**Title:** A formalization of one of the main claims of “‘Dunbar's number’ deconstructed” by Lindenfors et al. 2021

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**Abstract:**

Lindenfors et al. claimed in previous work that the cortex size of humans does not relate to their social group size. We present here a formalization of that claim, stating that all things of class “relative neocortex size” that are in the context of a thing of class “social group” never have a relation of type “affects” to a thing of class “social group size” in the same context.

1. **Introduction**

Lindenfors et al. [1] state that “A cognitive limit on human group size cannot be derived in this manner.”. We present here a formalization of the main scientific claim from this quote by using a semantic template called the super-pattern [2].

1. **Formalization**

Our formalization looks as follows:

| CONTEXT-CLASS (“in the context of all ..."): | [social group](https://www.wikidata.org/wiki/Q874405) |
| --- | --- |
| SUBJECT-CLASS (“things of type ..."): | [relative neocortex size](http://purl.org/np/RAhnnsMWVM8M29NixCJfVDLWzRzwwCPnUD7LI2kxT-FME#relative-neocortex-size) |
| QUALIFIER: | [never](https://w3id.org/linkflows/superpattern/terms/neverQualifier) |
| RELATION-TYPE (“have a relation of type...”): | [affects](https://w3id.org/linkflows/superpattern/terms/affects) |
| OBJECT-CLASS (“to things of type...”): | [social group size](http://purl.org/np/RAlKYv_sE8qwiSqsRdcr7KrkU1bsqlqiFmhDPtPBwpLrM#social-group-size) |

In the context class, we use “social group” (Q874405) from Wikidata. In the subject class, we use a new minted class “relative neocortex size” that is related to the class “size”(Q1152227) and “neocortex” (Q726562) from Wikidata. In the object class, we minted a new class “social group size” that is a subclass of “social group” (Q874405) from Wikidata.

1. **RDF Code**

This is our formalization as a nanopublication in TriG format:

@prefix this: <http://purl.org/np/RAbWbJCYlLhlYBDn9PVxdJP\_WUbbi058aRcK-3sOJsRwY> .

@prefix sub: <http://purl.org/np/RAbWbJCYlLhlYBDn9PVxdJP\_WUbbi058aRcK-3sOJsRwY#> .

@prefix np: <http://www.nanopub.org/nschema#> .

@prefix dct: <http://purl.org/dc/terms/> .

@prefix nt: <https://w3id.org/np/o/ntemplate/> .

@prefix npx: <http://purl.org/nanopub/x/> .

@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

@prefix orcid: <https://orcid.org/> .

@prefix prov: <http://www.w3.org/ns/prov#> .

@prefix sp: <https://w3id.org/linkflows/superpattern/terms/> .

sub:Head {

this: np:hasAssertion sub:assertion ;

np:hasProvenance sub:provenance ;

np:hasPublicationInfo sub:pubinfo ;

a np:Nanopublication .

}

sub:assertion {

sub:spi a sp:SuperPatternInstance ;

rdfs:label "The cortex size of humans does not relate to their social group size" ;

sp:hasContextClass <http://www.wikidata.org/entity/Q874405> ;

sp:hasSubjectClass <http://purl.org/np/RAhnnsMWVM8M29NixCJfVDLWzRzwwCPnUD7LI2kxT-FME#relative-neocortex-size> ;

sp:hasQualifier sp:neverQualifier ;

sp:hasRelation sp:affects ;

sp:hasObjectClass <http://purl.org/np/RAlKYv\_sE8qwiSqsRdcr7KrkU1bsqlqiFmhDPtPBwpLrM#social-group-size> .

}

sub:provenance {

sub:activity a sp:FormalizationActivity ;

prov:used sub:quote , <https://royalsocietypublishing.org/doi/10.1098/rsbl.2021.0158> ;

prov:wasAssociatedWith orcid:0000-0002-0191-7211 .

sub:assertion prov:wasGeneratedBy sub:activity .

sub:quote prov:value "A cognitive limit on human group size cannot be derived in this manner." ;

prov:wasQuotedFrom <https://royalsocietypublishing.org/doi/10.1098/rsbl.2021.0158> .

}

sub:pubinfo {

sub:sig npx:hasAlgorithm "RSA" ;

npx:hasPublicKey "MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQC3cICbOHZ1ecuLOsgovKwUlFRRvNWNgBJxoXCFAYWtU2OK97i/SjoIaxFphg9tkv9WxOjtPqYJ4cuM0E76wxeRZ7VBMHBrBIyCAGTvAfESWVQZCDgulG46VjffEzXuRmqOka/C5Ur6beLijFPMtiWEg6I2Mbj8z9vuHPxReIu4JwIDAQAB" ;

npx:hasSignature "ZFigeQHif/2IZT/QsVTqDThjV1P0Uy4IkGEmOC8W/Iygn8sGpJt4DOBDLDrT2egAwiesYqFxVqSDQnWCeY2C/yaVIob6j49CYlZor+VZQo1HdsGvEq3V7xiLobl/w4sMPxA690y9DF5zp8w3wggXaJxMjrAESSCpaPxtnKGhxt0=" ;

npx:hasSignatureTarget this: .

this: dct:created "2021-11-17T18:03:20.686+01:00"^^xsd:dateTime ;

dct:creator orcid:0000-0002-0191-7211 ;

npx:introduces sub:spi ;

npx:supersedes <http://purl.org/np/RA7MgxMCcVykE2RBJHm-Ou\_CuuhPXqfcinswtIfjXReOc> ;

<https://w3id.org/linkflows/reviews/isUpdateOf> <http://purl.org/np/RAYJe1ruxzvy8idQGuxziYN4ri8OFeKZxzK-QdJPvDug0> ;

nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RAB\_oy10D3XUP-zYlqGz7Uj58AsUXhEKeGqmRFg5LSgDM> ;

nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RA2vCBXZf-icEcVRGhulJXugTGxpsV5yVr9yqCI1bQh4A> , <http://purl.org/np/RAA2MfqdBCzmz9yVWjKLXNbyfBNcwsMmOqcNUxkk1maIM> , <http://purl.org/np/RAjpBMlw3owYhJUBo3DtsuDlXsNAJ8cnGeWAutDVjuAuI> ;

nt:wasCreatedFromTemplate <http://purl.org/np/RAv68imZrEjfcp2rnEg1hzoBqEVc0cQMtp9\_1Za0BxNM4> .

}

The following nanopublications introduce the newly minted classes in TriG format.

This is the class definition of “relative neocortex size”:

@prefix this: <http://purl.org/np/RAhnnsMWVM8M29NixCJfVDLWzRzwwCPnUD7LI2kxT-FME> .

@prefix sub: <http://purl.org/np/RAhnnsMWVM8M29NixCJfVDLWzRzwwCPnUD7LI2kxT-FME#> .

@prefix np: <http://www.nanopub.org/nschema#> .

@prefix dct: <http://purl.org/dc/terms/> .

@prefix nt: <https://w3id.org/np/o/ntemplate/> .

@prefix npx: <http://purl.org/nanopub/x/> .

@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

@prefix orcid: <https://orcid.org/> .

@prefix prov: <http://www.w3.org/ns/prov#> .

@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

sub:Head {

this: np:hasAssertion sub:assertion ;

np:hasProvenance sub:provenance ;

np:hasPublicationInfo sub:pubinfo ;

a np:Nanopublication .

}

sub:assertion {

sub:relative-neocortex-size a <http://www.w3.org/2002/07/owl#Class> ;

rdfs:label "Relative size of the neocortex" ;

skos:definition "This class signifies the weight or volume of a part of the brain called neocortex." ;

skos:relatedMatch <http://www.wikidata.org/entity/Q322481> , <http://www.wikidata.org/entity/Q726562> .

}

sub:provenance {

sub:assertion prov:wasAttributedTo orcid:0000-0002-0191-7211 .

}

sub:pubinfo {

sub:sig npx:hasAlgorithm "RSA" ;

npx:hasPublicKey "MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQC3cICbOHZ1ecuLOsgovKwUlFRRvNWNgBJxoXCFAYWtU2OK97i/SjoIaxFphg9tkv9WxOjtPqYJ4cuM0E76wxeRZ7VBMHBrBIyCAGTvAfESWVQZCDgulG46VjffEzXuRmqOka/C5Ur6beLijFPMtiWEg6I2Mbj8z9vuHPxReIu4JwIDAQAB" ;

npx:hasSignature "NMWYJ3I459BEnN7NgKELsfNucMayG4MXMMjOrZm0h+g/5Mbu8vbLVhkSi5C9N+SGc67qW6YtdndVxrMS7qpWfzUTv+FzVOgydGqs30VKUC5F0TNBzvTnTNvT9Bq61oQ5cNIxUHef6/Mqte2auchZPLgY8yap3ImLEaNTWwdQpTM=" ;

npx:hasSignatureTarget this: .

this: dct:created "2021-10-19T14:07:44.194+02:00"^^xsd:dateTime ;

dct:creator orcid:0000-0002-0191-7211 ;

npx:introduces sub:relative-neocortex-size ;

npx:supersedes <http://purl.org/np/RAIwMZ0StXU9DCY1WGoJMwD2NAc30mijCb0FML8TXIB0Y> ;

<https://w3id.org/linkflows/reviews/isUpdateOf> <http://purl.org/np/RAIwMZ0StXU9DCY1WGoJMwD2NAc30mijCb0FML8TXIB0Y> ;

nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RANwQa4ICWS5SOjw7gp99nBpXBasapwtZF1fIM3H2gYTM> ;

nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RAA2MfqdBCzmz9yVWjKLXNbyfBNcwsMmOqcNUxkk1maIM> , <http://purl.org/np/RAOGu9Lh0BD4tbIRB9RG6RGRA\_ObDh75NTbIqaWgxxs8M> , <http://purl.org/np/RAjpBMlw3owYhJUBo3DtsuDlXsNAJ8cnGeWAutDVjuAuI> ;

nt:wasCreatedFromTemplate <http://purl.org/np/RAdpgRpigXtt8iPV9uOPf3wIT3qzOI8Sg2Q72CNV8g-Yo> .

}

This is the class definition of “social group size”:

@prefix this: <http://purl.org/np/RAlKYv\_sE8qwiSqsRdcr7KrkU1bsqlqiFmhDPtPBwpLrM> .

@prefix sub: <http://purl.org/np/RAlKYv\_sE8qwiSqsRdcr7KrkU1bsqlqiFmhDPtPBwpLrM#> .

@prefix np: <http://www.nanopub.org/nschema#> .

@prefix dct: <http://purl.org/dc/terms/> .

@prefix nt: <https://w3id.org/np/o/ntemplate/> .

@prefix npx: <http://purl.org/nanopub/x/> .

@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .

@prefix orcid: <https://orcid.org/> .

@prefix prov: <http://www.w3.org/ns/prov#> .

@prefix skos: <http://www.w3.org/2004/02/skos/core#> .

sub:Head {

this: np:hasAssertion sub:assertion ;

np:hasProvenance sub:provenance ;

np:hasPublicationInfo sub:pubinfo ;

a np:Nanopublication .

}

sub:assertion {

sub:social-group-size a <http://www.w3.org/2002/07/owl#Class> ;

rdfs:label "Social group size" ;

rdfs:subClassOf <https://www.wikidata.org/wiki/Q874405> ;

skos:definition "Social group size is the size of a group of humans that a person socially interacts with (on a regular basis)." .

}

sub:provenance {

sub:assertion prov:wasAttributedTo orcid:0000-0002-0191-7211 .

}

sub:pubinfo {

sub:sig npx:hasAlgorithm "RSA" ;

npx:hasPublicKey "MIGfMA0GCSqGSIb3DQEBAQUAA4GNADCBiQKBgQC3cICbOHZ1ecuLOsgovKwUlFRRvNWNgBJxoXCFAYWtU2OK97i/SjoIaxFphg9tkv9WxOjtPqYJ4cuM0E76wxeRZ7VBMHBrBIyCAGTvAfESWVQZCDgulG46VjffEzXuRmqOka/C5Ur6beLijFPMtiWEg6I2Mbj8z9vuHPxReIu4JwIDAQAB" ;

npx:hasSignature "WBZ10x+hSX0zXoXQAGBkM89SWDOnViMI8NoLH8w1GsjOWSjT/pasNugo6CEDZkWb5ZyHsXSSzG7JDCldnhVQkH64Nuok6C3QvV9+EUVMZaDHByMhObzJ3Pld8pYNHWtW1wNve4xkb91Mzq5zYfBw+Y4ufB5Kqi39zH1dr6XRZRo=" ;

npx:hasSignatureTarget this: .

this: dct:created "2021-06-22T09:49:42.152Z"^^xsd:dateTime ;

dct:creator orcid:0000-0002-0191-7211 ;

npx:introduces sub:social-group-size ;

nt:wasCreatedFromProvenanceTemplate <http://purl.org/np/RANwQa4ICWS5SOjw7gp99nBpXBasapwtZF1fIM3H2gYTM> ;

nt:wasCreatedFromPubinfoTemplate <http://purl.org/np/RAA2MfqdBCzmz9yVWjKLXNbyfBNcwsMmOqcNUxkk1maIM> ;

nt:wasCreatedFromTemplate <http://purl.org/np/RAdpgRpigXtt8iPV9uOPf3wIT3qzOI8Sg2Q72CNV8g-Yo> .

}

**References**

[1] Lindenfors, P., Wartel, A. and Lind, J. ‘Dunbar's number’ deconstructed. Biol. Lett.(2021). doi: 10.1098/rsbl.2021.0158.

[2] Bucur, C.I., Kuhn, T., Ceolin, D., Ossenbruggen, J. van. Expressing high-level scientific claims with formal semantics. In: Proceedings of the 11th Knowledge Capture Conference 2021. doi: 10.1145/3460210.3493561.