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PASSIVE VOICE, FIRST PERSON PRONOUNS AND MENTAL PROCESS VERBS IN THE PHYSICAL SCIENCES RESEACH ARTICLE

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Abstract: *Recent studies have suggested that there has been a decrease in passive use, and an increase in the use of first person pronouns in scientific writing. This study looks at six sample texts from the physical sciences. The correlation between low passive use and use of first person pronoun subjects is only partial. The influx of verbs of a mathematical nature in recent decades has led to an increase in verbs of mental process. These lend themselves more easily to the use of first person pronouns. There are now two models available, a progressive model using fewer passives and a number of first person pronoun subjects, and a traditional model using passive forms extensively and avoiding first person pronoun subjects.*

Keywords: *first person pronoun, mathematical verbs, mental process, passive voice, scientific writing.*

INTRODUCTION

Ever since Barber's seminal article (1962), the passive voice has been considered a feature of scientific writing, and a vast literature has accumulated over the years on this question. Barber found that in his sample, 28% of the 1475 non-modal finite verbs in his corpus, and 58% of the 288 modal finite verbs were passive, thus implying an overall passive rate of 33%. This was the sort of rate that was commonly found, including a study of oceanographical texts (Banks, 1994), in which a rate of just over 30% was found. Tarone et al. (1981), in a study of two astrophysics papers, found a lower rate, but pointed out that these results might be specific to the field of astrophysics. Tarone et al. (1998) point out that papers in astrophysics have the rhetorical structure of logical argument, rather than that of experimental report, and that this might be a contributing factor. Use of the passive in the scientific research article has frequently been attributed to the supposed impersonal nature of scientific discourse. Thus, in the mid 1960s, Cooray claimed that the passive voice "helps the writer to maintain an air of scientific impersonality" (Cooray, 1967: 207). More recently, Ding has expressed a similar view, saying that "the passive voice suggests that experiments are not discrete events, which do not depend on any particular individuals" (Ding, 2002: 147), and he links this to the verifiability of scientific experiments: "The passive voice, through de-emphasizing the roles of human agents in experimental accounts and emphasizing things and objects, helps turn a particular discrete event into a verifiable experiment" (Ding, 2002: 150). Hundt et al. claim that "academic style is more impersonal and thus more likely to make extensive use of agentless passives than fiction writing or newspaper language" (Hundt et al., 2016, 32). Others (Rodman, 1981; Halliday, 1988; Banks, 2008a, 2008b; Leong Ping, 2014) have claimed that thematic structure is the basis of the use of the passive. The scientific writer, wishing to highlight the experiment or the object of study, places this in thematic, and therefore initial, position in the clause, where it will typically function as subject. One of the most usual ways of achieving this is to use the passive voice.

Despite the fact that the passive voice has been considered a standard feature of scientific writing over a relatively long period, style manuals and instructions to authors have often argued in favour of using the active voice and avoiding the passive. Bennett studied a wide range of academic style manuals, and discovered that there were "a great many authors that argue categorically in favour of the active voice" (2009: 49). Minton, on the other hand, has recently argued that opposition to the use of the passive is frequently directed at misuse of the form, but that when used appropriately it is perfectly valid.

> The passive voice is an intrinsic part of the English language and used appropriately to maintain the natural flow of writing and presentation of information, it is an essential feature of good writing. Its function is not to conceal or obfuscate, but to maintain stylistic patterns in the presentation of information that have established themselves for very valid reasons in the English language over centuries of usage. (Minton, 2015: 9)

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Since numerous studies reported a passive rate in science research articles of the order of 30%, it seemed until recently that scientific writers took little notice of admonitions by style manuals to avoid the form. However, some researchers, notably Seoane and various collaborators (Seoane & Loureiro-Porto, 2005; Seoane, 2006; Seoane & Williams, 2006) claim to have detected a change leading to a marked decrease in passive use. Seoane and Loureiro-Porto claim that "recent studies have shown that there is a dramatic decrease in the number of passives found in scientific British and American English in the 20th century" (Seoane & Loureiro-Porto, 2005: 107). They find that this change is radical in the mid- to late twentieth century, although more marked in American than in British English. The authors consider the possibility that this is part of a general change to a more colloquial style, but conclude that this is not the case since other markers of colloquialism do not increase. Seoane (2006) again considers this "dramatic decrease in the frequency of the use of the passive voice" (Seoane, 2006: 191) and suggests that there is a "shift from an impersonal and detached style to a more subjective and emotive way of writing" (Seoane, 2006: 199). It should be noted, however, that recent studies by the same authors (Seoane & Hundt, 2018; Hundt et al., 2018) seem to be toning down these claims to some extent.

The inverse of this question is the use of first person pronouns with active verbs, since it would be reasonable to expect that if use of the passive voice decreases, at least part of the slack would be taken up by use of the active voice with a first person pronoun subject: "we did this" rather than "this was done". This question has been considered over a relatively extensive period by Hyland, as author or co-author (Hyland, 2001, 2002, 2010; Hyland & Jiang, 2016, 2017, 2018). In Hyland (2001), he found that self-mention, notably in the form of pronouns, was common in physics, marketing and biology, though not in mechanical engineering. In Hyland (2002), he pointed out the need for students to be able to recognize when the first person pronoun can be used appropriately and effectively. Hyland and Jiang (2016, 2017, 2018) find that use of the first person pronoun has increased in academic writing in general, but perhaps most notably in biology. This change is most marked from 1985 onwards, and is a sign that scientific writers are becoming more willing to increase their presence in the text. Lafuente Millán (2010) also noted increasing use of first person pronouns. He found that this varied by discipline, and suggested that it involved an attempt to balance authorial claims with appropriate modesty. Harwood (2005) noted that the first person pronoun is often used for self-promotional purposes. And Nunn (2008), basing his comments on his experience as a journal editor, says: "... first person uses are potentially legitimate choices available within the transitivity system and the analysis of examples allows me to suggest that expert users often make full use of all available options by code switching." (Nunn, 2008: 226). In Banks (2017), it was suggested that there did indeed appear to be evidence of a decrease in the use of passive voice in the scientific research article, and a corresponding rise in the use of first person pronouns. The hypothesis was put forward that this was due to the increasing use of mathematical modelling, particularly in the physical sciences. This in itself leads to an increased use of verbs of a mathematical nature, which can be considered to be a specific type of mental process. The situation in the biological sciences is, for the moment less clear. The present paper is a first attempt towards testing this hypothesis in the physical sciences. The theoretical background is that of Systemic Functional Linguistics (Halliday, 2014; Banks, 2005a, 2019), but I hope that what follows is sufficiently transparent to be clear to those who are not familiar with this approach.

SAMPLE TEXTS

For the purposes of this pilot study, I have taken a small sample of papers from Proceedings of the Royal Society A, which might be considered a mini-corpus (Banks, 2005b). This periodical covers the mathematical, physical, and engineering sciences, and thus this study is restricted to that area. My sample consists of six randomly chosen articles published in 2018. I simply took the first freely available articles for that year on the Royal Society website. No single authored articles turned up in the sample, but if they had they would have been excluded, since it is reasonable to suppose that single-authored articles follow different linguistic conventions to those that have more than one author (Banks, 2017). Details of the articles in the sample are given in Appendix A. In the text of this paper, individual articles are indentified by the first named author. It is not possible to distinguish between British and American English, as Seoane and Loureiro-Porto (2005) do. The number of co-authors varies between two and six; there is no way of knowing whether the article was drafted by an English-speaker: many of the co-authors have names which are not typically Anglophone, though this does not necessarily mean that they are not English-speakers; nor is there any way of knowing whether correctors or translators were used (though this seems unlikely in the present cases). The only indication is that all of the co-authors, with one exception, give institutional addresses in the UK, so it is not impossible that these texts tend towards a British model.

Because of the small number of texts in this sample, it is in some ways closer to a set of case studies than a genuine corpus study. The analyses presented here have been carried out manually. Recent research has made great use of electronic corpora, analysed using computer tools. I feel, however, that it would be unfortunate if computer analysis came to be used exclusively, to the exclusion of manual analysis: manual analysis still has some advantages that automatic analysis lacks. This is notably the case where it is difficult, if not impossible, to reduce the feature being analysed to a set of forms. While it seems feasible to analyse use of passive voice and first

person pronouns using computer software, I do not feel that this is possible in the case of process types. Hence, manual analysis has been used for the purposes of this study. In addition, I make no claims to being a statistician, and although my results are quantified, they are presented simply as raw data.

PASSIVE VOICE

Table 1 gives the incidence of the passive voice, as a percentage of all finite verbs in the six articles in the sample.

Table 1. Passive voice.

Article	% passives	No of passives	No of verbs
Cooper	27%[1]	146	550
Fairclough	41%	159	387
Gower	11%	53	502
Perona	17%	57	334
Wacks	27%	151	552
Zhao	54%	259	483
Overall	29%	825	2808

The overall passive rate is 29%, which corresponds roughly to the "traditional" rate of about 30%, and does not fit with Seoane's findings. However, there are considerable differences between individual articles. Two correspond roughly to the traditional figure: Cooper and Wacks, with 27% each. Two have considerably more: Fairclough with 41% and Zhao with 53%. And two have considerably less: Perona with 17% and Gower with 11%. These last two seem to be following the model described by Seoane.

FIRST PERSON PRONOUNS

Table 2 shows the incidence of first person pronouns functioning as the subjects of active verbs as a percentage of all finite verbs.

Table 2. First person pronouns.

Article	1st person pronouns	N	No of verbs
Cooper	17%	93	550
Fairclough	-	-	387
Gower	33%	166	502
Perona	12%	39	334
Wacks	*[2]	1	552
Zhao	*	2	483
Overall	11%	301	2808

The overall rate of 11% does not seem particularly high, but, once again there are considerable differences between individual articles. Gower uses first person pronoun subjects extensively, accounting for 33% of the finite verbs. Cooper, with 17%, and Perona with 12%, use them relatively frequently, while Wacks and Zhao use them hardly at all, and there are no examples at all in Fairclough. It is true that this includes a few verbs that are not passivizable, but these are relatively rare; there are only 145 examples in the whole sample, so excluding these would only reduce the overall rate to 10% (and this is partly because of rounding: the reduction is in fact from 10.7% to 10.2%).

[1] Percentages are rounded to the nearest integer.

[2] An asterisk indicates a percentage of less than 0.5%.

Table 3 compares the use of passives with the use of first person pronoun subjects.

Table 3. Passives and 1st person pronouns.

Article	Passives	1st person pronouns
Cooper	27%	17%
Fairclough	41%	-
Gower	11%	33%
Perona	17%	12%
Wacks	27%	*
Zhao	53%	*
Overall	29%	11%

Here it can be seen that there is some degree of correlation between high passive use and low first person pronoun use, and vice versa, but this is not total. The two articles which use passives extensively, Zhao and Fairclough, do not use first person pronouns. Of the two articles which use the passive moderately, Cooper uses first person pronouns relatively frequently, but Wacks does not use them. Of the two articles which use the passive more sparingly, Gower uses first person pronouns fairly extensively, while Perona does so quite moderately, much less than Gower, and even less than Cooper.

On the basis of this, I would like to suggest that, while the present situation is probably in a state of flux, there are two basic models in use, which I shall call the "traditional" and the "progressive" models (though I should like to point out that these terms do not imply any value judgement). The traditional model uses the passive voice extensively and avoids the use of first person pronouns. This would be the case of Zhao and Fairclough. The progressive model uses the passive voice sparingly, and first person pronouns much more readily. This would be the case of Gower. At the same time authors are free to mix features of both models, and the other authors here seem to be doing this to varying extents.

PROCESS TYPE

It is of interest to know whether the use of either passives or first person pronoun subjects is favoured by any particular process type. I use a set of five process types based on those provided for in Systemic Functional Linguistics (Halliday, 2014; Banks, 2005a, 2019). The five types are material, mental, relational, verbal and existential. Material processes are physical actions or events, such as:

(1) The air phase **is not** directly **driven** by the capillary pressure, but **can be set** in motion by the water velocity at the air-water boundary.[3] (Cooper)

Mental processes are events of a cerebral nature, such as:

(2) In this study, the limiting material stress **has** thus far **been assumed** to be the same in tension and compression. (Fairclough)

Relational processes link an entity with one of its characteristics, or with another entity, such as:

(3) However, such a formulation **is** restrictive as it **is not** valid for magnetic media in the electromagnetism context or for scatterers with varying density in acoustics, as identified in [19]. (Gower)

Verbal processes are processes of communication, such as:

(4) For instance, Zheng et al. [27,28] **proposed** multi-stage approaches involving the decomposition of the water network using graph algorithms and then the optimization of the decomposed networks using linear and nonlinear programming and DE. (Zhao]

Existential processes state the existence of an entity, such as:

(5) That is, in the limit where there **are** no cylinders, except one fixed at x_2, the averaged scattering coefficient A^n tends to the scattering coefficient of one lone cylinder, even for $0 < x_2 < \dot{x}$. (Gower)

[3] The relevant parts of examples are printed in **bold**.

Within the systemic approach there is a range of interpretations of process type from a more grammatical point of view to one that is more conceptual (O'Donnell et al., 2008). The approach used here is of the conceptual type (Banks, 2005a, 2016, 2019). Table 4 gives the distribution of process types.

Table 4. Process Types.

Article	Material		Mental		Relational		Verbal		Existential	
	N	%	N	%	N	%	N	%	N	%
Cooper	74	14%	221	40%	203	37%	49	9%	-	-
Fairclough	69	18%	113	29%	174	45%	29	7%	2	1%
Gower	62	12%	193	38%	198	40%	48	10%	1	*
Perona	116	35%	78	23%	118	35%	21	6%	1	*
Wacks	165	30%	97	18%	236	43%	52	9%	2	*
Zhao	105	22%	165	34%	154	32%	51	11%	7	1%
Overall	591	21%	867	31%	1083	39%	250	9%	13	*

Overall, relational process is the commonest process type, accounting for 39% of the finite verbs. It is also the commonest type in four of the six articles, Fairclough, Gower, Perona and Wacks, albeit in the case of Gower only by a single percentage point. The second most frequent type overall is mental process, accounting for 31% of the finite verbs. However, this overall figure masks a more complex situation: mental processes are the commonest type in Cooper and Zhao, second commonest in Fairclough and Gower, and third commonest in Perona and Wacks. Material process is the third commonest type overall, accounting for 21% of the finite verbs. It is also third commonest in four of the six articles, Cooper, Fairclough, Gower and Zhao. It is the second commonest type in Perona and Wacks. Verbal process is the fourth commonest type overall, and in each individual article, with an overall rate of 9%. Examples of existential process are rare.

From the late nineteenth century onwards, the physical sciences, which hitherto had been basically experimental, began introducing mathematical modelling (Banks, 2008a). Obviously, before that date, phenomena had been measured, but articles in the physical sciences were basically descriptive, reporting on experiments. From the late nineteenth century onwards there was a rapid increase in the use of mathematics, reinforced by the introduction of computers in the course of the twentieth century. This development has continued, and today, mathematical modelling is a dominant feature in the physical sciences research article. This means that there is a considerable number of verbs of a mathematical nature, and the question arises as to the process type to which these verbs belong. Since mathematical calculation is essentially a question of cerebral activity, my suggestion is that these processes should be treated as a type of mental process, and that is indeed what I have done so far in this article. That is processes of a mathematical type have been included in the count of mental processes. Perhaps rather more controversially, I extend this to cases where the calculation is aided (or indeed "carried out") by an instrument such as a computer. Using an instrument does not change the essential nature of the process. The essential nature of the process when using a computer to calculate is still cerebral, not for example the pressing of keys on the keyboard. In the same way seeing is a mental perception process even if it is done using a telescope. The fact that mental process is the second most common type, and more common overall than material process, may be due to the influx of verbs of a mathematical nature. It is therefore useful to look at this question in more detail. It has been usual, in Systemic Functional Linguistics to distinguish three types of mental process: cognitive, perception, and affective (Halliday, 2014; Banks, 2005a, 2019). Some would add to this a desiderative type (Thompson, 2004); I would conflate the affective and desiderative types, but this is not pertinent in the present case since there is only one process of this type in the whole sample. The following is an example of cognitive mental process:

(6) We **consider** a macroscale soil domain, Ω. (Cooper)

The following is an example of perception mental process:

(7) We **can see** this same discrepancy in figure 3*b*, where the angular frequency is varied between $1\text{KHz} < \omega < 12\text{MHz}$ while the radius $a_s = 25$ μm is fixed. (Gower)

The following is the only example encoded as affective mental process in the sample:

(8) The modern suspension bridge form, pioneered by James Finlay in the USA, **started to find favour** at the turn of the nineteenth century [1], and is still employed in the world's longest span bridge structures, such as the 1991 m span Akashi Kaikyo Bridge in Japan [2]. (Fairclough)

The mathematical category which I am suggesting would include examples like (9) and (10):

(9) The resilience to uprooting and the prediction entropy **can** also **be calculated** starting from the rooting depth and the expected scouring dynamics. (Perona)

(10) This is an advancement from the work of Daly & Roose [8] as we **have combined** the equations for fluid flow with the equations for exudates diffusion. (Cooper)

It would also include examples like (11) and (12):

(11) After the above initial trials and given the proposed methodology, the optimization of the water network operation **was** then **simulated** from 30 April 2016 to 30 January 2017. (Zhao)

(12) The simulations **have been conducted** using a well-known DNS code SENGA [11-17], where the governing equations of mass, momentum, energy and reaction progress variable **are solved** in non-dimensional form. (Wacks)

It is probable that in contemporary physics all calculations are in fact carried out by computer, but (9) does not make this explicit. In (10), the terminology makes it evident that computers are being used.

The distribution of types of mental process are given in Table 5.

Table 5. Types of mental process.

Article	Cognitive		Perception		Affective		Mathematical	
	N	%	N	%	N	%	N	%
Cooper	72	33%	10	5%	-	-	139	62%
Fairclough	44	39%	2	2%	1	1%	66	58%
Gower	62	32%	9	5%	-	-	121	63%
Perona	33	42%	8	10%	-	-	37	47%
Wacks	57	59%	8	8%	-	-	32	33%
Zhao	50	30%	3	2%	-	-	112	68%
Overall	318	37%	40	5%	1	*	507	59%

Overall, mathematical mental processes are the most frequent type of mental process, accounting for 59% of the sample. Moreover, this is true of five of the six individual papers; only Wacks is different in this respect with cognitive processes being the most frequent, with 59%, followed by mathematical, with 33%. Cognitive processes account for 37% overall; perception processes are rare, never accounting for more than 10%, while affective processes are to all intents and purposes non-existent.

In Table 5 the incidence of processes is expressed as a percentage of all mental processes. However, if the incidence of these types is expressed as a percentage of all finite verbs, an interesting feature emerges. This is shown in Table 6.

Table 6. Mental process types as percentage of finite verbs.

Article	Cognitive	Perception	Affective	Mathematical
Cooper	13%	2%	-	25%
Fairclough	11%	1%	*	17%
Gower	12%	2%	-	24%
Perona	10%	2%	-	11%
Wacks	10%	1%	-	8%
Zhao	10%	1%	-	23%
Overall	11%	1%	*	18%

As can be seen, as a percentage of all finite verbs, the cognitive and perception types are strangely stable over the six articles in the sample. Three of the six have a rate of 10% and all are within the range 10% to 13%, with an overall rate of 11%. The perception type is rare in all cases, with a rate of only 1% or 2%. The rates for the mathematical type are, on the other hand, much more varied. The overall rate is 18%, and even if one discounts the 8% found in Wacks, the only case where mathematical process is not the most frequent mental process type,

the others still range from 11% to 25%. Three cluster in the range 23% to 25% but two are considerably lower, with 17% and 11%. This suggests that there is something peculiar, and perhaps significant, about mathematical mental processes.

PASSIVES AND PROCESS TYPE

I would now like to consider the process types which occur in the passive form. Table 7 gives the distribution of passive forms by process type.

Table 7. Process types of passives.

Article	Material		Mental		Relational		Verbal	
	N	%	N	%	N	%	N	%
Cooper	15	10%	113	77%	7	5%	11	8%
Fairclough	37	23%	92	58%	7	4%	23	14%
Gower	4	8%	44	83%	1	2%	4	8%
Perona	19	33%	27	47%	5	9%	6	11%
Wacks	31	21%	86	57%	3	2%	31	21%
Zhao	65	25%	146	56%	8	3%	40	15%
Overall	171	21%	508	62%	31	4%	115	14%

Overall, 62% of passive verbs are examples of mental process, and mental process is the commonest type for passive verbs for each of the individual articles, but with a relatively wide range of 47% (Perona) to 83% (Gower). In four of the articles (Cooper, Fairclough, Perona, and Zhao), material process is the second commonest type of passive with verbal process in third position. In the other two articles these two types are equally frequent. If we now look at the detailed figures for mental process, we find the results given in Table 8.

Table 8. Mental process and passives.

Article	Cognitive		Perception		Mathematical	
	N	%	N	%	N	%
Cooper	30	27%	8	7%	75	66%
Fairclough	31	34%	1	1%	60	65%
Gower	16	36%	-	-	28	64%
Perona	11	40%	3	11%	13	48%
Wacks	47	55%	8	9%	31	36%
Zhao	47	32%	3	2%	96	66%
Overall	182	36%	23	5%	303	60%

Hence, 60% of the mental process passives are of the mathematical type. And with the exception of Wacks, mathematical is the commonest type of mental process passive in the other five articles. So when passives occur, they are most frequently mental process verbs, and of these the commonest subtype is mathematical, which accounts for 60% of mental process passives.

If these are calculated as percentages of all finite verbs in each category the results given in Table 9 are found.

Table 9. Mental process passives as percentage of finite verbs.

Article	Cognitive	Perception	Mathematical
Cooper	5%	1%	14%
Fairclough	7%	*	11%
Gower	3%	-	6%
Perona	3%	1%	4%
Wacks	9%	1%	6%
Zhao	10%	1%	20%
Overall	6%	1%	11%

Overall, 11% of all finite verbs are passive mathematical mental process types, with a range of 4% to 20%.

FIRST PERSON PRONOUN SUBJECTS AND PROCESS TYPE

We can now look at first person pronoun subjects in a similar way. The distribution of first person pronoun subjects by process type is given in Table 10.

Table 10. Process types and first person pronouns.

Article	Material		Mental		Relational		Verbal	
	N	%	N	%	N	%	N	%
Cooper	-	-	68	73%	7	8%	18	19%
Fairclough	-	-	-	-	-	-	-	-
Gower	4	2%	124	75%	5	3%	33	20%
Perona	-	-	33	85%	1	3%	5	13%
Wacks	-	-	1	100%	-	-	-	-
Zhao	-	-	2	100%	-	-	-	-
Overall	4	1%	228	76%	13	4%	56	19%

As can be seen, first person pronoun subjects hardly ever occur with material process verbs. They occur in only one of these articles (Gower) accounting for 2% of the first person pronoun subjects in that article and only 1% overall. In contrast, 76% of first person pronoun subjects occur with mental process verbs, with a further 19% occurring with verbal processes. Hence 95% of all first person pronoun subjects occur with either mental or verbal processes. It is perhaps interesting to note that at one stage in the development of Systemic Functional Linguistics, what is now known as verbal process was considered a subtype of mental process, and was then called externalized mental process (Berry 1975). If we look at the cases of mental process in detail, the results found in Table 11 emerge.

Table 11. Mental process and first person pronoun subjects.

Article	Cognitive		Perception		Mathematical	
	N	%	N	%	N	%
Cooper	30	44%	-	-	38	56%
Fairclough	-	-	-	-	-	-
Gower	34	27%	4	3%	86	69%
Perona	9	27%	-	-	24	73%
Wacks	-	-	1	100%	-	-
Zhao	1	50%	1	50%	-	-
Overall	74	32%	4	2%	150	66%

Two-thirds of the first person pronoun subjects with mental process verbs occur in the mathematical type, with a range, for the three articles which use first person pronoun subjects, of 56% to 73%. Thus, mathematical mental processes account for 66% percent of the first person pronouns occurring with mental processes, and 5% of all finite verbs.

TOWARDS PROFILES OF TWO MODELS

As suggested above, there seem to be two basic models at work, which I have provisionally labelled “traditional” and “progressive”. This is seen most clearly in the use of first person pronouns; progressive authors use them readily, while traditional authors virtually avoid them altogether. These authors also tend to have a low rate of passive use. Of the six authors in the sample, three seem to be good candidates for classification as progressive authors: Cooper, Gower and Perona. On the basis of the results of this study, it seems possible to set up a set of features which would be characteristic of this type of author. The characteristics are as follows:

1. Rate of first person pronoun use greater than 1%
2. Rate of passive uses less than 20%
3. Rate of material process verbs less than 25%

4. Rate of mental process verbs greater than 30%
5. Rate of mathematical mental process verbs greater than 20%
6. Rate of passives with material process verbs less than 20%
7. Rate of passives with mental process verbs greater than 60%
8. Rate of passives with mathematical mental process verbs less than 10%
9. Rate of mental process verbs with first person pronouns subjects greater than 1%
10. Rate of mathematical mental process verbs with first person pronouns subjects greater than 0

Table 12 shows to which of the three candidates these criteria apply. A tick means that the article exhibits the feature, a cross that it does not. The numbers in the top line refer to the features above.

Table 12. Progressive features and most likely candidates.

Article	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Cooper	✓	x	✓	✓	✓	✓	✓	x	✓	✓
Gower	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Perona	✓	✓	x	x	x	x	x	✓	✓	✓

Of these Gower scores 10 ticks, and Cooper 8. Perona is much more moderate, with a score of 5 ticks. The three other articles, Fairclough, Wacks and Zhao are candidates for the traditional profile; these can be expected not to correspond to the above features. The extent to which this is true is shown in Table 13.

Table 13. Progressive features and least likely candidates.

Article	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
Fairclough	x	x	✓	x	x	x	x	✓	x	x
Wacks	x	x	x	x	x	x	x	✓	x	x
Zhao	x	x	✓	✓	✓	x	x	x	x	x

Here it can be seen that Fairclough and Wacks correspond closely to the traditional pattern, having only one progressive feature each, while Zhao is a little more expansive scoring three ticks. Thus of our six articles, Cooper and Gower can be said to correspond to the progressive pattern, Fairclough and Wacks to the traditional pattern, while Perona and Zhao are to some extent hybrid.

FINAL REMARKS

In this paper I have tried to show that while claims that there has recently been a decrease in the use of passives and an increase in the use of first person pronoun subjects are to some extent justified, the situation is rather more complex than those bald statements would imply. I claim that use of mathematical mental processes is a significant factor in the changes taking place. Of the six sample texts studied, two have a relatively low rate of passive use, two a moderate rate, and two a high rate. Three of the sample texts use first person pronoun subjects, two of them fairly readily, and one extensively. The other three use them hardly at all. The inverse correlation between passive use and use of first person pronoun subjects is only partial. The authors who have a high rate of passives do not use first person pronoun subjects, but otherwise correlation is not total. The second most common process type is mental (following relational), and the most common type of mental process is mathematical. Most passives are mental processes and most of these mental processes are mathematical. Verbs which have a first person pronoun subject are hardly ever material; they are usually mental (and to some extent verbal) and most of these are mathematical.

The increasing use of mathematical modelling in the physical sciences has led to a vast influx of verbs of a mathematical type, which are basically a type of mental process. The result is that mental processes are now more common than material processes. I would contend that mental processes are distinctly human in nature, and that this lends itself more easily to the use of first person pronoun subjects. While my actions can potentially

be repeated by anyone, I am the only person that can have my thoughts, feelings or perceptions. I am suggesting that this fact means that I am much more likely to use a first person pronoun subject with this type of process. A similar point might be made for verbal processes. Thus this can explain the fact that the vast majority (95%) of first person pronouns that occur do so with mental or verbal processes.

A profile of the progressive model can be built up. Progressive texts will usually use first person pronouns, and have a correspondingly low rate of passives; they will have a relatively low rate of material processes and a high rate of mental processes including a high rate of mathematical mental processes; Passive verbs will also have a relatively low rate of material processes and a high rate of mental processes, but not necessarily a high rate of mathematical mental processes; and mental process verbs, including those of the mathematical type, will tend to have first person pronoun subjects. The traditional model will have the inverse of these features.

Therefore, there seems to be at the moment a complex situation in which both the traditional and progressive models are acceptable, with the possibility of hybrids combining features of both. To the extent to which this is true, only the future will show whether this situation perdures, or progresses towards the adoption of one particular model.

It will be noted that this study is based on a very small sample. It should not be confused with a corpus study, and is probably closer to a set of case studies. It is therefore impossible to come to firm conclusions on the basis of the results presented here. At the same time, these results seem perfectly coherent, and can thus furnish a provisional explanation of the current situation, and provide hypotheses for further study.

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APPENDIX A

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