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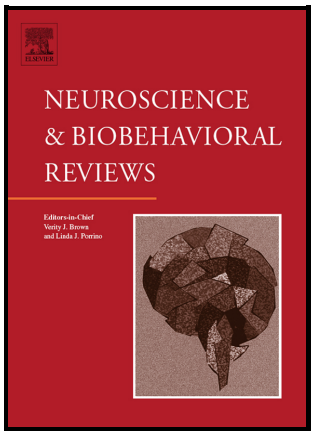

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Daniela Schiller, Alessandra N.C. Yu, Nelly Alia-Klein, Susanne Becker, Howard C. Cromwell, Florin Dolcos, Paul J. Eslinger, Paul Frewen, Andrew H. Kemp, Edward F. Pace-Schott, Jacob Raber, Rebecca L. Silton, Elka Stefanova, Justin H.G. Williams, Nobuhito Abe, Moji Aghajani, Franziska Albrecht, Rebecca Alexander, Silke Anders, Oriana R. Aragón, Juan A. Arias, Shahar Arzy, Tatjana Aue, Sandra Baez, Michela Balconi, Tommaso Ballarini, Scott Bannister, Marlissa C. Banta, Karen Caplovitz Barrett, Catherine Belzung, Moustafa Bensafi, Linda Booij, Jamila Bookwala, Julie Boulanger-Bertolus, Sydney Weber Boutros, Anne-Kathrin Bräscher, Antonio Bruno, Geraldo Busatto, Lauren M. Bylsma, Catherine Caldwell-Harris, Raymond C.K. Chan, Nicolas Cherbuin, Julian Chiarella, Pietro Cipresso, Hugo Critchley, Denise E. Croote, Heath A. Demaree, Thomas F. Denson, Brendan Depue, Birgit Derntl, Joanne M. Dickson, Sanda Dolcos, Anat Drach-Zahavy, Olga Dubljević, Tuomas Eerola, Dan-Mikael Ellingsen, Beth Fairfield, Camille Ferdenzi, Bruce H. Friedman, Cynthia H.Y. Fu, Justine M. Gatt, Beatrice deGelder, Guido H.E. Gendolla, Gadi Gilam, Hadass Goldblatt, Anne Elizabeth Kotynski Gooding, Olivia Gosseries, Alfons O. Hamm, Jamie L. Hanson, Talma Hendler, Cornelia Herbert, Stefan G. Hofmann, Agustin Ibanez, Mateus Joffily, Tanja Jovanovic, Ian J. Kahrilas, Maria Kangas, Yuta Katsumi, Elizabeth Kensinger, Lauren A.J. Kirby, Rebecca Koncz, Ernst H.W. Koster, Kasia Kozlowska, Sören Krach, Mariska E. Kret, Martin Krippl, Kwabena Kusi-Mensah, Cecile D. Ladouceur, Steven Laureys, Alistair Lawrence, Chiang-shan R. Li, Belinda J. Liddell, Navdeep K. Lidhar, Christopher A. Lowry, Kelsey Magee, Marie-France Marin, Veronica Mariotti, Loren J. Martin, Hilary A. Marusak, Annalina V. Mayer, Amanda R. Merner, Jessica Minnier, Jorge Moll, Robert G. Morrison, Matthew Moore, Anne-Marie Mouly, Sven C. Mueller, Andreas Mühlberger, Nora A. Murphy, Maria Rosaria Anna Muscatello, Erica D. Musser, Tamara L. Newton, Michael Noll-Hussong, Seth Davin Norrholm, Georg Northoff, Robin Nusslock, Hadas Okon-

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Singer, Thomas M. Olino, Catherine Ortner, Mayowa Owolabi, Caterina Padulo, Romina Palermo, Rocco Palumbo, Sara Palumbo, Christos Papadelis, Alan J. Pegna, Silvia Pellegrini, Kirsi Peltonen, Brenda W.J.H. Penninx, Pietro Pietrini, Graziano Pinna, Rosario Pintos Lobo, Kelly L. Polnaszek, Maryna Polyakova, Christine Rabinak, S. HeleneRichter, Thalia Richter, Giuseppe Riva, Amelia Rizzo, Jennifer L. Robinson, Pedro Rosa, Perminder S. Sachdev, Wataru Sato, Matthias L. Schroeter, Susanne Schweizer, Youssef Shiban, Advaith Siddharthan, Ewa Siedlecka, Robert C. Smith, Hermona Soreq, Derek P. Spangler, Emily R. Stern, Charis Styliadis, Gavin B. Sullivan, James E. Swain, Sébastien Urben, Jan Van den Stock, Michael A. vander Kooij, Mark van Overveld, Tamsyn E. Van Rheenen, Michael B. VanElzakker, Carlos Ventura-Bort, Edelyn Verona, Tyler Volk, Yi Wang, Leah T. Weingast, Mathias Weymar, Claire Williams, Megan L. Willis, Paula Yamashita, Roland Zahn, Barbra Zupan, Leroy Lowe, Gan Gabriela, Huggins Charlotte F, Loeffler Leonie

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Ferdenzi, Bruce H. Friedman, Cynthia H.Y. Fu, Justine M. Gatt, Beatrice deGelder, Guido H.E. Gendolla, Gadi Gilam, Hadass Goldblatt, Anne Elizabeth Kotynski Gooding, Olivia Gosseries, Alfons O. Hamm, Jamie L. Hanson, Talma Hendler, Cornelia Herbert, Stefan G. Hofmann, Agustin Ibanez, Mateus Joffily, Tanja Jovanovic, Ian J. Kahrilas, Maria Kangas, Yuta Katsumi, Elizabeth Kensinger, Lauren A.J. Kirby, Rebecca Koncz, Ernst H.W. Koster, Kasia Kozlowska, Sören Krach, Mariska E. Kret, Martin Krippl, Kwabena Kusi-Mensah, Cecile D. Ladouceur, Steven Laureys, Alistair Lawrence, Chiang-shan R. Li, Belinda J. Liddell, Navdeep K. Lidhar, Christopher A. Lowry, Kelsey Magee, Marie-France Marin, Veronica Mariotti, Loren J. Martin, Hilary A. Marusak, Annalina V. Mayer, Amanda R. Merner, Jessica Minnier, Jorge Moll, Robert G. Morrison, Matthew Moore, Anne-Marie Mouly, Sven C. Mueller, Andreas Mühlberger, Nora A. Murphy, Maria Rosaria Anna Muscatello, Erica D. Musser, Tamara L. Newton, Michael Noll-Hussong, Seth Davin Norrholm, Georg Northoff, Robin Nusslock, Hadas Okon-Singer, Thomas M. Olino, Catherine Ortner, Mayowa Owolabi, Caterina Padulo, Romina Palermo, Rocco Palumbo, Sara Palumbo, Christos Papadelis, Alan J. Pegna, Silvia Pellegrini, Kirsi Peltonen, Brenda W.J.H. Penninx, Pietro Pietrini, Graziano Pinna, Rosario Pintos Lobo, Kelly L. Polnaszek, Maryna Polyakova, Christine Rabinak, S. HeleneRichter, Thalia Richter, Giuseppe Riva, Amelia Rizzo, Jennifer L. Robinson, Pedro Rosa, Perminder S. Sachdev, Wataru Sato, Matthias L. Schroeter, Susanne Schweizer, Youssef Shiban, Advaith Siddharthan, Ewa Siedlecka, Robert C. Smith, Hermona Soreq, Derek P. Spangler, Emily R. Stern, Charis Styliadis, Gavin B. Sullivan, James E. Swain, Sébastien Urben, Jan Van den Stock, Michael A. vander Kooij, Mark van Overveld, Tamsyn E. Van Rheenen, Michael B. VanElzakker, Carlos Ventura-Bort, Edelyn Verona, Tyler Volk, Yi Wang, Leah T. Weingast, Mathias Weymar, Claire Williams, Megan L. Willis, Paula Yamashita, Roland Zahn, Barbra Zupan, Leroy Lowe, Gan Gabriela, Huggins Charlotte F and Loeffler Leonie, The Human Affectome, *Neuroscience and Biobehavioral Reviews,* (2023) doi:https://doi.org/10.1016/j.neubiorev.2023.105450

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The Human Affectome

Daniela Schiller [1 * Ψ], Alessandra N. C. Yu [2 * Ψ], Nelly Alia-Klein[3], Susanne Becker [4,5], Howard C. Cromwell [6], Florin Dolcos [7, 8], Paul J. Eslinger [9], Paul Frewen [10], Andrew H. Kemp [11], Edward F. Pace-Schott [12, 13], Jacob Raber [14, 15], Rebecca L. Silton [16], Elka Stefanova [17, 18], Justin H. G. Williams [19], Nobuhito Abe [20], Moji Aghajani [21, 22], Franziska Albrecht [23, 24, 25, 26], Rebecca Alexander [27, 28], Silke Anders [29, 30], Oriana R. Aragón [31, 32], Juan A. Arias [11, 33, 34], Shahar Arzy [35], Tatjana Aue [36], Sandra Baez [37], Michela Balconi [38], Tommaso Ballarini [23], Scott Bannister [39], Marlissa C. Banta [40], Karen Caplovitz Barrett [41, 42], Catherine Belzung [43], Moustafa Bensafi [44], Linda Booij [45, 46], Jamila Bookwala [47], Julie Boulanger-Bertolus [48], Sydney Weber Boutros [14], Anne-Kathrin Bräscher [49, 50], Antonio Bruno [51], Geraldo Busatto [52], Lauren M. Bylsma [53], Catherine Caldwell-Harris [54], Raymond C. K. Chan [55], Nicolas Cherbuin [56], Julian Chiarella [45, 46], Pietro Cipresso [57, 58], Hugo Critchley [59], Denise E. Croote [60, 61], Heath A. Demaree [62], Thomas F. Denson [63], Brendan Depue [64], Birgit Derntl [65], Joanne M. Dickson [66], Sanda Dolcos [7, 8], Anat Drach-Zahavy [67], Olga Dubljević [68, 18], Tuomas Eerola [39], Dan-Mikael Ellingsen [69], Beth Fairfield [70, 71], Camille Ferdenzi [44], Bruce H. Friedman [72,] Cynthia H. Y. Fu [73, 74], Justine M. Gatt [75, 27], Beatrice de Gelder [76], Guido H. E. Gendolla [77], Gadi Gilam [78, 79], Hadass Goldblatt [80], Anne Elizabeth Kotynski Gooding [62], Olivia Gosseries [81], Alfons O. Hamm [82], Jamie L. Hanson [83], Talma Hendler [84, 85] Cornelia Herbert [86] Stefan G. Hofmann [87], Agustin Ibanez [88, 89, 90, 91], Mateus Joffily [92], Tanja Jovanovic [93], Ian J. Kahrilas [16], Maria Kangas [94], Yuta Katsumi [95, 8], Elizabeth Kensinger [96], Lauren A. J. Kirby [97], Rebecca Koncz [98, 99], Ernst H. W. Koster [100], Kasia Kozlowska [101], Sören Krach [102], Mariska E. Kret [103], Martin Krippl [104], Kwabena Kusi-Mensah [105, 106, 107], Cecile D. Ladouceur [108], Steven Laureys [81], Alistair Lawrence [109, 110], Chiang-shan R. Li [111], Belinda J. Liddell [75], Navdeep K. Lidhar [112], Christopher A. Lowry [113], Kelsey Magee [62], Marie-France Marin [114, 115], Veronica Mariotti [116], Loren J. Martin [112], Hilary A. Marusak [93, 117], Annalina V. Mayer [102], Amanda R. Merner [62], Jessica Minnier [118], Jorge Moll [119], Robert G. Morrison [16], Matthew Moore [7, 8, 120], Anne-Marie Mouly [121], Sven C. Mueller [100], Andreas Mühlberger [122], Nora A. Murphy [123], Maria Rosaria Anna Muscatello [51], Erica D. Musser [124], Tamara L. Newton [125], Michael Noll-Hussong [126], Seth Davin Norrholm [93], Georg Northoff [127], Robin Nusslock [128], Hadas Okon-Singer [129], Thomas M. Olino [130], Catherine Ortner [131], Mayowa Owolabi [132, 133], Caterina Padulo [134], Romina Palermo [135], Rocco Palumbo [134], Sara Palumbo [136], Christos Papadelis [137, 138], Alan J. Pegna [139], Silvia Pellegrini [116], Kirsi Peltonen [140, 141], Brenda W.J.H. Penninx [22], Pietro Pietrini [142], Graziano Pinna [143], Rosario Pintos Lobo [124], Kelly L. Polnaszek [16], Maryna Polyakova [144], Christine Rabinak [145], S. Helene Richter [146], Thalia Richter [129], Giuseppe Riva [57, 147], Amelia Rizzo [51], Jennifer L. Robinson [148], Pedro Rosa [52], Perminder S. Sachdev [98, 149], Wataru Sato [150], Matthias L. Schroeter [23, 24], Susanne Schweizer [151, 152], Youssef Shiban [122, 153], Advaith Siddharthan [154], Ewa Siedlecka [63], Robert C. Smith [155], Hermona Soreq [156], Derek P. Spangler [157], Emily R. Stern [158, 50], Charis Styliadis [159], Gavin B. Sullivan [160], James E. Swain [161], Sébastien Urben [162], Jan Van den Stock [163], Michael A. van der Kooij [164], Mark van Overveld [165], Tamsyn E. Van Rheenen [166], Michael B. VanElzakker [167], Carlos Ventura-Bort [168], Edelyn Verona [169], Tyler Volk [170], Yi Wang [55], Leah T. Weingast [171], Mathias Weymar [168, 172], Claire Williams [11, 173], Megan L. Willis [174], Paula Yamashita [113], Roland Zahn [74], Barbra Zupan [175], and Leroy Lowe [176 * Ψ]

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Affiliations

1 Department of Psychiatry, the Nash Family Department of Neuroscience, and the Friedman Brain Institute, at the Icahn School of Medicine at Mount Sinai, New York, NY, United States
2 Nash Family Department of Neuroscience, Icahn School of Medicine at Mount Sinai, New York, NY 10029, United States
3 Department of Psychiatry and Neuroscience, Icahn School of Medicine at Mount Sinai, New York, NY, United States
4 Department of Cognitive and Clinical Neuroscience, Central Institute of Mental Health, Medical Faculty Mannheim, Heidelberg University, J5, 68159 Mannheim, Germany

5 Integrative Spinal Research Group, Department of Chiropractic Medicine, University Hospital Balgrist, University of Zurich, Balgrist Campus, Lengghalde 5, 8008 Zurich, Switzerland
6 J.P. Scott Center for Neuroscience, Mind and Behavior, Department of Psychology, Bowling Green State University, Bowling Green, OH, 43403, United States
7 Beckman Institute for Advanced Science & Technology, University of Illinois at Urbana-Champaign, Urbana, IL, United States
8 Department of Psychology, University of Illinois at Urbana-Champaign, Champaign, IL, United States
9 Departments of Neurology, Neural & Behavioral Science, Radiology, and Public Health Sciences, Penn State Hershey Medical Center and College of Medicine, Hershey, PA, United States
10 Departments of Psychiatry, Psychology and Neuroscience at the University of Western Ontario, London, Ontario, Canada
11 School of Psychology, Faculty of Medicine, Health & Life Science, Swansea University, Swansea, United Kingdom
12 Harvard Medical School and Massachusetts General Hospital, Department of Psychiatry, Boston, MA, United States
13 Department of Psychiatry, Massachusetts General Hospital, Boston, MA, United States
14 Department of Behavioral Neuroscience, Oregon Health & Science University, Portland, OR 97239, United States
15 Departments of Neurology, Radiation Medicine, Psychiatry, and Division of Neuroscience, ONPRC, Oregon Health & Science University, Portland, OR, United States
16 Department of Psychology, Loyola University Chicago, Chicago, IL, United States
17 Faculty of Medicine, University of Belgrade, Serbia
18 Neurology Clinic, Clinical Center of Serbia, Serbia
19 Griffith University, Gold Coast Campus, 1 Parklands Dr, Southport QLD 4215, Australia
20 Institute for the Future of Human Society, Kyoto University, 46 Shimoadachi-cho, Yoshida Sakyo-ku, Kyoto, Japan
21 Institute of Education & Child Studies, Section Forensic Family & Youth Care, Leiden University, The Netherlands
22 Department of Psychiatry, Amsterdam UMC, Location VUMC, GGZ InGeest Research & Innovation, Amsterdam Neuroscience, The Netherlands
23 Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany
24 Clinic for Cognitive Neurology, University Hospital Leipzig, Leipzig, Germany
25 Division of Physiotherapy, Department of Neurobiology, Care Sciences and Society, Karolinska Institutet, Stockholm, Sweden
26 Karolinska University Hospital, Women's Health and Allied Health Professionals Theme, Medical unit Occupational Therapy & Physiotherapy, Stockholm Sweden
27 Neuroscience Research Australia, Randwick, Sydney, NSW, Australia
28 Australian National University, Canberra, ACT, Australia
29 Department of Neurology, University of Lübeck, Lübeck, Germany
30 Center of Brain, Behavior and Metabolism, University of Lübeck, Lübeck, Germany
31 Yale University, 2 Hillhouse Ave, New Haven, CT, United States
32 Cincinnati University, Marketing Department, 2906 Woodside Drive, Cincinnati, OH 45221-0145, United States
33 Department of Statistics, Mathematical Analysis, and Operational Research, Universidade de Santiago de Compostela, Spain
34 The Galician Center for Mathematical Research and Technology (CITMAga), 15782 Santiago de Compostela, Spain
35 Department of Medical Neurobiology, Hebrew University, Jerusalem, Israel
36 Institute of Psychology, University of Bern, Fabrikstr. 8, 3012 Bern, Switzerland
37 Universidad de Los Andes, Bogotá, Colombia
38 International Research Center for Cognitive Applied Neuroscience, Catholic University of Milan, Milan, Italy

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39 Durham University, Palace Green, DH1 RL3, Durham, United Kingdom
40 Lebanon VA Medical Center, Lebanon, PA, United States
41 Department of Human Development & Family Studies, Colorado State University, Fort Collins, CO, United States
42 Department of Community & Behavioral Health, Colorado School of Public Health, Denver, CO, United States
43 UMR 1253, iBrain, Université de Tours, Inserm, Tours, France
44 Research Center in Neurosciences of Lyon, CNRS UMR5292, INSERM U1028, Claude Bernard University Lyon 1, Lyon, Centre Hospitalier Le Vinatier, 95 bd Pinel, 69675 Bron Cedex, France
45 Department of Psychology, Concordia University Montreal, Canada
46 CHU Sainte-Justine, University of Montreal, Montreal, Canada
47 Department of Psychology, Lafayette College, Easton, PA, United States
48 Department of Anesthesiology and Center for Consciousness Science, University of Michigan, Ann Arbor, Michigan, United States
49 Department of Clinical Psychology, Psychotherapy and Experimental Psychopathology, University of Mainz, Wallstr. 3, 55122 Mainz, Germany
50 Nathan Kline Institute for Psychiatric Research, Orangeburg, NY, United States
51 Department of Biomedical, Dental Sciences and Morpho-Functional Imaging – University of Messina, Italy
52 Laboratory of Psychiatric Neuroimaging (LIM-21), Departamento e Instituto de Psiquiatria, Hospital das Clinicas HCFMUSP, Faculdade de Medicina, Universidade de Sao Paulo, Sao Paulo, Brazil
53 Departments of Psychiatry and Psychology; and the Center for Neural Basis of Cognition, University of Pittsburgh School of Medicine, Pittsburgh, PA, United States
54 Department of Psychological and Brain Sciences, Boston University, Boston, MA, United States
55 Neuropsychology and Applied Cognitive Neuroscience Laboratory, CAS Key Laboratory of Mental Health, Institute of Psychology, Chinese Academy of Sciences, Beijing, China
56 Centre for Research on Ageing, Health, and Wellbeing, Australian National University, Canberra, ACT, Australia
57 Applied Technology for Neuro-Psychology Lab., Istituto Auxologico Italiano, Milan, Italy
58 Department of Psychology, University of Turin, Turin, Italy
59 Psychiatry, Department of Neuroscience, Brighton and Sussex Medical School (BSMS), University of Sussex, Sussex, United Kingdom
60 Departments of Psychiatry and Neuroscience, Icahn School of Medicine at Mount Sinai and Friedman Brain Institute, New York, NY 10029, United States
61 Hospital Universitário Gaffrée e Guinle, Universidade do Rio de Janeiro, Brazil
62 Department of Psychological Sciences, Case Western Reserve University, Cleveland, OH, United States
63 School of Psychology, University of New South Wales, Sydney, NSW, Australia
64 Departments of Psychological and Brain Sciences and Anatomical Sciences and Neurobiology, University of Louisville, Louisville, KY, United States
65 Department of Psychiatry and Psychotherapy, Tübingen Center for Mental Health, University of Tübingen, Tübingen, Germany
66 Edith Cowan University, Psychology Discipline, School of Arts and Humanities, 270 Joondalup Dr, Joondalup, WA 6027, Australia
67 The Faculty of Health and Welfare Sciences, University of Haifa, Haifa, Israel
68 Institute for Biological Research "Siniša Stanković", National Institute of Republic of Serbia, Belgrade, Serbia
69 Department of Diagnostic Physics, Division of Radiology and Nuclear Medicine, Oslo University Hospital, Oslo, Norway
70 Department of Humanistic Studies, University of Naples Federico II, Naples, Italy
71 UniCamillus, International Medical University, Rome, Italy
72 Department of Psychology, Virginia Tech, Blacksburg, VA, United States
73 School of Psychology, University of East London, United Kingdom

Journal Pre-proof

74 Centre for Affective Disorders, Institute of Psychiatry, Psychology and Neuroscience, King's College London, United Kingdom
75 School of Psychology, University of New South Wales, Randwick, Sydney, NSW, Australia
76 Department of Psychology and Neuroscience, Maastricht University, Maastricht, Netherlands
77 Geneva Motivation Lab, University of Geneva, FPSE, Section of Psychology, CH-1211 Geneva 4, Switzerland
78 The Institute of Biomedical and Oral Research, Faculty of Dental Medicine, Hebrew University of Jerusalem, Jerusalem, Israel
79 Systems Neuroscience and Pain Laboratory, Stanford University School of Medicine, CA, United States
80 Department of Nursing, Faculty of Social Welfare & Health Sciences, University of Haifa, Haifa, Israel
81 Coma Science Group, GIGA Consciousness & Centre du Cerveau[2], University and University Hospital of Liege, Liege, Belgium
82 Department of Biological and Clinical Psychology/Psychotherapy, University of Greifswald, Greifswald, Germany
83 Department of Psychology, University of Pittsburgh, Pittsburgh, PA 15206, United States
84 Tel Aviv Center for Brain Function, Wohl Institute for Advanced Imaging, Tel Aviv Sourasky Medical Center, Tel Aviv, Israel
85 School of Psychological Sciences, Tel-Aviv University, Tel Aviv, Israel
86 Department of Applied Emotion and Motivation Psychology, Institute of Psychology and Education, Ulm University, Ulm, Germany
87 Department of Clinical Psychology, Philipps University Marburg, Germany
88 Universidad de San Andres, Buenos Aires, Argentina
89 National Scientific and Technical Research Council (CONICET), Buenos Aires, Argentina
90 Latin American Brain Health Institute (BrainLat), Universidad Adolfo Ibáñez, Santiago, Chile
91 Global Brain Health Institute (GBHI), University of California San Francisco (UCSF), United States and Trinity Collegue Dublin (TCD), Ireland
92 Groupe d'Analyse et de Théorie Economique (GATE), 93 Chemin des Mouilles, 69130, Écully, France
93 Department of Psychiatry and Behavaioral Neurosciences, Wayne State University, Detroit, MI, United States
94 Department of Psychology, Macquarie University, Sydney, Australia
95 Department of Neurology, Massachusetts General Hospital and Harvard Medical School, Charlestown, MA, USA
96 Department of Psychology and Neuroscience, Boston College, Boston, MA, United States
97 Department of Psychology and Counseling, University of Texas at Tyler, Tyler, TX, United States
98 Centre for Healthy Brain Ageing, Discipline of Psychiatry and Mental Health, University of New South Wales, Sydney, Australia
99 Specialty of Psychiatry, The University of Sydney, Concord, New South Wales, Australia
100 Department of Experimental Clinical and Health Psychology, Ghent University, Ghent, Belgium
101 University of Sydney Medical School, Sydney, Australia
102 Social Neuroscience Lab, Translational Psychiatry Unit, University of Lübeck, Lübeck, Germany
103 Leiden University, Cognitive Psychology, Pieter de la Court, Waassenaarseweg 52, Leiden, 2333 AK, the Netherlands
104 Faculty of Natural Sciences, Department of Psychology, Otto von Guericke University Magdeburg, Universitätsplatz 2, Magdeburg, Germany
105 Department of Psychiatry, Komfo Anokye Teaching Hospital, P. O. Box 1934, Kumasi, Ghana
106 Department of Psychiatry, University of Cambridge, Darwin College, Silver Street, CB3 9EU, Cambridge United Kingdom
107 Behavioural Sciences Department, School of Medicine and Dentistry, Kwame Nkrumah University of Science and Technology, Kumasi Ghana
108 Departments of Psychiatry and Psychology and the Center for Neural Basis of Cognition (CNBC), University of Pittsburgh, Pittsburgh, PA, United States
109 Scotland's Rural College, King's Buildings, Edinburgh, Scotland
110 The Roslin Institute, University of Edinburgh, Easter Bush, Scotland

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111 Connecticut Mental Health Centre, Yale University, New Haven, CT, United States
112 Department of Psychology, University of Toronto Mississauga, Mississauga, ON, Canada
113 Department of Integrative Physiology and Center for Neuroscience, University of Colorado Boulder, Boulder, CO, United States
114 Department of Psychology, Université du Québec à Montréal, Montreal, Canada
115 Research Center, Institut universitaire en santé mentale de Montréal, Montreal Canada
116 Department of Clinical and Experimental Medicine, University of Pisa, Pisa, Italy
117 Merrill Palmer Skillman Institute for Child and Family Development, Wayne State University, Detroit, MI, United States
118 School of Public Health, Oregon Health & Science University, Portland, OR, United States
119 Cognitive Neuroscience and Neuroinformatics Unit, D'Or Institute for Research and Education, Rio de Janeiro, Brazil
120 War Related Illness and Injury Study Center (WRIISC), Veterans Affairs Palo Alto Health Care System, Palo Alto, CA, United States
121 Lyon Neuroscience Research Center, CNRS-UMR 5292, INSERM U1028, Universite Lyon, Lyon, France
122 Department of Psychology (Clinical Psychology and Psychotherapy), University of Regensburg, Regensburg, Germany
123 Department of Psychology, Loyola Marymount University, Los Angeles, CA, United States
124 Center for Children and Families, Department of Psychology, Florida International University, Miami, FL, United States
125 Department of Psychological and Brain Sciences, University of Louisville, Louisville, KY, United States
126 Psychosomatic Medicine and Psychotherapy, TU Muenchen, Langerstrasse 3, D-81675 Muenchen, Germany
127 Mind, Brain Imaging and Neuroethics Research Unit, University of Ottawa Institute of Mental Health Research, Royal Ottawa Mental Health Centre, Canada
128 Department of Psychology and Institute for Policy Research, Northwestern University, 2029 Sheridan Road, Evanston, IL, United States
129 School of Psychological Sciences, University of Haifa, Haifa, Israel
130 Department of Psychology, Temple University, 1701N. 13th St, Philadelphia, PA, United States
131 Thompson Rivers University, Department of Psychology, 805 TRU Way, Kamloops, BC, Canada
132 Department of Medicine and Center for Genomic and Precision Medicine, College of Medicine, University of Ibadan; University College Hospital, Ibadan, Oyo State, Nigeria
133 Blossom Specialist Medical Center Ibadan, Oyo State, Nigeria
134 Department of Psychological, Health and Territorial Sciences, University of Chieti, Chieti, Italy
135 School of Psychological Science, University of Western Australia, Perth, WA, Australia
136 Department of Surgical, Medical and Molecular Pathology and of Critical Care, University of Pisa, Pisa, Italy
137 Jane and John Justin Neuroscience Center, Cook Children's Health Care System, Fort Worth, Texas, United States
138 Department of Bioengineering, University of Texas at Arlington, Arlington, Texas, United States
139 School of Psychology, University of Queensland, Saint Lucia, Queensland, Australia
140 Research Centre for Child Psychiatry, University of Turku, Turku, Finland
141 INVEST Research Flagship, University of Turku, Turku, Finland
142 IMT School for Advanced Studies, Lucca, Italy
143 The Psychiatric Institute, Department of Psychiatry, University of Illinois at Chicago, Chicago, IL, United States
144 Neurology Department, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany
145 Department of Pharmacy Practice, Wayne State University, Detroit, MI, United States
146 Department of Behavioural Biology, University of Münster, Badestraße 13, Münster, Germany,
147 Humane Technology Lab., Università Cattolica del Sacro Cuore, Milan, Italy
148 Auburn University, Auburn, AL, United States
149 Neuropsychiatric Institute, The Prince of Wales Hospital, Sydney, Australia

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150 Psychological Process Research Team, Guardian Robot Project, RIKEN, 2-2-2 Hikaridai, Seika-cho, Soraku-gun, Kyoto, Japan
151 Department of Psychology, University of Cambridge, Cambridge, United Kingdom
152 School of Psychology, University of New South Wales, Sydney, Australia
153 Department of Psychology (Clinical Psychology and Psychotherapy Research), PFH – Private University of Applied Sciences, Gottingen, Germany
154 Knowledge Media Institute, The Open University, Milton Keynes MK7 6AA, United Kingdom
155 Departments of Medicine and Psychiatry, Michigan State University, East Lansing, MI, United States
156 Department of Biological Chemistry, Edmond and Lily Safra Center of Brain Science and The Institute of Life Sciences, Hebrew University, Jerusalem, Israel
157 Department of Biobehavioral Health, The Pennsylvania State University, State College, PA, United States
158 New York University School of Medicine, New York, NY, United States
159 Neuroscience of Cognition and Affection group, Lab of Medical Physics and Digital Innovation, School of Medicine, Aristotle University of Thessaloniki, Thessaloniki, Greece
160 International Psychoanalytic University, Berlin, Germany
161 Departments of Psychiatry & Behavioral Health, Psychology, Obstetrics, Gynecology & Reproductive Medicine, and Program in Public Health, Renaissance School of Medicine at Stony Brook University, New York, United States
162 Division of Child and Adolescent Psychiatry, Lausanne University Hospital (CHUV) and University of Lausanne, Lausanne, Switzerland
163 Neuropsychiatry, Department of Neurosciences, Leuven Brain Institute, KU Leuven, Leuven, Belgium
164 Translational Psychiatry, Department of Psychiatry and Psychotherapy, Universitatsmedizin der Johannes Guttenberg University Medical Center, Mainz, Germany
165 Erasmus University Rotterdam, Rotterdam, the Netherlands
166 University of Melbourne, Melbourne Neuropsychiatry Centre, Department of Psychiatry, 161 Barry Street, Carlton, VIC, Australia
167 Division of Neurotherapeutics, Massachusetts General Hospital, Boston, MA, United States
168 Department of Biological Psychology and Affective Science, Faculty of Human Sciences, University of Potsdam, Potsdam, Germany
169 Department of Psychology, University of South Florida, Tampa, FL, United States
170 Professor Emeritus of Biology and Environmental Studies, New York University, New York, NY, United States
171 Department of Social Work and Human Services and the Department of Psychological Sciences, Center for Young Adult Addiction and Recovery, Kennesaw State University, Kennesaw, Georgia, United States
172 Faculty of Health Sciences Brandenburg, University of Potsdam, Germany
173 Elysium Neurological Services, Elysium Healthcare, The Avalon Centre, United Kingdom
174 School of Behavioural and Health Sciences, Australian Catholic University, Sydney, NSW, Australia
175 Central Queensland University, School of Health, Medical and Applied Sciences, Bruce Highway, Rockhampton, QLD, Australia
176 Neuroqualia (NGO), Truro, Nova Scotia, Canada

*Co-corresponding authors at: Departments of Psychiatry and Neuroscience, and Friedman Brain Institute, Icahn School of Medicine at Mount Sinai, New York, NY, United States, E-mail address: daniela.schiller@mssm.edu (Daniela Schiller), and alessandra.yu@icahn.mssm.edu (Alessandra N. C. Yu), Neuroqualia (NGO), 229a Forrester Hall, NSCC, 36 Arthur Street Truro, Nova Scotia, Canada, E-mail address: leroy.lowe@neuroqualia.org (Leroy Lowe)

Author Sequencing: Nelly Alia-Klein, Susanne Becker, Howard C. Cromwell, Florin Dolcos, Paul J. Eslinger, Paul Frewen, Andrew H. Kemp, Edward F. Pace-Schott, Jacob Raber, Rebecca L. Silton, Elka Stefanova, and

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[1] For affiliations and acknowledgments, see supplementary material.

daniela.schiller@mssm.edu
alessandra.yu@icahn.mssm.edu

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nelly.alia-klein@mssm.edu
sbecker@uni-duesseldorf.de

hcc@bgsu.edu
fdolcos@illinois.edu

peslinger@pennstatehealth.psu.edu
pfrewen@gmail.com
a.h.kemp@swansea.ac.uk
EPACE-SCHOTT@mgh.harvard.edu

raberj@ohsu.edu

rsilton@luc.edu
steela21@gmail.com

Justin.Williams@health.qld.gov.au

abe.nobuhito.7s@kyoto-u.ac.jp
m.aghajani@fsw.leidenuniv.nl

franziska.albrecht@ki.se

r.alexander@neura.edu.au

silke.anders@neuro.uni-luebeck.de

aragonor@ucmail.uc.edu

jescarbaciones@gmail.com

shahar.arzy@gmail.com
tatjana.aue@unibe.ch
sjbaezb@gmail.com
michela.balconi@unicatt.it
ballarini.tommaso@outlook.it
S.C.Bannister@leeds.ac.uk
mca31@pitt.edu
Karen.Barrett@ColoState.EDU

catherine.belzung@gmail.com
moustafa.bensafi@cnrs.fr
linda.booij@concordia.ca

BOOKWALJ@lafayette.edu
jboulangerbertolus@gmail.com
sydneyboutros@boisestate.edu
abraesch@uni-mainz.de

antonio.bruno@unime.it
geraldo.busatto@gmail.com
Bylsmal@pitt.edu

Journal Pre-proof

charris@bu.edu
rckchan@psych.ac.cn
nicolas.cherbuin@anu.edu.au
julianchiarella@gmail.com

p.cipresso@auxologico.it

H.Critchley@bsms.ac.uk
denise.croote@icahn.mssm.edu

had4@case.edu
t.denson@unsw.edu.au
brendan.depue@louisville.edu
Birgit.Derntl@med.uni-tuebingen.de
j.dickson@ecu.edu.au
sdolcos@illinois.edu

anatdz@research.haifa.ac.il
ogd992@gmail.com

tuomas.eerola@durham.ac.uk
d.m.ellingsen@psykologi.uio.no
bfairfield@unich.it

camille.ferdenzi@cnrs.fr
bhfriedm@vt.edu
C.Fu@uel.ac.uk

j.gatt@neura.edu.au

b.degelder@maastrichtuniversity.nl
Guido.Gendolla@unige.ch
gadi.gilam@gmail.com

goldblat@univ.haifa.ac.il
anniekotynski@gmail.com
ogosseries@uliege.be
hamm@uni-greifswald.de
jamielh@pitt.edu

cornelia.herbert@uni-ulm.de
stefan.g.hofmann@gmail.com
agustin.ibanez@gbhi.org

joffily@gate.cnrs.fr
tjovanovic@med.wayne.edu
ikahrilas@luc.edu
maria.kangas@mq.edu.au
YKATSUMI@mgh.harvard.edu

elizabeth.kensinger@bc.edu
lkirby@uttyler.edu
r.koncz@unsw.edu.au

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Ernst.Koster@UGent.be
kkoz6421@uni.sydney.edu.au
soerenkrach@googlemail.com
m.e.kret@fsw.leidenuniv.nl
martin.krippl@ovgu.de
kkusimensah@yahoo.com

ladouceurcd@upmc.edu
steven.laureys@uliege.be
Alistair.Lawrence@sruc.ac.uk

chiang-shan.li@yale.edu
b.liddell@unsw.edu.au
navi.lidhar@mail.utoronto.ca
christopher.lowry@colorado.edu
kem151@case.edu
marie-france.marin@umontreal.ca

veronica.mariotti@unipi.it
lj.martin@utoronto.ca
hmarusak@med.wayne.edu

ann.mayer@uni-luebeck.de
arm251@case.edu
minnier@ohsu.edu
jorge.moll@idor.org
rmorrison@luc.edu
mmoore16@illinois.edu

annemarie.mouly@cnrs.fr
Sven.Mueller@UGent.be
Andreas.Muehlberger@psychologie.uni-regensburg.de
Nora.Murphy@lmu.edu
maria.muscatello@unime.it
emusser@fiu.edu
tamara.newton@louisville.edu
minohu@gmx.net
SNorrholm@wayne.edu
Georg.Northoff@theroyal.ca
nusslock@northwestern.edu
Hadasos@psy.haifa.ac.il
thomas.olino@temple.edu
Cortner@tru.ca
mayowaowolabi@yahoo.com

caterina.padulo@unich.it
romina.palermo@uwa.edu.au
roccopalumbo@gmail.com
sara.palumbo@unipi.it
christos.papadelis@cookchildrens.org

a.pegna@uq.edu.au
silvia.pellegrini@unipi.it
kirsi.peltonen@utu.fi

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b.penninx@amsterdamumc.nl
pietro.pietrini@imtlucca.it
gpinna@uic.edu
rpintosl@fiu.edu
kellypolnaszek@gmail.com

rabinak@wayne.edu
richterh@uni-muenster.de
thalia.richter173@gmail.com
giuseppe.riva@unicatt.it

amelia.rizzo@unime.it
jrobinson@auburn.edu
pedrogomesrosa@icloud.com
p.sachdev@unsw.edu.au

wataru.sato.ya@riken.jp
schroet@cbs.mpg.de

ss816@cam.ac.uk

youssef2k@gmail.com

advaith.siddharthan@open.ac.uk
esiedlecka@hotmail.com
smithrr@msu.edu
hermona.soreq@mail.huji.ac.il
dpspang@gmail.com
Emily.Stern@nki.rfmh.org

styliadis@hotmail.com
ab7809@coventry.ac.uk
James.Swain@stonybrookmedicine.edu
Sebastien.Urben@chuv.ch
jan.vandenstock@kuleuven.be
Michael.vanderKooij@lir-mainz.de
moverveld@rsm.nl
tamsyn.van@unimelb.edu.au
Michael.Vanelzakker@tufts.edu
ventura@uni-potsdam.de
everona@usf.edu
tyler.volk@nyu.edu
wangyi@psych.ac.cn
leweingas@gmail.com
mathias.weymar@uni-potsdam.de

claire.williams@swansea.ac.uk

dr.megan.willis@gmail.com
Paula.Yamashita@colorado.edu
roland.zahn@kcl.ac.uk
barbrazupan@gmail.com

leroy.lowe@neuroqualia.org

gabriela.gan@mssm.edu

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chuggins@exseed.ed.ac.uk

lloeffler@ukaachen.de

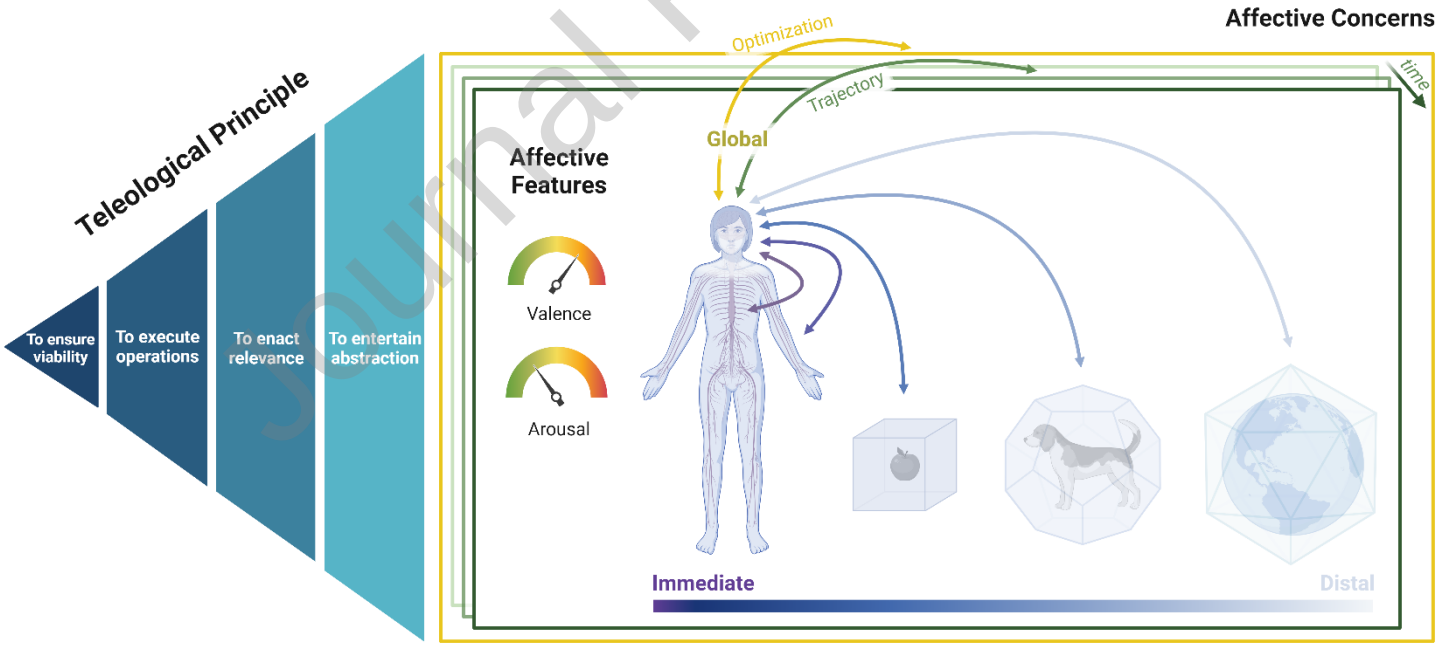
* These authors contributed equally.

Ψ Corresponding authors: Daniela Schiller (daniela.schiller@mssm.edu), Alessandra N. C. Yu (alessandra.yu@icahn.mssm.edu), and Leroy Lowe (leroy.lowe@neuroqualia.org

Highlights

- The affective sciences have grown disparate due to differing assumptions.
- A teleological principle for human affective phenomena can organize the field's assumptions.
- Some affective phenomena adapt based on the comfort zone (*affective concerns*).
- Others monitor that adaptive process (*affective features*).
- This Human Affectome framework organizes existing research and provides a research agenda.

Graphical Abstract



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Abstract

Over the last decades, the interdisciplinary field of the affective sciences has seen proliferation rather than integration of theoretical perspectives. This is due to differences in metaphysical and mechanistic assumptions about human affective phenomena (what they are and how they work) which, shaped by academic motivations and values, have determined the affective constructs and operationalizations. An assumption on the purpose of affective phenomena can be used as a teleological principle to guide the construction of a common set of metaphysical and mechanistic assumptions—a framework for human affective research. In this capstone paper for the special issue "Towards an Integrated Understanding of the Human Affectome", we gather the tiered purpose of human affective phenomena to synthesize assumptions that account for human affective phenomena collectively. This teleologically-grounded framework offers a principled agenda and launchpad for both organizing existing perspectives and generating new ones. Ultimately, we hope Human Affectome brings us a step closer to not only an integrated understanding of human affective phenomena, but an integrated field for affective research.

Key Words: affect, framework, enactivism, allostasis, feeling, sensation, emotion, mood, wellbeing, valence, arousal, motivation, stress

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Introduction

The affective sciences—the interdisciplinary study of affective phenomena, such as sensation, emotion, mood, and wellbeing—have their roots in neuroscience and psychology, but also intersect with philosophy, sociology, linguistics, anthropology, computer science, and economics (Ekman and Davidson, 1994; LeDoux, 1998; Panksepp, 2004; Davidson and Sutton, 1995; Damasio, 2005; Davidson et al., 2009; Kleinginna and Kleinginna, 1981; Sander and Scherer, 2009; Dalgleish et al., 2009; Gendron et al., Adolphs and Anderson, 2018; Gross and Barrett, 2013; Keltner and Lerner, 2010; Gordon, 2017; Solomon, 1978; Lutz and White, 1986; Mesquita et al., 1992; Beatty, 2014, 2019; Armony and Vuilleumier, 2013; Solomon, 1993; Goldie, 2009; Deonna and Teroni, 2012; Scarantino, 2016; Picard, 2000; Hoque et al., 2011; Calvo et al., 2015; Dukes et al., 2021). This interdisciplinary field seeks to explain the mechanisms of affective phenomena by inferring affective constructs from observable data, in order to predict future effects (Mill, 1856; Whewell, 1858; Machamer et al., 2000; Glennan, 2002, 2008; Azzouni, 2004; Bechtel and Abrahamsen, 2005; Chang, 2005; Morganti and Tahko, 2017; Ivanova and Farr, 2020; Levenstein et al., 2023; Hempel and Oppenheim, 1948; Hempel, 1965; Kauffman, 1971; Glennan, 1996), a scientific endeavor that has gained traction in the last few decades and secured the rise of affective research (Dukes et al., 2021). This growth, however, has been accompanied by a surge in theoretical divisions: divergent academic communities differ in their background assumptions on the **metaphysics** of affective phenomena (i.e., what they are), (Marr, 2010; Danziger, 1997; Dayan and Abbott, 2005; Dixon, 2003, 2012; Solomon, 2008; Goldie, 2009; Deonna and Scherer, 2010; Izard, 2010a, 2010b; Gendron, 2010; Mulligan and Scherer, 2012; Barrett, 2012; Scarantino, 2012, 2016; Adolphs, 2017; Fox, 2018; Tappolet, 2022; Moors, 2022) which further distances their assumptions about the **mechanism** of those phenomena (i.e., how affective phenomena arise) (Scherer, 2005; Bridgman, 1927; Chang, 2004; Levenstein et al., 2023). These assumptions *frame* the basic terms of a theory, such as each theory's affective **constructs**, the scientific abstractions of affective phenomena that should be used (i.e.,

what should be studied), as well as their appropriate **operationalizations**, the methods of measuring those abstractions (i.e., how to observe them) (Hempel, 1952, 1965; Carnap and Gardner, 1966, Lewis, 1970, 1972). Even when assumptions are not explicitly disclosed, they are hidden in decision points at each stage of the scientific process meant to test that theory—from experimental design and methodology all the way to analysis and interpretation (Mill, 1872; Whewell, 1858; Azzouni, 2004; Chang, 2005; Morganti and Tahko, 2017; Ivanova and Farr, 2020; Scarantino, 2016; Fox, 2018). Thus, despite the field's agreement that studying affective phenomena is important, discrepancies have yielded lasting theoretical debates, bodies of experimental work within separate frameworks have proliferated, and limited progress has been made in pruning or integrating existing frameworks with no clear consensus in sight (Kuhn, 1974, 2012; Box, 1976; Craver and Darden, 2013; Strevens, 2008; Levy and Bechtel, 2013; Woodward, 2014).

This persistence of theoretical splitting is in part due to empirical data being inadequate in arbitrating between sets of theoretical assumptions (Popper, 1963; Kuhn, 2012; Holton, 1975; Lakatos, 2014, 1978; Laudan, 1978; Lowe, 2002; Godfrey-Smith, 2009; Ormerod, 2009; Notturno and Popper, 2014). Such disagreements can only be settled by examining each camp's take on **theoretical virtues** (i.e., what qualities make good framework and resulting theory), and comparing each theory's underlying sets of assumptions (Galilei, 1953; Newton, 1999; Einstein, 1934; Achinstein, 1983; Duhem, 1954; Sober, 2015; Poincaré, 2022; Schindler, 2018; Keas, 2018; Ivanova and Farr, 2020). In addition, proponents of different theories with separate overarching frameworks differ in their assumptions about *why* certain affective phenomena are scientifically important—why their particular versions of the phenomena should be studied and why their methods of observation should be used (Bromberger, 1966; Achinstein, 1983; De Regt and Dieks, 2005; Kitcher, 2001; Brown, 2010; Dayan and Abbott, 2005; Kording et al., 2020; Levenstein et al., 2023). These **pragmatic** motivations tend to be prone to biases, such as which research tradition has been status quo in a proponent's local context, which methods for observation are practical, which types of observational data are accessible, and which questions about affective phenomena are of interest to certain audiences (Ivanova and Farr, 2020; Duhem, 1954; Lowe, 2002; Ivanova, 2014, 2017; Paul, 2012; Ladyman, 2012; Latour and Woolgar, 2013; Achinstein, 1983; van Fraassen, 1980). Therefore, when evaluating sets of assumptions, collaboration across proponents of different camps and members of different disciplines can go a long way in shoring up these theoretical blind spots (**Table 1**) (Wray, 2002; Andersen and Wagenknecht, 2013; Callard and Fitzgerald, 2015; MacLeod, 2018).

[INSERT TABLE 1 HERE]

Even if comprehensive collaboration on scientific incentives and theoretical virtues could be achieved, it would be unproductive to compare the metaphysical and mechanistic assumptions governing affective research without a premise of *why* affective phenomena exist in the first place—i.e., a **teleological** assumption (Deacon, 2011; Mayr, 1974; Levenstein et al., 2023). A framework for the *purpose* of affective phenomena would allow us to (1) bridge across metaphysical and mechanistic assumptions behind different theories, (2) organize theories with respect to that teleological principle, and (3) evaluate theories in light of scientific motivations and theoretical virtues (Craver, 2007; Schindler, 2018; Keas, 2018; Levenstein, 2023). Therefore, to truly achieve an integrated understanding of affective phenomena, collaborative and interdisciplinary efforts should aim to integrate scholarly and theoretical values in order to synthesize *a common set of metaphysical and mechanistic assumptions grounded in teleological principles*—a **framework** with which to articulate and organize theories for conducting affective research

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as well as compare and integrate existing ones (Popper, 1963; Kuhn, 2012; Holton, 1975; Lakatos, 2014, 1978; Laudan, 1978; Godfrey-Smith, 2003; Ormerod, 2009; Jabareen, 2009; Notturno and Popper, 2014).

In this capstone paper, we conclude the special issue "Towards an Integrated Understanding of the Human Affectome" (Cromwell and Papadelis, 2022, this issue) by synthesizing the various assumptions ruling different affective fields and camps into a common teleologically-grounded set: the Human Affectome (Cromwell and Lowe, 2022, this issue). To get to this point, 173 researchers from 28 countries came together as a global, interdisciplinary taskforce to examine existing assumptions and approaches in the study of affective constructs. As a preliminary step, a team within this working group performed an exploratory computational linguistic analysis: identifying 3,664 words for feelings, sorting them into feeling categories, and characterizing more specific senses for each word (Siddharthan, 2018). Guided by the themes that emerged from that initial exploration, twelve teams went on to produce the twelve reviews of this special issue. Each review summarized the state of current behavioral and neuroscientific research with special emphasis on theoretical concerns (this issue: Arias et al., 2020; Raber et al., 2019; Becker et al., 2019; Pace-Schott et al., 2019; Williams et al., 2020; Cromwell et al., 2020; Dolcos et al., 2020; Stefanova et al., 2020; Alia-Klein et al., 2020; Frewen et al., 2020; Alexander et al., 2021; Eslinger et al., 2021; Cromwell and Papadelis, 2022). Thus, the initial linguistic approach encouraged an exploratory, yet integrative approach in reviewing the sampling of theoretical perspectives across the affective domains. However, these themes have yet to be considered holistically by the taskforce from a top-down perspective: how can the metaphysical and mechanistic assumptions in the affective sciences be rooted in common teleological principles to motivate shared scientific constructs and operationalizations, and frame consequent testable theories? (Machamer et al., 2000; Craver, 2007; Bechtel, 2007, 2008, 2009, 2013; Bechtel and Richardson, 2010)

In what follows, we probe the question of purpose: *why are there affective phenomena?* We synthesize a common set of teleological principles to guide the metaphysical and mechanistic assumptions and, ultimately, motivate shared scientific constructs and operationalizations. What we offer here is not another theory, nor is it a history or review of the field—it is a scaffold of premises that accommodates existing theories by organizing them in terms of a common set of assumptions, and promotes the articulation of new theories. Thus, this synthesis can facilitate a better understanding of assumptions, differences, and possible cohesion among perspectives in the field. We hope that you, reader, whether you are an affective neuroscientist, philosopher of emotion, cognitive psychologist, computational psychiatrist, clinician, or another interested in affect, will take something away from this synthesis. We recommend not to treat this work as the ultimate answer to the long-lasting debates the field has been entrenched in, but as the beginning of the incremental untangling of assumptions in a principled way toward a new integrative paradigm. Practically speaking, we encourage you to start with your own work—to situate your explanatory goals within the Human Affectome, relate them to other theories based on principles distilled by this synthesis, and articulate your future theories and accompanying hypotheses using these teleological terms. Ultimately, we hope that the wider community of affective sciences leverages this cohesive framework to generate and test more specific theories and hypotheses on the basis of its premises—so that in due course we will build a concrete, comprehensive, and, most importantly, principled set of affective constructs and operationalizations (analogous to Schuler et al., 1996, and Sporns et al., 2005). In this manner, this rich and sprawling field can come to an integrated understanding of human affective phenomena within which to situate past and future research.

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Table 1. Domains of Assumptions Shaping Scientific Frameworks and Resulting Theory

This table summarizes domains of theoretical assumptions of scientific frameworks, which shape their resulting scientific theories. As a case study, we highlight the framework of assumptions for Affect-as-Information Theory, to provide an exemplar in affective research. The dark grey rows correspond to assumptions embedded in our individual contexts as affective researchers; the lighter rows are the assumptions about affective phenomena themselves. These form the basis for the constructs and operationalizations we use in empirical practice, indicated by the lightest rows. Finally, the last row corresponds to the collective of all the domains of assumptions above it.

Domain of Assumptions (collectively, **framework**)	**Description**	**Relationships between Domains of Assumptions**	**Shorthand**	**Exemplar in Affective Research** *Affect-as-Information Theory* (Schwarz and Clore, 1983, 2003; Clore et al., 2001; Schwarz, 2012)
pragmatics	assumed context-dependent motivation for the study of theoretical constructs	determined by contextual influences (e.g., exposure, practicality, accessibility, interest); determines **construct** studied and **operationalization** used	why a *construct* should be studied and why a certain *operationalization* should be used to study it	affect should be studied as information, by observing its effect on judgments, to situate subjective experience in decision-making
theoretical virtues	assumed desiderata for what makes good framework and theory (e.g., parsimony, elegance, simplicity)	determined by aesthetic preferences; determines how theory implementing ***construct*** and ***operationalization*** is evaluated	why an *explanation* of a phenomenon is good	characterizing affect as information provides parsimonious explanation for its influence on decision-making
metaphysics	assumed nature of phenomenon	determined by **pragmatics**	what the *phenomenon* is	one set of studies testing affect-as-information theory examine mood as an influence on decision-making.
construct	assumed abstraction of phenomenon	determined by **pragmatics**, **metaphysics**, and (sometimes) ***operationalization***	what *construct* is studied	mood is construed as ranging from positive to negative
mechanism	assumed process of phenomenon	determined by **pragmatics** and **metaphysics**	how *phenomenon* arises	in the mechanism of mood functioning as information, positive valence biases positive judgment and negative valence biases negative judgment
operationalization	assumed measurement of abstracted phenomenon	determined by **pragmatics**, ***construct***, and **mechanism**	how *construct* is observed	overall positive to negative was manipulated by prompting recall of happy or sad events
teleology	assumed purpose for the	determined by **pragmatics**; determines **metaphysics** and **mechanism**	why *phenomenon* exists	Affect-as-information theory suggests that mood functions as

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	phenomenon existing			information in order to indicate benign or problematic environment
framework (*or* paradigm)	a set of the above domains of assumptions; terms used to articulate and organize testable theories	usually explicitly or implicitly consists of all of the above	all of the above	all of the above

Teleological Principle: *Why are there human affective phenomena?*

Among the affective sciences, we are united by our interest in phenomena that are subjectively felt, have neurobiological basis, influence decision-making and behavior, and can be expressed through implicit and explicit means (Darwin, 1872; James, 2007; Scherer, 1984; Leighton, 1985; Frijda, 1986; Clore and Ortony, 1988; Schwarz and Clore, 1988, 2007; Kleinginna and Kleinginna, 1981; Solomon, 1993; Ekman and Davidson, 1994; LeDoux, 1998; Panksepp, 1998; Pugmire, 1998; Davidson and Sutton, 1995; Cacioppo and Gardner, 1999; Panksepp, 2004; Damasio, 2005; Davidson et al., 2009; Sander and Scherer, 2014; Dalgleish et al., 2009; Goldie, 2009; Deonna and Scherer, 2010; Keltner and Lerner, 2010; Hoque et al., 2011; LeDoux, 2012, 2015, 2023; Deonna and Teroni, 2012; Schwarz, 2012; Damasio and Carvalho, 2013; Gross and Barrett, 2013; Armony and Vuilleumier, 2013; Elpidorou and Freeman, 2014; Ekman, 2016; Scarantino, 2016; Deonna and Teroni, 2017; LeDoux and Brown, 2017; Adolphs and Anderson, 2018; Adolphs et al., 2019; Dukes et al., 2021). Our differing interpretations of those metaphysical and mechanistic assumptions, however, generate an expansive range of constructs and operationalizations, and resulting theories and hypotheses. Therefore, these assumptions require a teleological principle to be reduced and systematized. In this section, we will progress from the broadest purpose of an organism to the most specific principle that in humans, in order to synthesize metaphysical and mechanistic assumptions for complete coverage of human affective phenomena—the Human Affectome.

To ensure viability

An organism can be considered a system or network of interconnected parts collectively and continuously (re)generating and distinguishing itself, with the ultimate purpose of autonomously ensuring its own persistent recreation and integrity (**autopoiesis**) (Jonas, 1973; Maturana and Varela, 1991; Varela et al., 1974, 2017; Varela, 1979; Weber and Varela, 2002; Di Paolo and Thompson, 2014). This involves recursively creating its own components, so that those components can both sustain the processes producing them as well as maintain their coordination such that, altogether, they are an organization distinct from an environment, that is, the organism. Each of these processes enables others within the system such that they collectively support themselves and will disintegrate if disrupted (Beer and Di Paolo, 2023). This dependence entails the entire neurobiological system staying within a narrow range of states, such as a specific set of glucose levels, temperature, pH, etc. (**homeostasis**) (Cannon, 1929; MacArthur, 1955). Therefore, the primary purpose of an organism is to ensure its own viability, where being an organism can be considered a collective inherent act of self-generating and self-distinguishing itself into continuous being through error-correcting means (Weiner, 2019). This helps understand what neurobiological processes are doing at large—but more importantly for our purposes, this is our launchpad for tracing the purpose of human affective phenomena (Panksepp, 2004, 2005; Damasio and Carvalho, 2013; Strigo and Craig, 2016).

To execute operations

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Complex organisms execute many varied operations to ensure viability in the face of complex and changing environments. The capacity to discern more than just a handful of facets of the environment usually goes hand-in-hand with the capacity for many dimensions of action (Tooby and Cosmides, 1990, 2008; Cosmides and Tooby, 2000). This complexity poses more risks to viability, but also allows for flexibility when circumstances change. Such a complex organism cannot afford to let any one of the many elements push its system to the brink or it risks collapse (i.e., resulting in the organism dissolving, dying, ceasing to be). The complex organism does not remain idle but rather triumphs by doing the opposite: instead of remaining in a simplistic stable state, it moves between levels of relative stability (**attractor states**). When a perturbation to its ongoing organization approaches, the complex organism does not immediately address the breach, the way simpler life forms reset to more suitable states when an error is detected (Pereira, 2021). Instead, it acts in the direction of that breach so that, even if its actions temporarily make things worse, the organism will be on better footing in the future (Rosenblueth et al., 1943; Ruiz-Mirazo and Moreno, 2012; Boone and Piccinini, 2016; Williams and Colling, 2018; Fingelkurts and Fingelkurts, 2004). It preempts and prepares, choosing between different courses of action to anticipate and prevent a potentially fatal state brought on by the changing aspects of the environments before that point arrives (**allostasis**) (Sterling and Eyer, 1988; Carpenter, 2004; Cooper, 2008; McEwen and Wingfield, 2003; Sterling, 2012, 2020; Sterling and Laughlin, 2015; Schulkin and Sterling, 2019; Moors and Fischer, 2019).

For the complex organism, there are many, sometimes equally effective, ways to ensure viability, but all require operation. Some courses of action address metabolic intolerance more directly (e.g., raising food to one's mouth for consumption), while others require further intermediary steps (e.g., buying groceries) (Jonas, 2001). However, not all processes, especially in more intricate sequences, involve interacting with the external environment. Internal adjustments are what orchestrate the necessary shifts in approach to the environment, everything from attention to planning (**mental action**) (Kirsh and Maglio, 1994; Mele, 1997; Peacocke, 2006; Soteriou, 2013; Metzinger, 2017; Dolcos et al., 2020, this issue), serving as the bridge between the processes receiving inputs and those causing behavioral outputs, and enabling these two capacities to guide each other (**sensorimotor**) (O'Regan and Noë, 2001; Di Paolo et al., 2017). Collectively, these processes move the organism around a new set of states wherein the organism is comfortable—each state as a position on one of many dimensions of anticipated deviation from viability, addressable in many actionable ways (Panksepp, 2010; Cromwell and Lowe, 2022, this issue). This 'comfort zone' guides the adaptive use of a repertoire of operations, whose individual actions consider future possibilities (Moors and Fischer, 2019; Cromwell et al., 2020, this issue). To navigate this comfort zone, an organism needs the capacity to monitor how it is faring with respect to the multidimensional, continuous, and fluctuating norm—an implicit form of self-evaluation. That evaluation allows the organism to consider its tools of internal and external processes in order to deploy them to safeguard viability. Sometimes, the organism's adaptive capabilities are surpassed in a way that strains its processes (Karastoreos and McEwen, 2011; Peters et al, 2017). Exceeding the comfort zone too often can result in pervasive damage to proactive processes (**allostatic load**) (McEwen, 1998, 2000). Therefore, beyond viability, the purpose of cognitive processes in complex organisms is to execute operations, which naturally involves managing them.

To enact relevance

Affective phenomena, to both academics and laypeople, can be felt (Nagel, 1974; Chalmers, 1997; Lange, 1885; James, 2007; Scherer, 1982b; Frijda, 1986; Leighton, 1985; Schwarz and Clore, 1988, 2007; Pugmire, 1998; Lambie and Marcel, 2002; Craig, 2002; Panksepp, 2008; Barrett, 2005; Barrett et al., 2007; Izard, 2010; Deonna and Scherer, 2010; Schwarz, 2012; Damasio and Carvalho, 2013; Elpidorou and Freeman, 2014; Deonna and Teroni, 2017; LeDoux and Brown, 2017; Strigo and Arthur; 2016; Teroni and Deonna, 2017; LeDoux and Hoffman, 2018; Adolphs et al., 2019; LeDoux, 2012, 2015, 2023; Szanto and Landweer, 2020; Álvarez-González, 2023; Davidson and Sutton, 1995; Cromwell and Lowe, 2022, this issue; Cromwell and Papadelis, 2022, this issue). We experience them over a duration of time (**episodes**) (Tye, 2003; Wollheim, 2008; Goldie, 2000; Locke, 1847; Levine, 1983; Hardin, 1988; Stein et al., 1993), how they feel has qualities (**qualia**) (Nagel, 1974; Chalmers, 1996; Silva, 2023), and they tend to mean something to us when we feel them, usually about how our concerns

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relate to objects, either physical or mental, such as things, people, and situations (**intentionality**) (Brentano, 2012; Tye, 2014; Deonna and Teroni, 2012). This aspect of meaning obliges us to consider not only the meaning of each individual affective experience, but also how different meanings of affective experiences relate to each other in an organized way (**phenomenology**) (Heidegger, 2010; Husserl, 2012; Merleau-Ponty, 2011; Dreyfus, 1972; Sartre, 2022). A useful starting point for understanding why affective experiences exist would, therefore, be to ascertain how the structure in felt meaning relates to the entire system of neurobiological processes—including both those within the organism and those interacting with the environment (Horgan and Tienson, 2002; Strawson, 2004; Kriegel, 2014).

One major clue that the structure of affective experiences gives us is that they originate from a first-person perspective (**self**) (Descartes, 1644; Kant, 1890, Husserl, 2013; Wittgenstein, 1958; Shoemaker, 2003; Searle, 1992; James, 1980; Gallagher, 2000; Metzinger, 2003a, 2003b; Ochsner and Gross, 2005; Blanke and Metzinger, 2009, 2013; Christoff et al., 2011; Zahavi and Kriegel, 2015; Colombetti, 2011; Frewen et al., 2020, this issue). On the mechanistic side of things, this perspective seems to arise from the organism adeptly executing operations in order to ensure viability from a unified point of view (i.e., self). Being guided by a comfort zone means that all of the organism's considerations are driven by potential for action such that properties of the environment perceived and acted upon are features of action-worthiness (**affordances**) (Bourgine and Stewart, 2004; Stewart, 2010; Gibson, 1977; Teroni, 2007; Frijda, 1986). From the perspective of the organism, the world appears to it only in a manner relatable to its capacities (egocentric point of view, perceived surroundings, or **umwelten**) (Uexküll, 2013; Seboek, 2001; Chang, 2009; Feiten, 2020). If we want to be precise in studying affective mechanisms, we should not just look at the brain—we should consider the entire nervous system and the rest of the body (**embodied**) (Barsalou, 1999; Barsalou et al., 2003; Pfeifer and Bongard, 2006; Varela, 1997; Chemero, 2011; Gallagher and Zahavi, 2020; Fuchs, 2017). Among internal processes, the felt aspect of signals from our internal viscera is an important factor to consider given how often bodily sensations characterize affective experiences (**interoception**) (Craig, 2008; Sel, 2014; Critchley and Garfinkel, 2017; Tsakiris and De Preester, 2018). However, if we fixate too much on what's going on inside, we miss the dynamic interplay between an organism and its environment (**embedded**) (Beer, 2014), which shapes the organism's adaptive capacities and gives it its perspective (**situated**) (Roth and Jornet, 2013; Walter, 2014; Dawson, 2014; Stephan and Walter, 2020). Having that central comfort zone in mind is what gives the organism the imperative to make sense of the world through both perception as well as cause it to make sense through action (**sense-making**) (Di Paolo, 2005; Colombetti, 2013). Therefore, underpinned by their prospective concern for viability, and at the heart of the cognitive activity that defines them, complex organisms such as humans enact relevance for themselves—by not only taking in what is relevant but also by purposefully creating relevance (**enactive**) (Colombetti and Thompson, 2007; Colombetti, 2014; Ward, 2017; Newen et al., 2018; Cromwell et al., 2020, this issue). When that activity is challenged, the organism's awareness of its own comfort zone is, from its perspective, prioritized as intense feeling to orient it to more adaptive options for action (**stress**) (Averill, 1973; McEwen, 1998, 2005; Koolhaas et al., 2011; McEwen and Akil, 2020). Thus, our teleological foundation of affective phenomena seems to require this organism's emergent capacity to find things meaningful based on their actionability.

To entertain abstraction

Humans are not limited to affective processes that reflect our first-person needs of the current moment. While not fundamental to all affective phenomena, concerned foresight poses at least some detachment from the present and, therefore, enables a rudimentary form of abstraction (Neisser, 1963; Plutchik, 1982; Clore and Huntsinger, 2009; Plutchik and Kellerman, 2013). An object in the present context can be tied to some distant meaning, being associated with operations not presently executed. This form of practical symbolism is still grounded in proactive operation in the service of viability (Tenenbaum et al., 2011). This capacity for abstraction is often overlooked when painting a picture of affective phenomena. However, when it comes to humans in particular, this abstract capacity is essential as it enables us to reflect on our adaptive activities in general (especially when we are not concurrently exercising them) as well as enact relevance that is abstract. This equips us as humans with the

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capacity to consider adaptive operations while departing from our individual first-person perspective. We can imagine other origins of concerned perspective, starting with that of other individuals—inferring how they are oriented actionably toward the world (**theory of mind**) (Saxe, 2006; Brüne et al., 2016; Mehrabian and Epstein, 1972; Smith, 2006; Cuff et al., 2016; Fotopoulou and Tsakiris, 2017). As a result, we can share an orientation toward the environment with others such that we can complement each other's operations. This shared perspective enhances our adaptivity, expanding our operational repertoires to include cooperation and collaboration (Dunbar, 1996; Lakin et al., 2003; De Jaegher and Di Paolo, 2007; Grey et al., 2007; Fischer and Manstead, 2008, 2016; Weisman et al., 2017; Nummenmaa et al., 2018; Williams, 2020; Tomasello, 2020, 2022). Beyond this social competence, we can conceive of origins of operations other than those driven by viability: anything, animate or inanimate, can seem like it has an effect. This explodes into possibilities of conceptualizing the significance of events, situations, ideas—over and above the collective activities of many individuals, that is, groups.

These expansions to abstraction do not only grant us the capacity to associate any process of animate or inanimate change with designated labels (**language**) (Wittgenstein, 1953; Itkonen, 1978; Pinker, 2010; Perniss and Vigliocco, 2014; Adolphs, 2017, 2018) but also give us the adaptive reason to do so. Labelling specific abstract activities in our operations greatly influences what operation is possible, determining where we are in our comfort zone (Whissell, 1989; Besnier, 1990; Barrett et al., 2007; Lindquist, 2021; Colombetti, 2009). Our communication is not merely an add-on to what we enact or an afterthought to what we feel. Expression of what we feel through bodily, vocal, or visual means carves the kind of relevance we are able to enact, consequently, constraining the feeling itself (Williams et al., 2020, this issue; Wharton et al., 2021; Wharton and de Saussure, 2023). The comfort zone is so inherent to us that we project that orientation of relevance to others, assigning perspective to both the animate and inanimate, to make events unfamiliar to us part of our world of relevance. This results in us assuming things have purpose or direction even when they don't, including people, objects, events, or even ideas, as long as they look like they do (**intentional stance**) (Dennett, 1989; Brooks, 1991; Villabolos and Ward, 2015; Hutto and Satne, 2015; Hutto and Myin, 2017; Csibra and Gergely, 2007). Although this projection can seem futile, it allows us to articulate statements about not only our own concerns but also the hypothetical concerns of abstract objects (**propositional attitudes**) (Frege, 1948; Russell, 1905). This can be useful in that these articulations can match their targets in varying degrees of better or worse, making them more or less useful.

It's no surprise then that reality that is mapped poorly is difficult for us to operate in (**misrepresentation**) (Searle, 1983; Grice, 1957; Papineau, 1984; Millikan, 1987, 1989; Neander, 1993; Godfrey-Smith, 2006). In cases of psychopathology especially, we can be very off (Beck, 1971; Leventhal et al., 1992; Cummins, 2013). This usually becomes obvious in faulty communication with others, or when our operations prove to be ineffective (Burge, 2010; Izard et al., 2008). Abstractions provide the means to articulate mental processes in verbal language, mathematical symbols, or code (**cognitive science**) (Stillings et al., 1995; Eckardt, 1995; Clark, 2000; Thagard, 2005), such as what is happening when individuals have trouble navigating the environment in light of their comfort zone, as they are mapping either or both poorly. We can articulate such maladaptive mechanisms and use these labels to predict future outcomes of those individuals' subjective operations (**computational psychiatry**) (Egan, 2018, 2020; Shin and Liberzon, 2010; Maia et al., 2017; Petzschner et al., 2017; Smith et al., 2021; Friston, 2022; Browning et al., 2022; Hoemann et al., 2021). Taken together, there is much more associated with affective phenomena in humans than mere adaptive enaction of relevance. We cannot neglect our human capacity to entertain abstraction as it determines the versatility of our comfort zone.

Synthesizing the academic interests from different corners of the field, we have now built the teleological principle of human affective phenomena, illustrating how each purpose grounds the next. We began with root of purpose of a neurobiological organism—to ensure its viability. From there, we acknowledged the purpose of a complex organism—to execute operations in the service of its viability. We then explored the purpose of an organism's basic mental capacities—to enact its own relevance by executing operations for the sake of its viability. Finally, we discussed the purpose of conceptual capacity typical in humans—to entertain abstraction, when enacting relevance, by executing operations, to ensure our viability. To answer the question—*why are there*

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human affective phenomena?—using only one of these rationales seems incomplete: human affective phenomena collectively exist to serve these nested, intertwined purposes. Only together do these purposes account for all human affective phenomena together. Therefore, guided by this teleological principle, we are now poised to articulate assumptions about what human affective phenomena are and how they work to construct our integrated framework: the Human Affectome.

The Human Affectome: *What are human affective phenomena?*

The term 'affect' has traditionally referred to the collective phenomena of feeling, sensation, emotion, mood, wellbeing, etc. Here, we use it to refer to the phenomena of a human organism affecting their environment and being affected by that environment such that they are enacting their particular relevance in the world, by executing operations with respect to viability. This intrinsic teleological foundation, synthesized from a comprehensive sampling of perspectives in the field of affect, can guide a principled set of metaphysical and mechanistic assumptions, resulting in an integrated framework for understanding human affective phenomena (**Table 2**).

[INSERT TABLE 2 HERE]

Affective phenomena, being phenomena, are processes, both felt and mechanistic. While they are but a tangle among all the tightly interconnected dynamic processes of a human neurobiological system, we can carve up any set of those processes. When isolated, these processes can be described as algorithms, sequences of steps articulable in words, equations, or code that are executed for specific goals or to solve particular computational problems (Suppes, 1969; Cartwright, 1983; Marr, 2010; Pylyshyn, 1986; Rapaport, 2012; Vardi, 2012; Hill, 2016; Dennett¸ 2002; Chalmers, 2012; Egan, 2017, 2020). For our purposes, the processes we are most interested in are grounded by the teleological principle above, so that we can identify types of problems among affective phenomena and articulate how affective mechanisms attempt to solve them.

All human affective phenomena are situated in both experience and mechanism from the perspective of the human organism. We distinguish between algorithms that address the relevance of a physical or mental object to the organism, and the algorithms that monitor that adaptation (Figure 1). Thus, affective phenomena include the two sets of processes below:

(1) Algorithms reflecting *affective concerns* are processes that address the relevance of physical and mental objects, including things, people, and situations. These concerns signify what is of interest in affective experiences and are reflected in the felt actionability toward that object. These include concerns that have immediate to distal or global relevance to the organism. Several affective concerns can be active at the same time to make up any present moment's total experience.

(2) Algorithms reflecting *affective features* are processes that provide information on the adaptive process itself. They are the dimensional metrics of the organism's own performance in adaptation, integral to all affective concerns, and are reflected in qualitative aspects of affective experience. These include valence and arousal. These features are always present as they mark affective concerns, providing information on them.

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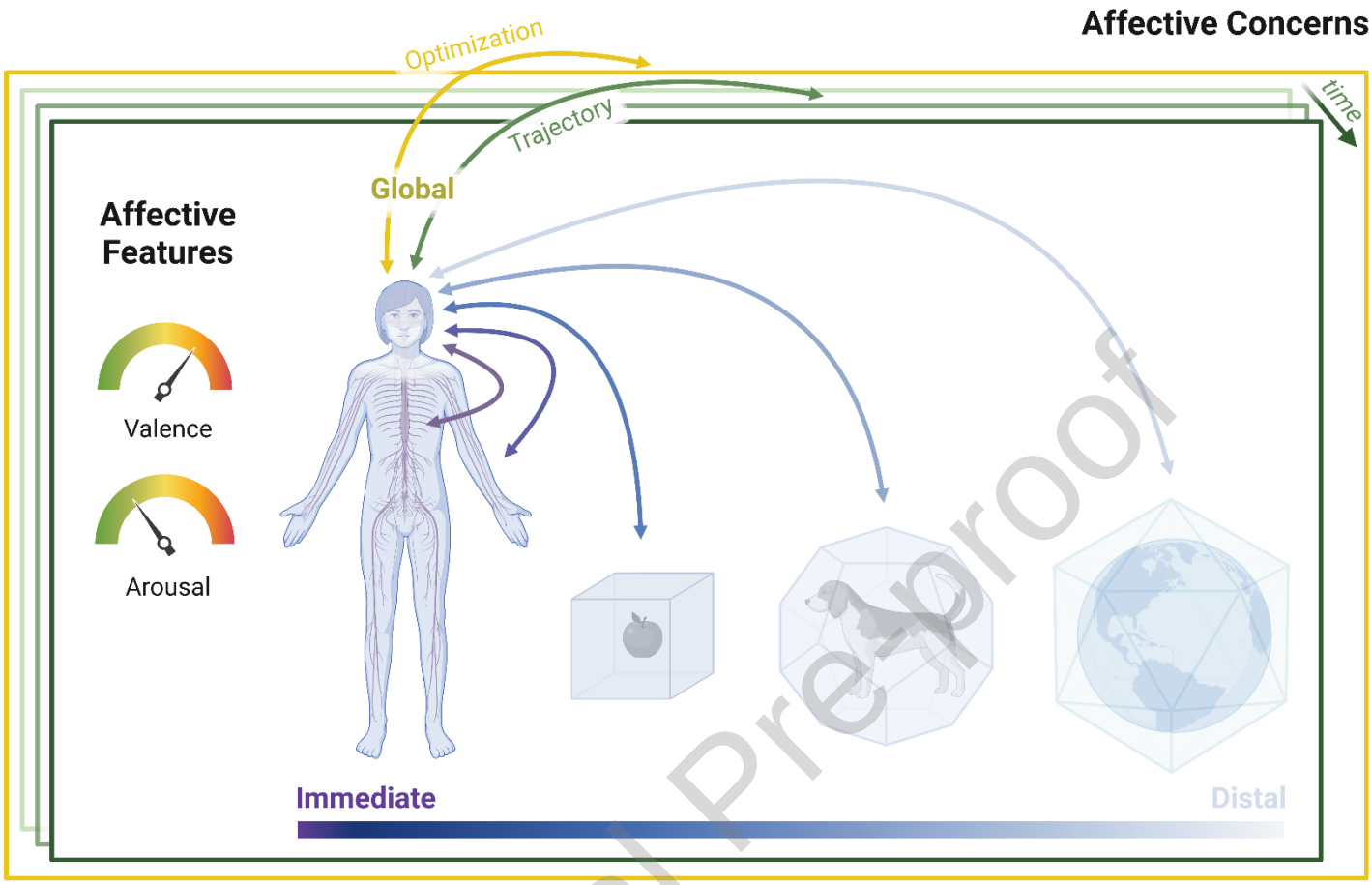

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Figure 1. The Human Affectome. This framework is guided by the teleological principle that the collection of human affective phenomena in their entirety can only be accounted for by the nested and intertwined purposes: to ensure viability, to execute operations, to enact relevance, and to entertain abstraction. The *bidirectional arrows* are used to indicate that the human is enacting—in both being affected by relevant aspects of their actionable world, and affecting that world in order to make it relevant. We characterize affective phenomena as algorithms that address the relevance of the environment and monitor that adaptation. We distinguish between processes that reflect affective concerns and those that reflect affective features. The algorithms that address **affective concerns** indicate the relevance of a physical or mental object by suggesting actions regarding that object. We can organize one set of these processes in a ***hierarchy*** according to the distance from metabolic impact that the actions demanded by the concerns would have. The most immediate concerns (**dark blue**) are also the most concrete, yet least complex in actionability (i.e., physiological concerns, such as consuming food to alleviate hunger). On the other end of the continuum, more distal concerns (**light blue**) are increasingly abstract and complicated in terms of actionability, wherein more causal steps are required to achieve homeostatic impact (i.e., operational concerns, such as running away from a dog to alleviate fear, flickering lights for right-of-way on the road to express irritation, or researching more on a topic to address interest). In addition, the set of algorithms addressing affective concerns that do not fall along this continuum of distance from metabolic impact instead summarize across affective concerns. These ***global*** concerns include *trajectory* (**green**), the direction that the environment is heading toward across time; *optimization* (**yellow**), the best match between the environment and organism's adaptive capacities across a given duration of time—the self-evaluations of aspects of the organism's own adaptive capacity that are persistent across time. Finally, algorithms expressing **affective features** provide momentary information on the status of adaptive process in relation to the comfort zone. These include valence and arousal. Created using Biorender.com.

Affective Concerns

These processes reflect concerns that address the relevance of physical or mental objects, including things, people, and situations, to the organism's viability. The organism is proactively oriented toward the object, which is reflected in the felt implications of those objects. The object is, therefore, meaningful to the organism in virtue of the organism's enactive orientation toward the object—the **affective concern** (Teroni, 2007; Frijda, 1986, 2017; Bedford, 1956; Kenny, 2003; Pitcher, 1965; Leighton, 1985; de Sousa, 1987; King 2009; Deonna et al., 2015; Varela et al., 1974; Gibson, 1977; Colombetti and Thompson, 2007; Di Paolo and Thompson, 2014; Shargel and Prinz, 2017; Slaby and Wüschner, 2014; Hufendiek, 2015; Hutto, 2012). As such, affective concerns can be clustered based on whether those operations address a potential breach in viability more or less directly, or as global summaries of those prospective operations. We can thus distinguish between different sets of mechanisms that address affective concerns:

- Algorithms that reflect *hierarchy* of immediate to distal concerns organize gradations of enactive relevance, according to the distance from metabolic impact that the actions demanded would have.
- Algorithms that reflect *global* concerns summarize across affective concerns in a comprehensive evaluation of adaptive performance across time, rather than being driven by a particular enactive relevance.

Many of these processes can be ongoing at the same time as well as rapidly changing moment to moment (Larsen and McGraw, 2014; Hoemann et al., 2017; Godfrey-Smith, 2020), collectively making up the human's profile of affective experience in a certain period of time.

Hierarchy

The algorithmic mechanisms that address a **hierarchy of immediate to distal concerns** reflect predictive actionability toward an object, its relevance, along a gradient or scale of distance to metabolic impact. This gradient can correspond to the number of causal steps needed to address the affective concern, the timescale necessary to achieve homeostatic impact, or its concreteness to abstractness (McEwen and Seeman, 1999; Pezzulo et al., 2015; Gilead et al., 2020). In formal and computational terms, this can be construed as hierarchical depth (Pezzulo et al., 2021; Levin, 2019; Friston, 2020; Tschantz et al., 2022; Tomasello, 2022). Immediate concerns, such as physiological ones, are inferred at a lowest level (i.e., shortest timescale, fewest number of calculations, closest mappings to one-to-one between prediction and sensory data) in the hierarchy of actionability. Distal concerns, such as moral and other abstract concerns, are those at the highest (Scherer, 1982b). Below, we organize ranges of concerns along the continuum of actionable depth.

Physiological

Algorithms reflecting **physiological concerns** can be addressed by the most immediate or concrete actions required to maintain organismic balance. This set of concerns requires actions that immediately affect the internal environment of one's own body, therefore dealing with the adaptive process in the most direct actionable manner. Physiological affective experience arises from interoceptive sensations, and typically reflects the integration of many interoceptive sources (Craig, 2002; Pace-Schott et al., 2019, this issue; Seth, 2013; Seth and Friston, 2016). In the English language, different feeling words along this dimension typically capture the intensity or degree of departure from the organism's comfort zone. Physiological affective states may pertain to nourishment (e.g., hungry or thirsty; Ombrato and Phillips, 2021), energy levels (e.g., rejuvenated; Podilchak, 1991; Caldwell, 2005; Iwasaki et al., 2005), and internal bodily concerns (e.g., sick; Quadt et al., 2018; pain; Coninx and Stillwell, 2021; Kiverstein et al., 2022), among others. Algorithms addressing physiological concerns seems to be what we tend to refer to as **sensation**.

Operational

Algorithms reflecting **operational concerns** are beyond immediate physiological needs as they demand the human organism to operate as a cohesive unit to interact with the environment in sophisticated sequences of

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actions (Frijda, 1986; LeDoux, 1989; Adolphs and Andler, 2018; Ekman and Cordaro, 2011; Lazarus, 2001; Roseman and Smith, 2001; Izard, 2007; Levenson, 2011; Panksepp and Watt, 2011; Poria et al., 2017 ; Scherer et al., 2010; Sander et al., 2003, 2005; Grandjean and Scherer, 2008; Scherer, 2009; Scherer and Moors, 2019; Clore and Ortony, 2000, 2013; Ortony et al., 1988; Russell, 2003; Barrett, 2017; Scarantino, 2014; Moors, 2022; Teroni, 2023). The meaning of an operational concern is such that addressing it won't impact metabolism in a few short steps. In fact, the hypothetical distance from metabolism means that there are many ways to address operational concerns. Given that these concerns demand complex sets of actions over extended periods of time, there are many possibilities for securing those future circumstances for the organism to remain viable. The more sophisticated the course of action, the more abstraction required from the present moment. In addition, while the first-person perspective of human organisms is always maintained, they may cast that perspective to other beings, inanimate objects, or even abstract concepts such that they may consider concerns that are not presently theirs or are imagined. In this way, operational concerns can vary in degree of complexity or abstractness along the higher levels of the hierarchy of distance from metabolic impact, ranging from more immediate and concrete (e.g., anger at a broken printer) or more distal and abstract (e.g., inspired by artwork). More strikingly, however, is the diversity of operational concerns—as they are as numerous as possible operations are for addressing the multidimensional spectrum of relevance to humans. Nevertheless, we offer some examples to demonstrate how potential operations toward objects tend to be clustered:

- ***Safety Concerns:*** suggest taking full advantage of an environment that enables and encourages exploration to expand one's action repertoire or play to simulate operations under low stakes (e.g., joy, happiness, exhilaration) (Fredrickson, 2001, 2005; Fredrickson and Joiner, 2002; Csikszentmihalyi, 2014)
- ***Danger Concerns:*** suggest avoiding potential threats that could cause harm such that viability is breached (e.g., fear, worry, dread) (Paterson and Neufeld, 1978; Schiller et al., 2008; LeDoux, 1996, 2022; Mobbs et al., 2019; Raber et al., 2019, this issue; Stefanova et al., 2020, this issue)
- ***Obstruction Concerns:*** suggest pushing through or against an object that hinders, obstacles, or violates one's adaptive capacity (e.g., frustration, annoyance, anger) (Britt and Janus, 1940; Kuppens et al., 2003; D'Mello and Graesser, 2012; Lench et al., 2016; Williams, 2017; Alia-Klein et al., 2020, this issue; Silva, 2021)
- ***Loss Concerns:*** suggest recognizing that a resource is lost and seeking new resource to replace it (e.g., disappointment, sadness, grief) (Draper, 1999; Freed and Mann, 2007; Zeelenberg et al., 2000; Chua et al., 2009; Horwitz and Wakefield, 2007; Lench et al., 2016; Averill, 1968; Bonanno and Kaltman, 2001; Archer, 2003; Shear and Shair, 2005; Kübler-Ross and Kessler, 2005; Parkes, 2013; Neimeyer et al., 2016; Bonanno, 2019; Arias et al., 2020, this issue; Tsikandalikis et al., 2023)
- ***Epistemic Concerns:*** suggest acquiring new knowledge to inform one's action repertoire or solving a gap in planned operations (e.g., curiosity, intrigue, fascination) (Ortony et al., 1988; Silvia, 2008; Vogl et al., 2020; Dolcos, 2020, this issue)
- ***Cooperation Concerns:*** suggest seeking out and sharing operations with other human beings for common goals (e.g., care, love, belonging, trust, empathy) (Eslinger et al., 2021, this issue; Heise, 1977; Isen, 1987; Leary, 2000; Schulkin, 2011; Forgas, 2001, 2012; van Hooff and Aureli, 2014; Atzil et al., 2018; Sznycer and Lukaszewski, 2019; Djerassi et al., 2021; Ho et al., 2022; Zoltowski et al., 2022; Migeot et al., 2023; Chemery, 2016; Fischer and Manstead, 2008; Fischer et al., 2016; Lin et al., 2023)
- ***Moral Concerns:*** suggest influencing potentially cooperative others via praise or punishment to adhere to the standards of operations for one's comfort zone (e.g., pride, admiration, shame, moral disgust) (Haidt, 2003; Tangney et al., 2007; Gray and Wegner, 2011; Deonna et al., 2012)
- ***Aesthetic Concerns:*** suggest slowing down to take in fit between the environment's actionable features and one's own action repertoire (e.g., awe, appreciation, beauty) (Vessel et al., 2012; Hogan, 2011, 2017; Van Dyck et al., 2017; Silvia, 2005; Scherer and Coutinho et al., 2013; Juslin, 2013; Desmet and Schifferstein, 2008; Markovic, 2012; Kaneko et al., 2014; Brouwer et al., 2017; Mastandrea et al., 2019; Menninghaus, 2019; Van de Cruys et al., 2022)

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It seems that what the field often refers to as **emotion** maps well onto algorithms reflecting operational concerns (Simon, 1967; Tooby and Cosmides, 1990; 2008; Clore and Palmer, 2009; Seth, 2013; Oatley and Johnson-Laird, 2014; Scarantino, 2014; Bach and Dayan, 2017; Atzil and Gendron, 2017; Hommel et al., 2017; Hommel, 2019; Al-Shawaf and Lewis, 2020; Al-Shawaf and Shackelford, 2021; Del Giudice, 2021; Suri and Gross, 2022; Quadt et al., 2022). This should be no surprise considering the term's etymology, which is inherently tied to movement and action (Dixon, 2003, 2012).

Global

Given that the hierarchical affective concerns above are comprised of separate process occurring at different timepoints and for different durations, other concerns are required to make sense of them combined or more globally. Algorithms reflecting **global concerns** are not driven by any particular level of enactive relevance, but instead summarize across hierarchical concerns in comprehensive evaluation at a higher timescale. These global concerns are not about particular objects but are rather directed at summations of concerns about particular objects to inform an overall state (LeDoux, 2012). Although integration across hierarchical concerns can be analyzed in a number of different ways, there are two orders of global concerns that are the most obvious and have been studied well in the field: trajectory and optimization.

Trajectory

Algorithms reflecting **trajectory concerns** summarize hierarchical concerns by reflecting their global direction with regard to the organism's comfort zone (Schwarz, 1983; Eldar et al., 2016). These processes take into account whether the slope of adaptation is trending in a positive or negative direction. This means that affective experiences reflecting trajectory concerns often feel like they are not directed at anything in particular or they are directed at everything—as the specificity of relevance is lost in the summary of trajectory (Deonna and Teroni, 2012; Kind, 2013; Bollnow and Boelhauve, 2009; Frijda, 1993; Gendolla, 2000; Crane, 1998; Goldie, 2000; Seager, 1999; Solomon, 1993; de Sousa, 1990; Mendelovici, 2013; Tye, 1995; Arregui, 1996; Kriegel, 2019; Gendolla et al., 2005; Gendolla and Krüsken, 2005). Processes reflecting trajectory concerns usually last for longer periods of time than the short-lived hierarchical concerns. The affective construct that fits this characterization is **mood**. When one is in a good mood, one can describe its relevant environment as heading in a good direction (Morris and Schnurr, 1989; Price, 2006; Pessiglione et al., 2023).

Optimization

Algorithms of **optimization concerns** summarize hierarchical concerns by reflecting their global performance at a high temporal scale, indicating the extent to which the human organism has achieved their best match between their adaptive capacities and the environment's actionable features, across an extended duration of time (Schwarz and Strack, 1999; Strack et al., 2007; Diener and Ryan, 2009; Diener, 2009; Diener et al, 2009; LeDoux, 2012; Krueger and Schkade, 2008; Maddux, 2017; Oishi et al., 2020). These processes assess how the organism is faring overall in their quest for the maintenance of their comfort zone, suggesting wholesale changes to future operations. This usually means that the organism has been able to consistently occupy its comfort zone despite engaging in various operations (De Neve et al. 2013; Lyubomirsky et al., 2005; Eid, 2008; Brown et al., 2020). These algorithms seem to be what the field often refers to as **wellbeing**, including affective experiences of life satisfaction, authenticity, fulfilment, and self-actualization (Alexander et al., 2021, this issue; Arias et al., 2020, this issue; Schwarz and Strack, 1999; Diener et al., 2013; Krueger and Schkade, 2008; Maddux, 2017; Oishi et al., 2020).

Affective Features

These processes reflect the momentary information on the adaptive process itself. Algorithms reflecting **affective features** monitor several standards inherent to the adaptive process:

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- Algorithms that reflect *valence* provide information on how well or poorly the human organism is doing with respect to the comfort zone.
- Algorithms that reflect *arousal* provide information on how much resources should be put to various systems.

Unlike affective concerns, which highlight the object of interest as actionably relevant during an affective experience, affective features are reflected in the qualitative aspects of the experience itself. In addition, each can have multiple dimensions as opposed to being constrained to single scalars with two extremes.

Valence

Across affective concerns, algorithms reflecting **valence** arise in the hedonic quality of affective experience, often described as pleasure and displeasure, marking how adaptation is faring with respect to the concern at the heart of the affective phenomenon (Becker et al., 2019, this issue). This characteristic of affective phenomena can be construed to have multiple dimensions, such as when both positive and negative valence seem to be present (e.g., nostalgia) (Colombetti, 2005; Lerner and Keltner, 2010; Viinikainen et al., 2010; Batcho, 2013; Vazard, 2022). There are more recent formal accounts of the mechanism of valence—some from the perspective of the environment being good, while others of the view that it is the evaluation of the environment being good (e.g., Rutledge et al., 2014; Joffily and Coricelli, 2013; Hesp et al., 2021)—but it is largely agreed upon that valence is an intrinsic characteristic of affective phenomena, momentarily informing adaptivity (Charland, 2005; Berridge and Kringelbach, 2008; Van de Cruys, 2017; Trofimova, 2018).

Arousal

Across affective concerns, algorithms reflecting **arousal** assess the quality of intensity in affective experience, often described as low to high, marking the extent of excitation, activation, or mobilization of processes serving a particular concern (Duffy, 1957; Anderson and Adolphs, 2014; Clore et al., 2021). Given that many processes can be implicated in an affective concern, there are many dimensions of arousal (e.g., wakefulness, emotional arousal, sexual arousal, physical activity, attention) (Duffy, 1957; Zuckerman, 1971; Pribram and McGuinness, 1975; Thayer, 1978; Robbins and Everett, 1995; Robbins, 1997; Cahill and McGaugh, 1998; Jones, 2003; Eysenck, 2012; Satpute et al., 2019; Dolcos et al., 2020, this issue). Although intermediate arousal across time can be an indication of effective adaptivity, these systems can have varying degrees of arousal at any one time (e.g., sexual arousal during fatigue) (Neiss, 1988; Griffiths, 2013).

Taken together, given the rapid change of a dynamic human neurobiological system, these algorithms rarely, if ever, reflect a neutral valence or arousal state, even in periods of high optimization. These two features are usually related but remain orthogonal due to operations that can involve opposing positions on their various spectra (Kuppens et al., 2013, 2017; Yik et al., 2023). These features are ever-present, marking every affective experience and evaluating every hierarchical affective concern. In addition, these are the sources of information used by algorithms of global concerns, responsible for summarizing across the dynamic momentary ones. Finally, these affective features are often what is referred to in the field as 'affect', perhaps because they are most inherently tied to the organism's comfort zone (Russell, 2003; Posner et al., 2005; Barrett and Satpute, 2019). We, however, distinguish them as the affective gauges, while concerns are the focus of affective phenomena.

The feature of **motivation** has also been suggested as part of affect, often citing dimensions of approach and avoidance (Lang and Bradley, 2008). However, within this framework, given the central role of our teleological principle, it seems that affective phenomena can be more cohesively organized if motivation is taken as an inherent aspect (Klinger, 1975; Nelkin, 1989, Rosenthal, 1991; Di Paolo, 2005; Colombetti, 2014; Cromwell et al., 2020, this issue). Given our teleological principle, an organism has algorithms reflecting affective concerns that address actionability, and thus relevance, of the environment through this enaction. Therefore, affective phenomena inherently involve motivation in that actionability is at the heart of relevance. As such, motivation

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folds into inherent enacting of relevance necessary for this framework's teleological foundation, whereas valence and arousal can be found as distinct capacities in the human organism's adaptive purpose.

Table 2. Affective Concerns and Features

This table describes two sets of algorithms among affective phenomena—affective concerns and features—providing examples and their theoretical rationale. Each phenomenon's computational problem is also specified, as well as algorithmic solutions existing in the field already.

Affective Phenomenon	Examples	Theoretical Rationale	Computational Problem	Existing Algorithmic Solutions
AFFECTIVE CONCERNS inference of objects as actionable and thus relevant, which is reflected in the felt implication of those objects	physiological, operational, global	Intentionality: feelings are about something (Frege, 1948; Russell, 1905; Dennett, 1989; Bedford, 1956; Brentano, 2012; de Sousa, 1990; Kenny, 1963; Leighton, 1985; Pitcher, 1965; Teroni, 2007; Deonna and Teroni, 2012; Clore and Huntsinger, 2009) Embodiment and Enactivism: all cognition is encoded as action (Varela et al., 2017; Colombetti and Thompson, 2007; Shargel and Prinz, 2017; Slaby and Wüschner, 2014; Hufendiek, 2015; Hutto, 2012) Affordances: the environment provides actionable meaning for the organism (Gibson, 1977) Motivation Theories: feeling states as motivational (Duffy, 1957; Frijda, 1986, 2007; Hommel et al., 2017)	how to infer relevance of objects	Bayesian: using observable (interoceptive or exteroceptive) sensory data to infer and update the non-observable meaning (hidden or latent conditional probabilistic states) of those sensory data (Barrett, 2017; Dayan et al., 1995; Doya, 2007; Friston et al., 2016; Knill and Pouget, 2004; Lee and Mumford, 2003; Neal, 2012; Seth, 2013; Seth and Friston, 2016; Smith et al., 2019; Wolpert et al., 1995; Palacios et al., 2020)
Immediate to Distal gradient of relevance according to the distance from metabolic impact that the actions demanded would have (i.e., complexity, timescale, abstractness)	physiological, operational	Evolutionary and Biological Theories: courses of action can be more immediate or more distal (Jonas, 2001)	how to organize needs with varying extents of actionability	Bayesian: hierarchical inference with varying levels of complexity, timescale, or abstractness; immediate concerns are hidden states inferred at a lowest level and distal concerns are those at the highest (Pezzulo et al., 2015; Pezzulo and Levin, 2016; Pezzulo et al., 2022)
Physiological concerns require the most immediate or concrete actions	nourishment (hunger), hydration (thirst), internal integrity (nauseous); **sensation**	Interoception and Homeostasis: internal state as indicative of homeostatic status (Craig, 2002; 2013; Pace-Schott et al., 2019, this issue)	how to address immediate needs	Reinforcement Learning: reflexive decision-making in reinforcement learning (i.e., model-free; van Swieten et al., 2021); pain as aversive prediction errors (Roy et al., 2014) Bayesian: fatigue as metacognitive inference (Stephan et al., 2016)

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Operational concerns range from proximal to distal, wherein an organism has a feeling toward an object that, if acted upon, has proximal to eventual metabolic impact	safety (joy, happiness, exhilaration), danger (fear, worry, dread), obstruction (frustration, annoyance, anger), loss (disappointment, sadness, grief), epistemic (curiosity, intrigue, fascination), cooperation (care, love, belonging, trust, empathy), moral (pride, admiration, shame, moral disgust), aesthetic (awe, appreciation, beauty); **emotion**	Evaluative or Action-Oriented Theories: feelings or emotions are evaluation of readiness for action (Dewey, 1895; Frijda, 1986, 2017; King, 2009; Deonna et al., 2015; Deonna and Teroni, 2012a; Scarantino, 2014, 2015; Simon, 1967; Tooby and Cosmides, 1990; 2008; Clore and Palmer, 2009; Seth, 2013; Oatley and Johnson-Laird, 2014; Bach and Dayan, 2017; Atzil and Gendron, 2017; Hommel et al., 2017;; Hommel, 2019; Suri and Gross, 2022; Quadt et al., 2022; Del Giudice, 2021) Basic and Discrete Appraisal Theories: differentiating emotion types by respective evaluations (Kragel and LaBar, 2016; Adolphs, 2017; Ekman and Cordaro, 2011; Lazarus, 2001; Roseman and Smith, 2001; Izard, 2007; Levenson, 2011; Panksepp and Watt, 2011; Scherer et al., 2010) Dimensional Appraisal Theory: infinite combinations of concerns differentiate an infinite typology of emotions (Grandjean and Scherer, 2008; Scherer, 2009; Scherer and Moors, 2019; Lerner and Keltner, 2000, 2001) Constitutive Appraisal Theory: emotions *are* these evaluated concerns (Clore and Ortony, 2000, 2013; Ortony et al., 1988) Constructionist Theories: emotions are constructed from lower-level ingredients (Damasio, 2003; Russell, 2003; Barrett, 2017; LeDoux, 2012)	how to address proximal to distal needs	Affective Computing, Reinforcement Learning, and Bayesian: models for differentiating between emotions (Gratch and Marsella, 2004; Scherer et al., 2010; Broekens et al., 2013; Lee et al., 2021; Marsella and Gratch, 2006; Marsella et al., 2010; Poria et al., 2017; Bach and Dayan, 2017; Sennesh et al., 2022; Smith et al., 2019).
Global summative adaptive states	trajectory, optimization	Constructionist Theory: summarizing overall organism state (LeDoux, 2012)	how to characterize own adaptive performance across time	See below.
Trajectory the direction of adaptation with regard to comfort zone	positive, negative; **mood**	Philosophical Theories: increased likelihood of positive/negative occurrences (Price, 2006; Railton, 2017);	how to characterize local direction of environment	Reinforcement Learning: momentum or trajectory of reward and punishment prediction errors (Eldar et al., 2016) Bayesian: mood as hyperpriors (Clark et al., 2018)
Optimization optimal match between the organism and the environment	low, high; **wellbeing**	Life Satisfaction: global evaluation of one's life (Schwarz and Strack, 1999; Strack et al., 2007; Diener and Ryan, 2009; Diener, 2009; Diener et al, 2009; LeDoux, 2012; Krueger and Schkade, 2008; Maddux, 2017; Oishi et al., 2020)	how to recognize best adaptive performance across an extensive period of time	Bayesian: maximizing momentary valence—using momentary judgments of adaptiveness to evaluate global optimality in adaptiveness (Smith et al., 2022; Miller et al., 2022) Information Theory: flow as mutual information (Melnikoff et al., 2022)

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AFFECTIVE FEATURES momentary information on the adaptive process	valence, motivation, arousal	Allostasis: measures of predicted homeostatic need (Cannon, 1929; Cooper, 2008; Sterling and Eyer, 1988; Carpenter, 2004; McEwen and Wingfield, 2003; Sterling, 2012, 2020; Schulkin and Sterling, 2019; Sennesh et al., 2022)	how to characterize momentary status of adaptive process	See below.
Valence metric of evaluation of goodness or badness	positive, negative	Core Affect: valence as ubiquitous across all affective experience (Russell et al., 1989; Russell, 2003; Posner et al., 2005; Kuppens et al., 2013) Philosophical Theory: minimal metacognition in self-assessment of own adaptiveness (Van de Cruys, 2017)	how to characterize momentary suitability for organism's adaptivity	Reinforcement Learning Implementation: predicted rewards and punishments as 'happiness' (Rutledge et al., 2014) Bayesian Implementation: organism's predictive evaluation of its adaptiveness or preparedness for its environment (Hesp et al., 2021)
Arousal metric of activation of various systems	low, high	Core Affect: arousal as ubiquitous across all affective experience (Russell, 2003; Russell et al., 1989; Posner et al., 2005; Kuppens et al., 2013) Wakeful, Sexual, Autonomic, Physical, and Affective Arousal Theories: activation can occur within different systems at different levels (Duffy, 1957; Zuckerman, 1971; Pribram and McGuinness, 1975; Thayer, 1978; Robbins and Everett, 1995; Robbins, 1997; Cahill and McGaugh, 1998; Jones, 2003; Eysenck, 2012; Satpute et al., 2019; Satpute et al., 2019; Neiss, 1988; Griffiths, 2013)	how to characterize momentary activation of system	Vigor: effort as an outcome of arousal (Niv et al., 2007)

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Conclusions: *How can we study human affective phenomena?*

This capstone paper builds a teleological principle to guide the construction of an integrative framework for human affective phenomena, a set of assumptions about what they are and how they work. To account for the entire collection of affective phenomena in humans, we can consider them as arising to entertain abstraction, when enacting relevance, by executing operations, to ensure viability. Based on this principle, affective phenomena can be considered processes that adapt based on the human's comfort zone (affective concerns) and monitor their adaptive process (affective features). Affective concerns, include a hierarchy of relevance ranging from courses of action with more immediate metabolic impact to those with more distal impact. They also include global concerns that summarize momentary affective concerns on the hierarchy at a higher timescale, such as tracking their trajectory and optimization with respect to the comfort zone. These global concerns use the momentary information that characterize all affective concerns provided by affective features—algorithms that monitor the adaptive process. These include multidimensional metrics of valence, how well or poorly the human organism performs in light of their comfort zone, and arousal, how much resource should be mobilized per necessary system for action. All affective phenomena are experientially and mechanistically organized from the perspective of the human organism, where affective concerns are the focus of the affective experiences and affective features mark them all as qualities of the experiences. This cohesive framework is offered to be used as a synthesized set of metaphysical and mechanistic assumptions organized around a teleological principle that is based on a comprehensive sampling of existing theoretical perspectives on affective phenomena (**Table 2**).

It is important to note that this is *not* intended as a semantic taxonomy of affective phenomena and their definitions, but rather as an ontology for how human affective phenomena might follow from a common principle and be related to each other (Fodor, 1998; Egan, 2017, 2020). To truly fold the richness of valid scholarly interests into an encyclopedia of semantic constructs in the field would require a full research program's worth of time and work, spanning years, or even decades. This endeavor is also *not* meant to be another falsifiable theory for generating testable hypotheses. What we offer here instead is a principled multidisciplinary theoretical launchpad for many threads of inquiry and a *scaffold* for hosting specific theories and hypotheses differentiated from or situated among the tenets of this framework (Popper, 1963; Kuhn, 2012; Holton, 1975; Lakatos, 2014, 1978; Laudan, 1978; Godfrey-Smith, 2003; Ormerod, 2009; Jabareen, 2009; Notturno and Popper, 2014).

We hope this framework provides a template for an organized research agenda for the affective sciences moving forward, following similar endeavors in neighboring fields: the *Human Genome*, organizing the complete set of human genetic information (Schuler et al., 1996), and the *Human Connectome*, organizing all networks of connectivity in the human brain (Sporns et al., 2005). By the same token, we dub this framework the **Human Affectome**, where the suffix '*ome*' means "all the constituents of, considered collectively or in total" (Oxford English Dictionary, 2023), so that it can be used by the field to organize the collection of algorithms across human affective phenomena. We aim for this framework to encourage the interdisciplinary field of the affective sciences to identify concrete algorithms in order to test specific theories and hypotheses about affective phenomena. This will be the exercise of characterizing and organizing human affective

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phenomena based on the teleological principle, ultimately, applying this framework to build out the Human Affectome in a principled and comprehensive manner.

For each member of the field, the initial approach we advocate is to triangulate your explanatory goals among these assumptions in order to compare them to others in the field on the basis of the teleological principle here. Paired with the perspectives incorporated into the teleological synthesis (**Table 2**), we offer an inverse, preliminary mapping of examples of the field's existing theoretical accounts onto this framework (**Table 3**). We also suggest ways the existing theoretical constructs in the field can be situated within this framework (**Table 4**).

[INSERT TABLE 3 HERE]

[INSERT TABLE 4 HERE]

We hope these resources can help efforts to regenerate existing theories and hypotheses as well as put forth new ones in terms of the teleologically-principled algorithms here. In this way, different disciplines, subdisciplines, and individual researchers can understand their different context-dependent interests, disclose their assumptions, and attempt to integrate their frameworks in a non-adversarial manner (Dijkstra, 1965; Mitchell, 2003, 2009; Bechtel, 2009; Tabery, 2014).

For the time being, we highlight a few avenues of guidance implicit in this paper:

Firstly, assuming affective phenomena to be *mechanistic* is not unique to empirical approaches. Beyond the sciences, affective phenomena are acknowledged as processes of change that not only shape the nature of the humanities but are a major part of the content among the humanities (Hogan, 2011, 2017; Van Dyck et al., 2017; Silvia, 2005; Scherer and Coutinho et al., 2013; Juslin, 2013; Desmet and Schifferstein, 2008; Kaneko et al., 2014; Brouwer et al., 2017; Mastandrea et al., 2019; Menninghaus, 2019). On the other hand, among the sciences, this mechanistic assumption need not result in methodological factions (Lange, 1885; Scherer, 1982a; Schwarz and Clore, 1983 Averill, 1994; Frijda, 1994; Keltner and Gross, 1999; Cacioppo, 1999; Mill, 1856; Whewell, 1858; Machamer et al., 2000; Glennan, 2002, 2008; Azzouni, 2004; Bechtel and Abrahamsen, 2005; Chang, 2005; Morganti and Tahko, 2017; Ivanova and Farr, 2020; Levenstein et al., 2023). The classical cognitivist approach—that affective mechanisms transform inputs into outputs or are otherwise processes between stimulus and response—accords with our felt experience and has underpinned efforts to localize affective processes to specific brain regions (Haugeland, 1978, 1997; Marr, 2010; Kanwisher, 2010; Cromwell and Papadelis, 2022, this issue). This is not incompatible with more distributed and dynamic perspectives—that these processes are interactions between nodes of a neural network that change in configuration over time (**connectionism**) (Fodor and Pylyshyn, 1988; Bechtel and Abrahamsen, 1991; Clark, 1989)—which invite the articulation of those processes of change in formal terms with differential equations (**dynamical systems theory**) (Horgan and Tienson, 1996; Thelen and Smith, 1994; Port and Van Gelder, 1995; Clark, 1998; Boone and Piccinini, 2016). These views can be reconciled by considering the classical linear and localizable processes as emergent from distributed and dynamic neural activity (Friston and Price, 2001a, 2001b; De Wolf and Holvoet, 2005).

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Secondly, we do not present an explicit formal or computational model precisely to encourage the multiple empirical interpretations of this framework by articulating the algorithms for your own hypotheses. We will caution that selecting a *modeling framework* introduces assumptions as well. For example, some frameworks that invoke the concept of **reward** tend to assume relevance and action to be separate (**reinforcement learning**) (Kaebling et al., 1996; Wiering and Van Otterlo, 2012; Sequeira et al., 2011; Moerland et al., 2018; Grahek et al., 2020; Levine, 2018; Sutton and Barto, 2018), while others view relevance as probabilistic (**Bayesian inference**) going as far as building relevance from action (**active inference**) (Attias, 2003; Botvinick and Toussaint, 2012; Knill and Pouget, 2004; Friston et al., 2009; Allen and Friston, 2018; Friston et al., 2013, Ramstead et al., 2019; Sajid et al., 2021; Clark, 2013, 2015; 2017; Parr et al., 2022; Kiverstein et al., 2022; Smith et al., 2019, 2022; Millidge et al., 2020; Miłkowski and Litwin; 2022; Di Paolo et al., 2022). Notwithstanding accounts that mix these methods, none to our knowledge have successfully built algorithms of affective phenomena up from the earliest principle of an organism, although the groundwork is being laid (Prokopenko et al., 2009; Fernández et al., 2014; Ringstrom, 2022; Heylighen and Busseniers, 2023; Hodson et al., 2023; Broekens et al., 2013; Cunningham et al., 2013; Scherer et al., 2010; Marsella and Gratch, 2009; Marsella et al., 2010, 2016; Calvo et al., 2015; Poria et al., 2017; Emanuel and Eldar, 2022).

Thirdly, we do not make a strong claim about consciousness (Berridge and Winkielman, 2003; Winkielman and Berridge, 2004; Hatzimoysis, 2007; Lacewing, 2007; De Waal, 2011; Carmel and Sprevak, 2014; Díaz, forthcoming; Reuter, forthcoming). We do assume, however, that the affective experiences discussed here are feelings and, therefore, are felt in the broadest sense (i.e., qualitatively organized by a unified perspective). As such, a *first-person perspective* from oneself—an assumption in the Human Affectome—should be taken seriously. One approach that has gained traction in the cognitive sciences is one that investigates the correlations between the structure of experience and the organization of neurocomputational mechanism (**neurophenomenology**) (Gallagher, 1997; Van Gelder, 1999; Varela, 1996; Thompson et al., 2005). This can be done through rigorous comparison of subjective report and case studies with neuroimaging and behavioral measures (Weiskrantz, 1997; Dehaene et al., 2003; Koch and Tsuchiya, 2007; Rosenthal, 2019; Cunningham, 1977; Scarantino, 2017; Wharton and de Saussure, 2023). Especially when it comes to psychopathology, investigation into aberrations in the capacity to maintain a perceived and actionable comfort zone is paramount—and methodologies to perform such studies are on the rise (Metzinger, 2003a, 2003b, 2013; Möller et al., 2021). For example, given the fundamental role that actionability plays in this framework, research into how an integrated sense of agency (Georgieff and Jeannerod, 1998; Horgan, 2003; Engbert et al., 2008; Gallagher, 2000; Hohwy, 2007; de Haan and de Bruin, 2010; David, 2012; Synofzik et al., 2008; 2013; Roessler and Eilan, 2003; Pacherie, 2008; Gallagher, 2012; Moore, 2016; Haggard, 2017; Braun et al., 2018) as well as sense of control over intended outcomes (Pacherie, 2007; Rotter, 1966; Lachman and Weaver, 1998; Bandura, 1977, 2006; Na et al., 2023) in relation to affective phenomena can be expanded.

Moreover, we should not shut out language and thought as non-affective phenomena. Indeed, both communication and thinking have felt aspect themselves (Siewert, 1998; Pitt, 2004; Bayne et al., 2014; Kind, 2001; Tulving, 1987; Roediger, 1990; Teroni, 2017; Gardiner and Java, 2019; Siewert, 2012; Wharton et al., 2021). Instead, we should emphasize these *abstract* activities as active constructs in our picture of affective phenomena, such as by considering them determinants of

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relevance and, thus, generating activities of subjective report and communication as dynamic processes in themselves (Wharton and de Saussure, 2023; Satpute et al., 2020, Ryan et al., 2023; Gohm and Clore, 2000; Robinson and Clore, 2002; Barrett, 2004; Cowen et al., 2017; Russell, 1980; Watson et al., 1988; Bradley and Lang, 1994; Boehner et al., 2007; Wilhelm and Grossman, 2010; Betella and Verschure, 2016; Shiffman et al., 2008; Csikszentmihalyi and Larson, 2014; Kuppens et al., 2022; Betz et al., 2019; Satpute and Lindquist, 2021; Ericcson and Simon, 1993; Wilson, 1994; Schwarz, 1999; Dehaene et al., 2003; Mauss and Robinson, 2009; Barrett et al., 2011; Lindquist et al., 2015; Harmon-Jones et al., 2016; Rosenthal, 2019; Li et al., 2023; Teoh et al., 2023). In addition, we should acknowledge that we academics, as humans ourselves, are performing the very same activity of abstraction and—if we choose not to investigate ourselves as affect-ridden researchers—should at least acknowledge and disclose the assumptions from our pragmatic context and theoretical virtues (e.g., Scarantino, 2016). All in all, we should take seriously the question whether cognition is truly separate from affect (Wharton and de Saussure, 2023; Lyons, 1999; Adolphs and Damasio, 2001; Duncan and Barrett, 2007; Okon-Singer, 2015; Zajonc, 1983; Bower, 1983; Isen, 1984; Hoffman, 1986; LeDoux, 1989; Izard, 1992; Ochsner and Phelps, 2007; Forgas, 2008; Zajonc et al., 2014; Storbeck and Clore, 2017).

Relatedly, as interdisciplinary and integrative as this framework is, only Western academic perspectives have been considered, while *Eastern* ones as well as *Indigenous* perspectives have not been breached. This is a significant drawback as Western academia tends to take a metaphysically categorical approach to affect, considering it separate from cognition, while this is not necessarily the case among Eastern and Indigenous psychologies and philosophies (e.g., Mercado et al., 1994; Reyes, 2015; Rošker, 2021; Sundararajan, 2015; Tuske, 2021; Zhou et al., 2021; Yik, 2010; Pernau, 2021; Briggs, 2000; Choi et al., 2007; Crivelli et al., 2016; Beatty, 2014, 2019; Allard, 2022; Michaels and Wulf, 2020; Pak, 2021; Yik et al., 2023). Further research and collaboration among those from different cultures of academia as well as beyond is highly encouraged.

In addition, areas of academic and industry perspectives in affective research beyond philosophy and science have not been touched upon, such as design and architecture (Desmet, 2003; Desmet et al., 2021; Hassenzahl and Tractinsky, 2006; Norman, 2002, 2013; Fokkinga and Desmet, 2022). These sectors pose fertile collaboration in studying affective phenomena in new ways—especially given the growing scientific interest in the embodiment of affect.

Finally, although this framework exclusively covers humans—obliging us to incorporate abstraction, language, and self-report—its core tenets can apply to non-human animals as well. This could involve a nested teleological principle focusing on ensuring viability, executing operations, and enacting relevance, while motivating a more limited set of affective concerns and features. Converging on such teleologically grounded affective phenomena in this way could promote translation and collaboration across levels of investigation in the context of non-human animal affective research.

In conclusion, assumptions ruling academic research into affective explananda have been tangled and discussed in disparate pockets of inquiry—each field, subfield, and researcher, with their own explanatory motives. In this capstone paper of the special issue "Towards an Integrated Understanding of the Human Affectome", we present the Human Affectome—a set of assumptions

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guided by a common teleological principle based on a synthesis of perspectives—in order to motivate a comprehensive and organized research agenda that differentiates the theoretical aspects of this integrative framework into specific theories and hypotheses. As we mentioned in the *Introduction*, we hope that you have taken something away, no matter how small and no matter what background you have in affect, from this endeavor and are inspired to bridge our rich and sprawling field further. We hope that we are one step closer to not only an integrated understanding of human affective phenomena, but an integrated field for affective research.

Table 3. Situating Existing Theoretical Accounts within the Human Affectome

This table summarizes explanatory goals of existing theoretical accounts of affective phenomena with their chosen methodologies and situates them within the algorithmic organization of the Human Affectome. For each entry of theoretical account in the table below, references to relevant theoretical accounts are **bolded** and references to the Human Affectome are *italicized*.

Theoretical Accounts	Explanatory Goal	Methodology	Situated within The Human Affectome
affective computing	matching, recognizing, or simulating affective phenomena often using multidimensional data (Picard, 2000; Gratch and Marsella, 2004; Poria et al., 2017)	computational modeling; machine learning	can be used to articulate affective algorithms. *To entertain abstraction, Operational concerns*.
appraisal	1. the commonality of relations between evaluations and emotions across populations (**discrete appraisal theories**; Lazarus, 2001; Roseman and Smith, 2001)	subjective report (fixed options); behavioral paradigms; physiological measures; affective computing	the actionable orientation with which the human organism evaluates an object as relevant. *Affective Concerns.*
	2. the variability in relations between emotions and combinations of evaluations across populations (**dimensional appraisal theories**; Grandjean and Scherer, 2008; Scherer, 2009; Scherer and Moors, 2019; Lerner and Keltner, 2000, 2001)	subjective report (dimensional responses); behavioral paradigms; physiological measures; affective computing	
	3. evaluations as distinguishing between what constitutes different	computational modeling and formalism	

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	emotion types, rather than causing them (**OCC model**; Ortony et al., 1988)		
autopoiesis	See **enactivism: autopoietic**.		
basic emotion	the commonality of physiological, neural, and behavioral indicators of types of emotion across populations	subjective report (fixed options); behavioral paradigms; physiological measures; neuroimaging	emotions can be grouped by their cluster of operational concerns but are not necessarily biologically determined. *Operational concerns*.
Bayesian inference	1. predictive inference of explanation for sensory data (**Bayesian brain hypothesis** or **predictive coding**) *1a*. predictive inference of explanation for sensory data based on principle of minimizing free energy by considering action (**active inference**)	behavioral paradigms; computational modeling and formalism; neuroimaging	objects are evaluated by their meaning. *Affective Concerns*. objects are evaluated by their actionable meaning. *Affective Concerns*.
cognitive science	interdisciplinary field studying the mind	behavioral paradigms; computational modeling and formalism; neuroimaging	*entertaining abstraction* allows us to engage in cognitive science, but we can also question whether cognition and affect are indeed separate. *Conclusions*.
computational psychiatry	the individual computational mechanisms at play in different people with psychiatric disorders	behavioral paradigms; computational modeling and formalism; neuroimaging	mechanisms in psychiatric disorders can be construed as algorithms of adaptivity gone awry. See **representation: misrepresentation**. *To entertain abstraction*.
connectionism	the distributed activity across nodes of a neural network (see **attractor states** in **Table 4** and **dynamical systems**)	computational modeling and formalism	an organism's processes unfold across many nodes. *To ensure viability*.
constructionist	1. the presence of felt bodily changes during emotional experience (**somatic marker hypothesis**) (Damasio, 1996)	subjective report; behavioral paradigms; physiological measures; neuroimaging	emotions being felt reflections of algorithms addressing operational concerns, which can be inferences of lower-level

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	2. the dimensional commonalities across all emotional experiences (**core affect**) (Russell, 2003; Russell et al., 1989; Posner et al., 2005; Kuppens et al., 2013)	subjective report (dimensional responses); behavioral paradigms; physiological measures; neuroimaging	affective concerns. *Operational concerns*.
	3. the variability in subjective reports of emotional experience (**theory of constructed emotion**) (Barrett, 2017)	subjective report (free labeling); behavioral paradigms; physiological measures; neuroimaging	
dynamical systems	the dynamics of distributed activity across time (see **attractor states** in **Table 4** and **dynamical systems**)	computational modeling and formalism	an organism's processes unfold across time as a complex system. *To ensure viability*.
embedded	interactions between organism and environment shape organism's capacities (see **situated**)	conceptual analysis	the human organism must interact with the environment to enact its relevance. *To enact relevance*.
embodied	mental processes involve whole body, not just brain and nervous system	subjective report; behavioral paradigms; physiological measures; neuroimaging; conceptual analysis	all processes in an organism are contributing to enacting relevance. *To enact relevance*.
enactive	1. everything an organism does, including cognition, is active—specifically, as interactions with its environment	computational modeling and formalism; conceptual analysis	the *Human Affectome* is guided, in part, by the *Teleological Principle* that human organisms enact relevance. All affective phenomena are enactive. (Emotions, as references to *operational concerns*, can therefore also be considered enactive.)
	*1a. t*o be an organism is to self-generate and self-distinguish (**autopoietic**)	conceptual analysis	*to ensure viability*.
	1b. the organism both makes sense of the world and makes the world make sense (**sense-making**)		*to enact relevance*.

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	2. how perception and action can guide each other (**sensorimotor**)	subjective report; behavioral paradigms; physiological measures; neuroimaging; conceptual analysis	*to enact relevance*.
	3. enaction allows us to do away with representation (**radical**)	conceptual analysis	the *Human Affectome* does not assume a strong claim on representation, but representations can be used to describe algorithms. *To enact relevance, To entertain abstraction*.
evolutionary	affective phenomena can be explained based on aspects that developed via natural selection (Izard, 1978; Nesse, 1990; Porges, 1997; Panksepp, 1998; LeDoux, 2012; Al-Shawaf et al., 2016).	behavioral paradigms; neuroimaging; conceptual analysis	the *Human Affectome* does not take up an explicit evolutionary perspective, despite the assumption that part of the purpose of affective phenomena is *to ensure viability*. All else, such as metabolism, reproduction, and evolution, arise from necessarily being a unity in the first place (Varela et al., 1974; Maturana, 1980; Panksepp, 1998)
extended	the mind extends further than the body to objects used in a relevantly similar and reliable way (Clark and Chalmers, 1998)	conceptual analysis	the *Human Affectome* does not assume an extended mind, but merely highlights the interactions between human organism and environment. *To enact relevance*.
goal-directed theories	integration of **dimensional appraisal** and **constructionist** theories of emotion (Moors, 2017)	conceptual analysis	emotion types grounded by clusters of goal-orientedness or action tendency. *Operational concerns*. See **goal** in **Table 4**.
homeostasis	how organism remains within viable states despite environmental change	behavioral paradigms; physiological measures; neuroimaging; conceptual analysis	this is entailed by **autopoiesis.** *To ensure viability*.

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Human Affectome	what affective phenomena are and how they work based on why they exist	conceptual analysis	entire framework of the *Human Affectome*.
intentionality	the aspect of a mental state being about something	conceptual analysis; phenomenological analysis	objects are relevant to an organism based on its actionable orientation toward them; allows distinction between affective types based on clusters of affective concerns. *Affective Concerns*.
	projecting intentionality onto something whose behavior seems to have it (**intentional stance**)		we can use the intentional stance to articulate processes, whether the source has intentionality or not. *To entertain abstraction*.
moral emotions	emotions that concern beliefs about violation	behavioral paradigms; conceptual analysis	moral emotions as affective experiences grounded by algorithms addressing a moral subset of operational concerns. *Operational concerns*.
motivational theories	1. the drive to act in emotion (**action tendency**; Frijda, 1986); see **appraisal**. 2. the evaluation in emotion in light of the drive to act (**felt bodily attitude**; (Deonna and Teroni, 2012) 3. the drive to act as well as emotional actions (**motivational theory of emotions**; Scarantino, 2014)	conceptual analysis; behavioral paradigms; physiological measures; neuroimaging	the actionability implied by an object in an affective phenomenon. *To enact relevance, Affective Concerns*.
phenomenology	the rich structure in the meaning of experience	conceptual analysis	this rich structure accompanies the organization of felt actionability implied by objects in affective phenomena. *To enact relevance*.
reinforcement learning	1. learned behavior based on reward		reward as intrinsic rather than in the

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			environment. *To enact relevance*.
	1a. momentary affect as a function of reward	behavioral paradigms; computational modeling	valence as metric of evaluation of goodness or badness. *Valence*.
	1b. mood as a momentum of reward		mood as trajectory. *Trajectory concerns*.
representation	1. mental content; can be written as **propositional attitudes**		we human organisms can seem as if we have representations, but this framework does not make a strong claim on representationalism. See **intentionality: intentional stance**.
	1a. mental content can be unjustified (**misrepresentation**)	conceptual analysis	if meaning is captured by actionability, then unjustified meaning is associated with maladaptivity. *To entertain abstraction*.
	2. providing sufficient coverage of the interests of members within a group; in this case, of the affective field; see **pragmatic** in **Table 1**		the *Human Affectome* provides a sampling of Western perspectives, but lacks in coverage of Eastern or non-analytic approaches. *Conclusions*.
situated	the mind is shaped by environment in the interactions that are possible; see **embedded**; can be applied to affective phenomena (**situated affectivity**) (Griffiths and Scarantino, 2005; Colombetti, 2017; Piredda, 2020)	conceptual analysis	the human organism's capacities are shaped by possible interactions with the environment. *To enact relevance*.
unconscious emotions	1. the behavior of organisms whose mental state we cannot access	behavioral paradigms; physiological measures, neuroimaging; computational modeling	the systematicity in feeling can be inferred to explain behavior, assuming that system is rational. See **intentionality**. *To enact relevance*.
	2. conscious feelings that the organism is not aware	conceptual analysis	emotions, as affective experiences, are feelings that are minimally felt,

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	of on a higher-order, reflective level	but do not require reflection or reporting to be felt. *To enact relevance.*

Table 4. Situating Existing Theoretical Constructs within the Human Affectome

This table summarizes meaning—and senses of meaning—of existing theoretical constructs of affective phenomena, situating them within the algorithmic organization of the Human Affectome. Within the entries below, references to relevant theoretical accounts are **bolded**; references to other theoretical constructs within this table are ***bolded and italicized***; and references to the Human Affectome are *italicized*.

Theoretical Construct	Sense	Situated Within Human Affectome
affect	1. all affective phenomena	*affectome*: all of the specified constituents of an organism's system of algorithms for affective phenomena, considered collectively or in total. *The Human Affectome.*
	2. aspects that characterize affective phenomena	affective features: the dimensional metrics of the organism's own performance in predictive adaptation, integral to all affective concerns, and reflected in qualitative aspects of affective experience. See ***valence*** and ***arousal***. *Affective Features.*
	3. valence and arousal (**core affect;** Russell, 2003; Russell et al., 1989; Posner et al., 2005; Kuppens et al., 2013); sometimes also dominance (Mehrabian and Russell, 1974; Bakker et al., 2014)	see ***valence*** and ***arousal***. *Affective Features.* Dominance can be seen as the manner in which the human organism is poised to act upon the world; see **appraisal** in **Table 3**; *Affective Concerns*. It can also be seen as the sense of agency the agent has or sense of control over intended outcomes or ***goal.*** *Conclusions.*
affordance	actionability features of objects in the environment	*to execute operations, Affective Concerns.*
allostasis	predictive process to maintain stability despite change	dynamic regulation and navigation within a complex and changing environment in order to anticipate the approach of a fatal state before it approaches, i.e., to safeguard homeostasis. See ***homeostasis***. *To execute operations.*
allostatic load	chronic burden on allostasis	the repeated surpassing of an organism's adaptive capabilities in anticipating its own needs due to a persistently difficult environment, usually consisting of persistent acute stress, resulting in chronic stress

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		(i.e., bearing allostatic load). See ***allostasis***. *To execute operations*.
algorithm	description of process	sequences of steps executed for the sake of a goal. *The Human Affectome*.
arousal	an aspect of affective experience	the metric of excitation, activation, or energy mobilization within different systems indicating the urgency to act; reflected in the aspect of intensity of an affective experience; measured as magnitude from low to high for each kind of arousal based on the system of interest or as a whole (e.g., wakefulness, emotional arousal, sexual arousal, physical activity, attention, etc.). *Affective Feature: Arousal*.
attractor states	configurations that a complex system is attracted to (see **connectionism** and **dynamical systems** in **Table 3**)	*to ensure viability* and in *executing operations*, a complex organism will hover around states of relative stability.
comfort zone	set of states	range of comfortable states which an organism seeks to sustain. See ***allostasis***. *To execute operations*.
consciousness	1. qualitative state	see ***feeling***. *To enact relevance*.
	2. phenomenology	see ***feeling: phenomenology.*** *To enact relevance*.
	3. higher-order, reflective experience	see ***metacognition***. *To entertain abstraction*.
emotion	a type of affective experience	affective experiences grounded in algorithms that reflect *operational concerns*, implications of an object's actionability in terms of sophisticated sequences of actions.
episodes	duration of time	affective experiences are episodes of experience. *To enact relevance*.
expression	articulation of affective phenomenon through implicit or explicit means	human organisms express affective phenomena to communicate with others as part of their adaptive operations. *To entertain abstraction*.
feeling	1. affective experiences	first-person, conscious mental states with qualitative character that is experienced which reflect affective algorithms. *To enact relevance*.
	2. aspect of experience (felt)	raw qualitative aspect that marks all experience. See ***qualia***. *To enact relevance*.
	3. experience	having a what it's like and rich structure. See ***qualia*** and ***phenomenology***. *To enact relevance*.
	4. metacognitive awareness	higher-order, reflective conscious awareness of being in an affective state; can sometimes be

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		verbalized in subjective report. See ***subjective report***. *To entertain abstraction, Conclusions*.
goal	1. final state that explains development (Aristotle, 1999)	as a dynamic, complex system, the human organism is not seeking, whether implicitly or explicitly, a final state. It can be considered a self-producing and self-distinguishing act. See **enactive: autopoiesis** in **Table 3**. *To ensure viability*.
	2. purpose that explains certain capacities or characteristics (Mayr, 1974; Cartwright, 1986; Schlosser, 1998; McLaughlin, 2000; Ward et al., 2017)	a *Teleological Principle*, an assumption about what purpose explains capacities and characteristics associated with affective phenomena, can ground other assumptions in the field. See **teleology** in **Table 1** and **goal-directed** in **Table 3**.
	3. hypothetical end result that explains explicit deliberation, decision, and planning	human organisms can explicitly aim for goals as individual agents or among a group in a collaborative context. See ***metacognition*** and ***theory of mind***. *To entertain abstraction*.
interoception	the afferent signaling, central neural, and perceptual representation of the internal (physiological) state of the body	interoception is among the internal processes in organism's adaptivity. *To enact relevance*.
language	designating and using symbols to communicate abstract meaning	human organisms can associate labels with abstracted operations. *To entertain abstraction, Conclusions*.
mental action	actions can be taken internally without interaction with the outside world	the organism uses mental actions to orchestrate operations. *To execute operations*.
metacognition	1. reflective consciousness	higher-order processing of oneself that is necessary for organisms to be able to subjectively report on their feelings but is not necessary for feeling itself. See ***subjective report***. *To entertain abstraction, Conclusions*.
	2. reported confidence	a measurement of subjective report about how confident a participant is about their responses, which is used as a parameter of precision in understanding that participant's algorithms. See ***metacognition: 3***. *Conclusions*.
	3. parameter of precision	a parameter used in algorithm which reflects an evaluation of weighting of a lower-level parameter, e.g., sensation, valence. See ***sensation*** and ***valence***. *To entertain abstraction, Valence, Conclusions*.
mood	a type of affective experience	an affective experience reflecting the direction or momentum of positive or negative outcomes in the environment. *Trajectory concerns*.

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motivation	an aspect of being actionably oriented toward the world	the entire *Human Affectome* is motivational. Not among *Affective Features*.
qualia	quality, or 'what it's like', of conscious experience	affective experiences have qualities that mark them—*Affective Features*. *To enact relevance*.
reward	inherent relevance of an object, learned with experience	see **reinforcement learning** in **Table 3**.
self	1. perspective from which conscious experience is organized	all affective phenomena are organized from the perspective of a self. *To enact relevance*.
	2. metacognitive reflection of self as an object	human organism can reflect abstractly upon itself. See ***metacognition: 1***. To *entertain abstraction*.
sensation	a type of affective experience	an affective experience grounded in algorithms reflecting *physiological concerns*.
stress	a type of affective experience	acute or chronic state of intense affective experience which can lead to **allostatic load** if persistent. *To execute operations*.
subjective report (*self-report*)	behavioral operationalization	verbalized account of one's feelings, which requires reflective, higher-order metacognition; an empirical measurement used to gain insight into the systematicity of feeling, but not required for feeling itself. See ***metacognition***. *Conclusions*.
theory of mind	the capacity to infer the mental state of others	human organisms can project their adaptive perspective to others in order to cooperate or to abstract about non-agentive objects. See **intentionality: intentional stance** in **Table 3**. *To entertain abstraction*.
umwelten	the way the world appears to an organism based on its adaptive capacities	the world appears to the human organism in a manner based on their adaptive capacities. *To enact relevance*.
valence	an aspect of affective experience	the metric of how good or bad something is evaluated with relation to affective concerns indicating how suited the human organism is; reflected in the aspect of pleasure or displeasure of an affective experience; measured as low to high positive or negative fit. *Affective Feature: Valence*.
wellbeing	1. life satisfaction	an affective experience reflecting the optimal match between the organism's adaptive capabilities and the environment's demands. *Optimization concerns*.
	2. mood	see ***mood***. *Trajectory concerns*.
	3. momentary affective state	see ***valence***. *Valence, Optimization*.

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Highlights

- The affective sciences have grown disparate due to differing assumptions.
- A teleological principle for human affective phenomena can organize the field's assumptions.
- Some affective phenomena adapt based on the comfort zone (*affective concerns*).
- Others monitor that adaptive process (*affective features*).
- This Human Affectome framework organizes existing research and provides a research agenda.

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