diversity, bacterial functional diversity, EcoPlate AWCD and substrates AWCD) between benthic zone and hyporheic zone. Significance codes: 0 (***), 0.001 (**), 0.01 (*) and 0.05 (*). A Kenward-Roger approximation was used to calculate the effective degrees of freedom (DF).

| (1) Log_{10} eumetazoa invertebrates biomass | Sum Sq | DF  | Den DF | F value | P (>F) | Sig |
|---------------------------------------------|--------|-----|--------|---------|--------|-----|
| Zone                                        | 191.49 | 1   | 130.56 | 202.55  | < 0.001*** |
| (2) Log_{10} protozoa biomass                | 93.50  | 1   | 131.26 | 168.09  | < 0.001*** |
| *Log_{10} bacterial biomass ~ zone           |        |     |        |         |         |     |
| Zone                                        | 1.56   | 1   | 130.79 | 2.79    | 0.096  |
| (3) α-diversity eumetazoa invertebrates     | 2687.10| 1   | 129.22 | 257.13  | < 0.001*** |
| (4) α-diversity protozoa                    | 640.12 | 1   | 131.17 | 131.07  | < 0.001*** |
| (5) Bacterial functional diversity (S-W, EcoPlate ) | 5.63   | 1   | 134.24 | 9.87    | 0.002** |
| (6) EcoPlate AWCD                           | 0.32   | 1   | 134.04 | 19.57   | < 0.001*** |
| (7) Amino acids AWCD                        | 0.15   | 1   | 134.26 | 4.34    | 0.039*  |
| (8) Carbohydrates AWCD                      | 0.50   | 1   | 134.13 | 22.46   | < 0.001*** |
| (9) Carboxylic acids AWCD                   | 0.23   | 1   | 134.78 | 11.51   | 0.001*** |
| (10) Phenolics compounds AWCD               | 0.17   | 1   | 134.99 | 5.12    | 0.025*  |
| (11) Amines AWCD                            | 0.12   | 1   | 134.70 | 4.46    | 0.036*  |
| (12) Polymers AWCD                          | 0.79   | 1   | 133.75 | 25.92   | < 0.001*** |
Table S5. Summary table of the fitted predictive equations after the casual three steps method routine for decay rate of cotton–strips ($k_{\text{cotton}}$). Details: Marginal $R^2$ of the model (Mar $R^2$), conditional $R^2$ of the model (Cond $R^2$), proportion of mediated effect (Prop. Mediated), Partial $R^2$, Standardised coefficients (Std $\beta$), standard errors (SE), degrees of freedom (DF), t values, lower (Low) and upper (Up) limits of the credible intervals (CrI) and P values (P). Significance codes (Sig): 0 (***) 0.001 (**), 0.01 (*) and 0.05 (·). A Satterthwaite approximation was used to calculate the effective degrees of freedom.

| Model                                      | Partial $R^2$ | Std $\beta$ | SE     | DF | t value | Low 95%CrI | Up 95%CrI | P  | Sig |
|---------------------------------------------|---------------|-------------|--------|----|---------|------------|-----------|----|-----|
| $k_{\text{cotton}} \sim \text{Zone}$       |               |             |        |    |         |            |           |    |     |
| Marg $R^2$ = 0.3094                          | Intercept     | --          | 0.0061 | 13.8200 | 10.2950  | 0.0050    | 0.0073    | -- | -- |
| Marg $R^2$ = 0.5188                          | Zone          | 0.3094      | -0.0041 | 128.4000 | -9.9380  | -0.0050   | -0.0033   | >0.001 | *** |
| $k_{\text{cotton}} \sim \text{Inv. Biomass} \sim \text{Zone}$ |               |             |        |    |         |            |           |    |     |
| Marg $R^2$ = 0.3910                          | Intercept     | --          | 0.6234 | 11.6302 | 3.5130   | 0.2875    | 0.9564    | -- | -- |
| Marg $R^2$ = 0.7080                          | Zone          | 0.3910      | -1.2618 | 129.7889 | -14.2560 | -1.4390   | -1.0900   | >0.001 | *** |
| $k_{\text{cotton}} \sim \text{Inv. div.} \sim \text{Zone}$ |               |             |        |    |         |            |           |    |     |
| Marg $R^2$ = 0.4011                          | Intercept     | 0.6677      | 0.1693 | 11.3062 | 3.9200   | 0.3223    | 0.9966    | -- | -- |
| Marg $R^2$ = 0.7651                          | Zone          | 0.4011      | 0.6677 | 0.0796 | 128.6020 | -16.0500  | -1.4379   | -1.1283  | >0.001 | *** |
| $k_{\text{cotton}} \sim \text{Inv. Biomass} \sim \text{Zone} \times \text{Inv. Biomass} \times \text{Inv. Div.}$ |               |             |        |    |         |            |           |    |     |
| Marg $R^2$ = 0.5668                          | Intercept     | --          | 0.0037 | 18.6300 | 8.0310   | 0.0027    | 0.0045    | -- | -- |
| Marg $R^2$ = 0.6308 Prop. Mediated = 68%    | Zone          | 0.0330      | -0.0013 | 94.9700 | -2.1130  | -0.0024   | -0.0001   | 0.0372 | **  |
|                                             | Inv. Biomass  | 0.1120      | 0.0022 | 143.7000 | 4.3420   | 0.0012    | 0.0031    | <0.001 | *** |
|                                             | Inv. Div.     | 0.0830      | 0.0016 | 102.9000 | 3.6220   | 0.0008    | 0.0026    | <0.001 | *** |
| $k_{\text{cotton}} \sim \text{Inv. Biomass} \sim \text{Zone} \times \text{Inv. Div.} \sim \text{Zone}$ |               |             |        |    |         |            |           |    |     |
| Marg $R^2$ = 0.6308 Prop. Mediated = 68%    | Zone          | 0.0410      | -0.0015 | 140.9000 | -2.6290  | -0.0026   | -0.0004   | <0.001 | *** |
|                                             | Zone          | 0.0350      | -0.0014 | 104.0000 | -2.3610  | -0.0027   | -0.0003   | 0.0201 | **  |

Inv.biomass: Log$_{10}$ biomass of Eumetazoa invertebrates, Inv. Div.: α–diversity of Eumetazoa invertebrates, Zone: Streambed compartment (2 levels factor: HZ and BZ).
Table S6. Summary table of the fitted predictive equations after the casual three steps method routine for decay rate of green–tea (k_{green}). See Table S5 for details.

| Model | Partial R² | Std β | SE  | DF  | t value | Low 95% CrI | Up 95% CrI | P  | sig |
|-------|-------------|-------|-----|-----|---------|-------------|------------|----|-----|
| Step 1 | | | | | | | | | |
| k_{green} ~ Zone | | | | | | | | | |
| Marg R² = 0.2800 | | | | | | | | | |
| Cond R² = 0.6450 | | | | | | | | | |
| Intercept | -- | 0.0031 | 0.0030 | 9.7040 | 23.2300 | 0.0028 | 0.0033 | -- | -- |
| Zone | 0.2800 | -0.0008 | 0.0001 | 129.2000 | -10.9600 | -0.0009 | -0.0006 | >0.001 | *** |
| | | | | | | | | | |
| Step 2 | | | | | | | | | |
| Prot. biomass ~ Zone | | | | | | | | | |
| Marg R² = 0.4319 | | | | | | | | | |
| Cond R² = 0.6098 | | | | | | | | | |
| Intercept | -- | 0.6229 | 0.1182 | 10.5666 | 5.2490 | 0.3922 | 0.8641 | -- | -- |
| Zone | 0.4319 | -1.3379 | 0.1029 | 130.0019 | -12.9930 | -1.5428 | -1.1244 | >0.001 | *** |
| | | | | | | | | | |
| Step 3 | | | | | | | | | |
| k_{green} ~ Zone + Prot. biomass + Zone × Inv. div. | | | | | | | | | |
| Marg R² = 0.3995 | | | | | | | | | |
| Cond R² = 0.7083 | | | | | | | | | |
| Prop. Mediated = 62% | | | | | | | | | |
| Intercept | -- | 0.0030 | 0.0001 | 15.7500 | 23.1600 | 0.0028 | 0.0001 | -- | -- |
| Zone | 0.0390 | -0.0003 | 0.0001 | 149.2000 | -2.9420 | -0.0006 | -0.0001 | 0.0038 | ** |
| Prot. Biomass | 0.1040 | 0.0002 | 0.00005 | 148.7000 | 4.9210 | 0.0001 | 0.0003 | 0.0000 | *** |
| Inv. Div. | 0.0100 | -0.0001 | 0.0001 | 150.2000 | -1.2960 | -0.0002 | 0.0001 | 0.1969 | ** |
| Zone × Inv. Div. | 0.0450 | 0.0003 | 0.0001 | 146.0000 | 3.3030 | 0.0001 | 0.0005 | 0.0012 | ** |

Prot.biomass: Log_{10} biomass of Protozoa, Inv. Div.: α–diversity of Eumetazoa invertebrates, Zone: Streambed compartment (2 levels factor: HZ and BZ).
Table S7. Summary table of the fitted predictive equations after the casual three steps method routine for decay rate of red–tea ($k_{\text{red}}$). See Table S5 for details.

| Model                        | Partial R² | Std β | SE   | DF | t value | Low 95%CrI | Up 95%CrI | P     | sig |
|------------------------------|------------|-------|------|----|---------|------------|-----------|-------|-----|
| **Step 1**                   |            |       |      |    |         |            |           |       |     |
| $k_{\text{red}} \sim \text{Zone}$ |            |       |      |    |         |            |           |       |     |
| Marg R²= 0.0883              |            |       |      |    |         |            |           |       |     |
| Cond R² = 0.5571             |            |       |      |    |         |            |           |       |     |
| Intercept                    | --         | 0.00082 | 0.00004 | 10.33000 | 22.05000 | 0.00075 | 0.00089 | --   | -- |
| Zone                         | 0.08835    | -0.00011 | 0.00002 | 123.10000 | -5.37000 | -0.00015 | -0.00007 | 0.00000 | ***|
| **Step 2**                   |            |       |      |    |         |            |           |       |     |
| $\text{Prot. biomass} \sim \text{Zone}$ |            |       |      |    |         |            |           |       |     |
| Marg R²= 0.43190             |            |       |      |    |         |            |           |       |     |
| Cond R² = 0.60980            |            |       |      |    |         |            |           |       |     |
| Intercept                    | --         | 0.62290 | 0.11820 | 10.56660 | 5.24900  | 0.39220  | 0.86410 | --   | -- |
| Zone                         | 0.43190    | -1.33790 | 0.10290 | 130.00190 | -12.99300 | -1.54280 | -1.12440 | >0.001 | ***|
| **Step 3**                   |            |       |      |    |         |            |           |       |     |
| $k_{\text{green}} \sim \text{Zone} + \text{Prot.biomass} + \text{Prok.biomass}$ |            |       |      |    |         |            |           |       |     |
| Marg R²= 0.39950             |            |       |      |    |         |            |           |       |     |
| Cond R² = 0.70830            |            |       |      |    |         |            |           |       |     |
| Prop. Mediated = 81%         |            |       |      |    |         |            |           |       |     |
| Intercept                    | --         | 0.00078 | 0.00004 | 11.94000 | 20.68200 | 0.00003 | 0.00085 | --   | -- |
| Zone                         | 0.00300    | -0.00002 | 0.00003 | 138.40000 | -0.89600 | -0.00008 | 0.00003 | 0.37182 |      |
| Prot. biomass                | 0.06600    | 0.00006 | 0.00002 | 145.00000 | 3.85300  | 0.00003 | 0.00009 | 0.00017 | ***|
| Prok. biomass                | 0.03600    | 0.00003 | 0.00001 | 145.10000 | 2.70900  | 0.00001 | 0.00006 | 0.00755 | **  |

Prot.biomass: $\log_{10}$ biomass of Protozoa, Prok.biomass: $\log_{10}$ biomass of Prokariota, Zone: Streambed compartment (2 levels factor: HZ and BZ).
Table S8. Summary table of the fitted predictive equations after the casual three steps method routine for stabilization factor coefficient (S). See Table S5 for details.

| Model | Partial R² | Std β  | SE       | DF | t value | Low 95%CI | Up 95%CI | P     | sig |
|-------|-------------|--------|----------|----|---------|-----------|----------|-------|-----|
| S ~ Zone |             |        |          |    |         |           |          |       |     |
|       |             |        |          |    |         |           |          |       |     |
| Marg R² = 0.2800 | | Cond R² = 0.6450 | | | | | | |  |
|       |             |        |          |    |         |           |          |       |     |
| Intercept | -- | 0.2837 | 0.0221 | 12.2206 | 12.8700 | 0.2398 | 0.3257 | -- | -- |
| Zone | 0.2853 | **0.1261** | 0.0116 | 126.6092 | 10.8600 | 0.1028 | 0.1491 | >0.001 | *** |

| Inv. Biomass ~ Zone |             |        |          |    |         |           |          |       |     |
|                    |             |        |          |    |         |           |          |       |     |
| Marg R² = 0.3910   | | Cond R² = 0.7080 | | | | | | |  |
|                   |             |        |          |    |         |           |          |       |     |
| Intercept | -- | 0.6234 | 0.1763 | 11.6302 | 3.5130 | 0.2875 | 0.9564 | -- | -- |
| Zone | 0.3910 | -1.2618 | 0.0888 | 129.7889 | -14.2560 | -1.4390 | -1.0900 | >0.001 | *** |

| Prot. Biomass ~ Zone |             |        |          |    |         |           |          |       |     |
|                     |             |        |          |    |         |           |          |       |     |
| Marg R² = 0.6098   | | Cond R² = 0.4319 | | | | | | |  |
|                    |             |        |          |    |         |           |          |       |     |
| Intercept | -- | 0.6229 | 0.1182 | 10.5666 | 5.2490 | 0.3922 | 0.8641 | -- | -- |
| Zone | 0.4319 | -1.3379 | 0.1029 | 130.0019 | -12.9930 | -1.5428 | -1.1244 | >0.001 | *** |

| Prok. F. Div. ~ Zone |             |        |          |    |         |           |          |       |     |
|                     |             |        |          |    |         |           |          |       |     |
| Marg R² = 0.4320   | | Cond R² = 0.6098 | | | | | | |  |
|                    |             |        |          |    |         |           |          |       |     |
| Intercept | -- | 0.6185 | 0.1182 | 10.5666 | 5.2490 | 0.3905 | 0.8545 | -- | -- |
| Zone | 0.4320 | -1.3369 | 0.1029 | 130.0019 | -12.9930 | -1.5380 | -1.1436 | >0.001 | *** |

| S ~ Zone + Inv. Biomass + Prot. Biomass + Prok. f. div. |             |        |          |    |         |           |          |       |     |
|                                                          |             |        |          |    |         |           |          |       |     |
| Marg R² = 0.3995 | | Cond R² = 0.7083 | | | | | | |  |
| Prop. Mediated = 59% | | | | | | | | |  |
|              |             |        |          |    |         |           |          |       |     |
| Intercept | -- | 0.3185 | 0.0211 | 13.8781 | 15.1720 | 0.2776 | 0.3607 | -- | -- |
| Zone | 0.0340 | **0.0513** | 0.0195 | 145.0262 | 2.6510 | 0.0129 | 0.0924 | 0.0089 | ** |
| Inv. Biomass | 0.0310 | -0.0201 | 0.0101 | 147.3874 | -2.0380 | -0.0396 | -0.0007 | 0.0434 | * |
| Prot. Biomass | 0.0680 | -0.0323 | 0.0085 | 139.7118 | -3.7680 | -0.0482 | -0.0167 | 0.0002 | *** |
| Bac. F. Div. | 0.0100 | -0.0124 | 0.0062 | 136.1964 | -1.9780 | -0.0235 | -0.0002 | 0.0500 | * |

Inv.biomass: Log₁₀ biomass of Eumetazoa invertebrates, Prot.biomass: Log₁₀ biomass of Protozoa, Prok.f.div: Prokariotic functional diversity, Zone: Streambed compartment (2 levels factor: HZ and BZ).
Fig S1. Linear regression model predicting benthic temperature (°C) as a response of the hyporheic temperature (covariate). $\beta_0$: intercept, $\beta_1$: slope, R-square: coefficient of determination.
**Fig S2:** Decay coefficients of green and rooibos–tea bioassays from sites in two of the study catchments. The negative exponential decay model is fitted to the data (where possible) highlighting that the k used in the analysis is generally supported for these assays. Data were collected by volunteers from the Eden Trust and Surrey Wildlife Trust as part of a Citizen Science Project: [http://www.riverflies.org/scratching-below-surface-monitoring-functioning-under-](http://www.riverflies.org/scratching-below-surface-monitoring-functioning-under-).
**Fig S3.** Cell size calibration from flow cytometer data. Cell size (μm) was estimated from the relationship between calibration beads of known size and forward scatter values returned by flow cytometer.
Fig S4. (a) Path diagram of a direct effect model. The variation in the response (Y) is explained just by the exposure variable (X) and the associate error. (b) Path diagram of a multiple mediation model. The variation in Y is explained by direct effect of X and indirect effect mediated by the mediators (M₁,2,...). (c) Diagram of the casual three–steps method proposed by Judd and Kenny (1981).
Fig S5. Shepard-plot of the NDMS ordination. Scatter around the regression of distances between each pair of communities against their original dissimilarities. The fit is shown as a monotone step line.
Fig S6. Influence of different taxa with the NMDS ordination model based on Bray-Curtis index comparing the dissimilarities in composition and abundance of benthos and hyporheos across the 30 studied systems. Ellipses show the 95% CIs on the location of centroids for benthos (yellow) and hyporheos (grey). Ellipses are kept in the panel to facilitate interpretation. The arrows depict the relationship of body size with the ordination. Code for taxa names is available in Table S2.
Fig S7. Descriptive Box-Plot showing global litter decay rate ($K$) values in the benthic and hyporheic zone of the studied systems.
Supplementary Methods.

Preparing and processing of cotton-strip and tea bags – Tensile strength of all cotton-strips was measured with an Instron Series IX tensiometer (Instron Corporation, Canton, Ohio) at 20 °C and 65% relative humidity in a climate-controlled room. Mean and standard deviation of pre-incubation tensile strength (631.0 ± 17 kg) was measured using 5 new cotton-strips. The green and rooibos-tea bags were dried for 2 days at 55°C and weighed (total bag weight) before incubation in the field. Initial bag weights were 2.12 g (SD = 0.02 g) and 2.15 g (SD = 0.02 g) for green-tea bags and rooibos-tea bags, respectively.

Samples preparation for organisms processing – Once in the laboratory, falcon vials containing bioassays collected in the field were shaken continuously for 1 min at 2500 rpm using a compact vortex shaker (SciQuip Vortex Mixers). Immediately after shaking, 10 ml water was collected with a pipette. From the collected water, 5 ml were filtered using cellulose acetate membrane filters (45 µm) to remove Protozoa and Eumetazoa invertebrates from the medium for later measurements of prokaryote biomass diversity and potential metabolic activity. The remaining water was kept unfiltered to process Protozoa. Both filtered and unfiltered water samples were stored in sterile conditions at 4 °C. The remaining content of the vials was retained on a 40–µm sieve for identification. Tea-bags and cotton-strips were stored and the remaining sieve contents were preserved in 4% formalin containing Bengal–rose stain so that invertebrates could be processed at a later time.

Body size-dry carbon content conversions – Body dimensions of all counted Protozoa and meiofauna (Eumetazoa invertebrates whose body size is into the range of 0.45–500.00 µm) were transformed to biovolume after Reiss and Schmid–Araya (2010). Protozoa individual biovolume was directly converted to dry carbon content assuming 0.14 pg C/µm³ (Putt & Stoecker, 1996). For meiofauna individual biovolume was first converted into fresh mass using published gravity values (Feller & Warwik, 1998) following the approach of previous studies (i.e. Reiss & Schmid–Araya, 2008; Tod & Schmid–Araya, 2009; Peralta–Maraver, Reiss, & Robertson, 2018). Measurements of macroinvertebrates (Eumetazoa invertebrates whose body size is larger than 500.00 µm) were converted to dry mass using published body length and biovolume formula (Feller
& Warwick, 1998; Benke, Huryn, Smock, & Wallace, 1999; Reiss & Schmid–Araya, 2008; Tod & Schmid–Araya, 2009). The individual carbon content of all Eumetazoa invertebrates was then calculated by using dry/wet mass ratio of 0.25 and dry mass/carbon content of 0.4 (Feller & Warwick, 1998).

Ecoplates processing – EcoPlates had 96 wells containing 31 different dissolved carbon sources and a blank (a control well which contains only water), replicated three times. EcoPlate substrates were grouped into six categories according to Feigl, Ujaczki, Vaszita and Molnár (2017): carbohydrates, carboxylic acids, phenolic compounds, amino acids and polymers (grouping of substrates is available as Table S9).

Table S9. Carbon source categories grouping the BIOLOG EcoPlate substrates.

| Carbon source category       | Eco-plate substrate                                                                 |
|------------------------------|-------------------------------------------------------------------------------------|
| Amino acids                  | • L-arginine                                                                          |
|                              | • L-asparagine                                                                        |
|                              | • L-phenylalanine                                                                     |
|                              | • L-serine                                                                            |
|                              | • glycyl-L-glutamic acid                                                              |
|                              | • L-theronine                                                                         |
| Carbohydrates                | • D-mannitol, glucose-1-phosphate,                                                   |
|                              | • D,L- alpha-glycerol phosphate,                                                      |
|                              | • beta-methyl-D-glucoside,                                                            |
|                              | • D-galactonic acid-gamma-lactone,                                                    |
|                              | • i-erythritol,                                                                       |
|                              | • D-xylene                                                                           |
|                              | • N-acetyl-D-glucosamine,                                                             |
|                              | • D-cellobiose,                                                                       |
|                              | • alpha-D-lactose                                                                    |
| Carboxylic acids             | • D-glucosaminic acid                                                                 |
|                              | • D-malic acid                                                                       |
|                              | • itaconic acid                                                                       |
|                              | • pyruvic acid methyl ester                                                           |
|                              | • D-galactouronic acid                                                                |
|                              | • alpha-ketobutyric acid                                                              |
|                              | • gamma-hydroxybutyric acid                                                           |
| Phenolic compound            | • 2-hydroxy benzoic acid                                                              |
|                              | • 4-hydroxy benzoic acid                                                              |
| Amines                       | • phenylethylamine                                                                    |
|                              | • putrescine                                                                          |
| Polymers                     | • Tween 40                                                                            |
|                              | • Tween 80                                                                            |
|                              | • alpha-cyclodextrine                                                                  |
|                              | • glycogen                                                                           |
A 100–μL aliquot was pipetted into each EcoPlate well and incubated in the dark at 15 °C for 5 days (three replicates by zone and study site by EcoPlate). After this period, colour development of each carbon category was measured as optical density (OD) at 595 nm using a Biotek HT absorbance reader (Biotek, Swindon, U.K.). Following EcoPlate protocols, OD values were corrected by subtracting the blank values in each EcoPlate and setting negative values to 0. Corrected OD values were used to calculate the plate average well colour development (AWCD) as:

\[ AWCD = \frac{\sum OD_i}{N} \]

where \( OD_i \) is the corrected OD value of each substrate containing well and \( N \) is the number of substrates (31) (Gryta, Frąc, & Oszust 2014). The average well colour development values for each substrate (Substrate AWCD) were also obtained using equation 2. For that propose, \( OD_i \) represented the corrected OD value of the substrates within the substrate category and \( N \) was the number of substrates in the category (Kenarova, Radeva, Traykov, & Boteva, 2014).

Prokaryotic functional diversity was calculated as Shannon–Wiener diversity value (\( H' \)) based on substrate utilization as:

\[ H' = -\sum_{i=1}^{Sr} P_i \ln(P_i) \]

where \( Sr \) is the number of wells with color development and \( P_i \) is the proportional colour development of the well over total color development of all wells of a plate.

Statistical analysis: models selection, fitting and models validation – Biomass of all identified groups and standardized decay coefficients (coefficients / standing stock biomass) were first Log10 transformed to solve heterogeneity of the residuals in the ANOVA tests and the regression models, but this was not necessary for the rest of the responses. Continuous covariates in the regression models were first centered by subtracting the mean and dividing by the standard deviation. Collinearity problems were detected among plate-AWCD (metabolic potential to utilize all carbon sources in EcoPlates) and individual substrate-AWCD (metabolic potential to utilize each carbon sources in EcoPlates) during data exploration. Therefore, plate-AWCD was maintained as a potential covariate of the regression models, while substrate-AWCD was not included. Intra–class correlation effects of the studied responses with the study site (samples collection from the same streams) and with catchment (streams sampled from the same catchment) were also detected during data exploration. Therefore, study site
(30 levels) and catchment (10 levels) were incorporated in the ANOVA tests as random factors (two random factors ANOVA) and the mediated regression models as random intercepts (Linear Mixed Models, LMMs).

In the case of mediated LMMs, backward selection based on the Akaike Information Criterion (AIC) was applied to find the optimal candidate for the mediation models. Full models containing all biological variables (mediators), streambed compartment and first–order interactions were fitted first. Then, less influential variables (lower AIC) were dropped sequentially using the drop1 function within R (R Core Team, 2014), and the reduced model was refitted at each time. Final mediation models were then fitted as part of the casual step method proposed by Judd and Kenny (1981) for statistical mediation analysis:

\[
1) \quad Y = \beta_0 + \beta X + \varepsilon_0 \\
2.1) = \beta_1 + \beta_1X + \varepsilon_1 \\
2.2) \quad M_2 = \beta_2 + \beta_2X + \varepsilon_2 \\
2.3) \quad M_j = \beta_j + \beta_jX + \varepsilon_j \\
3) \quad Y = \beta_j + \beta_j'X + \beta_1M_1 + \beta_2M_2 + \ldots \beta_jM_j + \varepsilon_{j+1}
\]

where equation 1 shows the total effect of streambed compartment (X) on the response (Y). Equations 2.1 to 2.3 show the effect of X on the mediator variables (M1, M2, …, Mj) included in the mediation model. Equation 3 (mediation model) shows the mediated effect of X (c’) and the effect of the mediators (b1, b1, …, bj) on Y. Interaction terms were added as the multiplication between streambed compartment and mediators in equation 3. In all equations, i represents the intercept and ε the error term. Proportion of the mediated effect was finally estimated as 1-(c’/c) (see Rijnhart, Twisk, Chinapaw, de Boer, & Heymans, 2017). According to the casual step method (Fig S3) the effect of exposure outcome variable (here streambed compartment) on the response (here decay coefficients) is mediated when a1 to aj, b1 to bj, and c coefficients are all significant (equations 1 and 2). Partial mediation occurs when c’ is also significant, while full mediation occurs when c’ coefficient is not significant. Following Rijnhart, Twisk, Chinapaw, de Boer and Heymans (2017), we reported both statistical significance and credible intervals for the coefficients estimation.

Previous equations were fitted using the function lmer of the R–package lme4 (Bates et al. 2016). Subsequently, 5000 values from the posterior joint distribution of the equation parameters were simulated with the function sim of the R–package arm.
This function uses an analytical direct-simulation method with uninformative priors (Gelman & Su, 2009). Obtained means of the simulated values from the joint posterior distribution of model parameters were used as estimates, and the 2.5% and 97.5% quantiles as lower and upper limits of 95% credible intervals. Furthermore, the `anova` function (based on F–statistic) and the summary function (based on t–statistic) from the R–package `lmerTest` (Kuznetsova, Brockhoff, & Christensen, 2015) were used to assess significance of ANOVA tests and LMMs coefficients, respectively. These functions implement the Kenward–Roger’s method for approximating degrees of freedom. This is a robust method, which allows obtaining the p–values related with the F and t statistic when applying mixed effect models (Kuznetsova, Brockhoff, & Christensen, 2017). Finally, the marginal–R² (variance explained by fixed factors) and conditional–R² (variance explained by both fixed and random factors) of the models were calculated to assess model fit using the function `rsquaredGLMM` of the R–package `MuMIn` (Nakagawa & Schielzeth, 2013). Subsequently, partial R² of each variable included in the LMMs were assessed using the function `r2beta` of R–package `r2glmm` (Jaeger, 2016). Validation of underlying assumptions of normality and homoscedasticity in ANOVA tests and optimal mediation LMMs residuals was applied following Zuur, Ieno, Walker, Savaliev and Smith, (2009).

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